SAVITRIBAI PHULE PUNE UNIVERSITY

(Formerly University of Pune)

M. Sc. Degree Course in MICROBIOLOGY

Choice Based Credit System [CBCS]
2019 Pattern

Syllabus for Second Year

Board of Studies (Microbiology)

Savitribai Phule Pune University [SPPU] Pune-411007

Savitribai Phule Pune University

Syllabus for M. Sc. Microbiology Part II (2019 Pattern)

(Affiliated Colleges)

1. M. Sc. Second year Microbiology syllabus, equivalence with 2013 Pattern and assessment of credits:

1. A) M. Sc. Second year Microbiology Semester III syllabus and equivalence with 2013 Pattern:-

Course Type	2013 Pattern Course Code	2013 Pattern Course Name	2019 Pattern Course Code		2019 Pattern Course Name	2019 Pattern Corrected Course Code
Core Compulsory Theory Papers	MB 701	Immunology	CCTP 7 (MB 701)		Immunology	MBCT 231
	MB 702	Molecular Biology-I	CCTP 8 (MB 702)		Molecular Biology	MBCT 232
	MB703	Industrial Waste Water Treatment	CCTP 9 (MB 703)		Clinical Microbiology	MBCT 233
Core Compulsory Practical paper	MB711	Practical course based on Immunology, Pharmaceutical Microbiology and Environmental Microbiology	MBCP 3		Practicals based on Compulsory Theory Credits.	MBCP 234
	MB712	Practical course based on Molecular Biology (I and II) and Microbial Technology	--		--	--
Choice Based Optional Papers Elective/ Departmental Course **Any one group**	--	--	Group I	MBTE 31	Cell Culture Techniques	MBET 235
	--	--		MBPE 31	Practical based on Cell Culture Techniques	MBEP 235
	OR					
	--	--	Group II	MBTE 32	Bioremediation and Biomass utilization	MBET 236
	--	--		MBPE 32	Practical based on Bioremediation and Biomass utilization	MBEP 236

	OR					
	--	--	Group III	MBTE 33	Microbial Virus Technology	MBET 237
	--	--		MBPE 33	Practical based on Microbial Virus Technology	MBEP 237

1. B) M. Sc. Second year Microbiology syllabus semester III assessment of credits: -

Course Type	Course Code	Course Name	Credit	Assessment		
				IA	UA	Total
Core Compulsory Theory Papers (CCTP)	MBCT 231	Immunology	4	30	70	100
	MBCT 232	Molecular Biology	4	30	70	100
	MBCT 233	Clinical Microbiology	4	30	70	100
Core Compulsory Practical Paper	MBCP 234	Practicals based on Compulsory Theory Credits	4	30	70	100
Choice Based Optional Papers (CBOP) Elective /Departmental Course	MBET 235	Cell Culture Techniques	2	15	35	50
	MBEP 235	Practicals based on Cell Culture Techniques	2	15	35	50
	OR					
	MBET 236	Bioremediation and Biomass utilization	2	15	35	50
	MBEP 236	Practicals based on Bioremediation and Biomass utilization	2	15	35	50
	OR					
	MBET 237	Microbial Virus Technology	2	15	35	50
	MBEP 237	Practicals based on Microbial Virus Technology	2	15	35	50

1. C) M. Sc. Second year Microbiology Semester IV syllabus and equivalence with 2013 Pattern: -

Course Type	2013 Pattern Course Code	2013 Pattern Course Name	2019 Pattern New Course Code		2019 Pattern Course Name	2019 Pattern Corrected Course Code
Core Compulsory Theory Papers	MB801	Pharmaceutical and medical Microbiology	CCTP 10 (MB 801)		Pharmaceutical Microbiology	MBCT 241
	MB802	Molecular Biology II	-		-	-
	MB803	Microbial Technology	CCTP 11 (MB 802)		Microbial Technology	MBCT 242
Core Compulsory Practical paper	MB 811	Dissertation I	MBCP 4		Dissertation	MBCP 243
	MB 812	Dissertation II	--		--	--
Choice Based Optional Papers Elective/ Departmental Course **Any two group**	--	--	Group I	MBTE 41	Quality Assurance and Validation in Pharmaceutical Industry and Development Of Anti Infectives	MBET 244
	--	--		MBPE 41	Practicals based on Quality Assurance And Validation In Pharmaceutical Industry And Development Of Anti infectives	MBEP 244
	OR					
	--	--	Group II	MBTE 42	Advances in Microbial Technology	MBET 245
	--	--		MBPE 42	Practicals based on Advances in Microbial Technology	MBEP 245
	OR					
	--	--	Group III	MBTE 43	Industrial Waste Water Treatment andIndustrial	MBET 246

					Production of Vaccines	
	--	--		MBPE 43	Practicals based on Industrial Waste Water Treatment and Industrial Production of Vaccines	MBEP 246
	OR					
			Group IV	MBTE 44	Bioethics, Biosafety, Quality Control and Quality Assurance	MBET 247
				MBPE 44	Practicals based on Bioethics, Biosafety,Quality Control and Quality Assurance	MBEP 247

1. D) M. Sc. Second year Microbiology Semester IV assessment of credits:-

Course Type	Course Code	Course Name	Credit	Assessment		
				IA	UA	Total
Core Compulsory Theory Papers (CCTP)	MBCT 241	Pharmaceutical Microbiology	4	30	70	100
	MBCT 242	Microbial Technology	4	30	70	100
Core Compulsory Practical Paper	MBCT 243	Dissertation	4	30	70	100
Any Two: Choice Based Optional Papers (CBOP) Elective /Departmental Course	MBET 244	Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti infectives	2	15	35	50
	MBEP 244	Practicals based on Quality Assurance And Validation In Pharmaceutical Industry And Development Of Anti Infectives	2	15	35	50
	OR					

	MBET 245	Advances in Microbial Technology	2	15	35	50
	MBEP 245	Practicals based on Advances in MicrobialTechnology	2	15	35	50
	OR					
	MBET 246	Industrial Waste Water Treatment andIndustrial Production of Vaccines	2	15	35	50
	MBEP 246	Practicals based on Industrial Waste WaterTreatment and Industrial Production of Vaccines	2	15	35	50
	OR					
	MBET 247	Bioethics, Biosafety, Quality Control andQuality Assurance	2	15	35	50
	MBEP 247	Practicals based on Bioethics, Biosafety,Quality Control and Quality Assurance	2	15	35	50

Savitribai Phule Pune University

2019 Pattern

Syllabus M.Sc. II Semester III

MBCT 231- Immunology - Semester III Core Compulsory Theory Paper Total: 4 Credits Workload: -15 hrs /credit (Total Workload :- 4 credits x 15 hrs = 60 hrs in semester)		
Credit	**Credit Title and Contents**	**Lectures**
Credit I	**Cell surface molecules and receptors** i. Definition, general Structure and mechanism (dimerization and rotation), components of signal transduction (extracellular signaling molecule, receptor proteins, intracellular signaling proteins and target proteins) ii. Adhesion molecules in immune activation,structure and function of B Cell Receptor, TCR-CD3 complex, Toll-like receptors, Cytokine receptors, G-protein coupled receptors iii. Signal transduction pathways: IL-2 pathway(JAK/STAT, Ras /MAP Kinase Pathways, TCR-CD3 activation pathway)	15
Credit II	**Regulation of Immune response** i. Negative regulation-Immunological tolerance,Mechanisms of tolerance induction (related experimentation using transgenic animals), T cell mediated suppression of immune response ii. Regulation of immune responses by antigen, iii. Antigen-antibody complexes, Network theoryand its experimental evidence iv. Cytokine mediated cross regulation of THsubsets (TH1-TH2) v. Regulation of complement system – Classicaland alternative pathway vi. Biological Response Modifiers for cancertherapy and autoimmune disorders	15
Credit III	**Experimental Immunology** i. *In vitro* systems –Quantification of cytokines(ELISPOT assay), functional assays for phagocytes and cytokines (cytotoxicity and growth assays) ii. *In vivo* systems – Experimental animals in immunology research (Inbred animal strains,Knockout mice, transgenic animals), Animalmodels for autoimmunity and AIDS	15

Credit IV	**Tumor Immunology** i. Cellular transformations during neoplastic growth, Classification of tumors based on histological, Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease) ii. Escape mechanisms of tumor from host defense, Host immune response to tumor – Effecter mechanisms, Immuno- surveillance theory iii. Diagnosis of tumors – biochemical and immunological tumor markers iv. Approaches in cancer immunotherapy: Immune adjuvant and tumor vaccine therapy	15

Suggested references MBCT 231 Immunology Semester III	
Credit I	**Cell surface molecules and receptors** 1. Austyn J. M. and Wood K. J. (1993). Principles of Molecular and Cellular Immunology.First edition Oxford University Press, New York. 2. Barret J. T. (1983). Text Book of Immunology. Fourth edition. Saint Louis, Mosby,London. 3. Boyd W. C. (1966). Fundamentals of Immunology, Interscience Publishers, New York. 4. Gangal S. and Sontakke S. (2013). Textbook of Basic and Clinical Immunology.University Press, India. 5. Garcia K. C. and Adams E. J. (2005). How the T cell Receptor Sees Antigen-AStructural View. Cell. 122(3): 333–336. 6. Hafler D. A. (2007). Cytokines and interventional immunology, Nature Reviews,Immunology. 7(6): 423-423. 7. Kindt T. J., Osborne B. A. and Goldsby R. A. (2006). Kuby Immunology, Sixth edition, W. H. Freeman & Co. 8. Yoshimura A., Naka T. and Kubo M. (2007). SOCS proteins, cytokine signalling and immune regulation. Nature Reviews, Immunology, 7(6): 454-465.
Credit II	**Regulation of Immune response** 1. Abbas A. K. and Lichtman A. H. (2004). Basic Immunology. Functions and Disorders ofImmune System. Second edition. Elsevier Inc. 2. Carroll M. C. (2004). The complement system in regulation of adaptive immunity. NatureImmunology. 5(10): 981-986. 3. Kindt T. J., Osborne B. A. and Goldsby R. A. (2006). Kuby Immunology. Sixth edition. W. H. Freeman & Co 4. Patwardhan B., Gautam M. and Diwanay S. (2006). Botanical immunomodulators and chemoprotectants in cancer therapy. In Drug Discovery and Development Volume I: Drug Discovery. Ed. Chorghade Mukund S. Wiley- Interscience, John Wiley and SonsInc. USA. 405-424. 5. Roitt I. M. (1984) Essentials of Immunology. P. G. Publishers Pvt. Ltd., New Delhi. 6. Roitt I. M. 1988. Essentials of Immunology. ELBS, London.

	7. Yoshimura A., Naka T. and Kubo M. (2007). SOCS proteins, cytokine signalling and immune regulation. Nature Reviews. Immunology. 7(6): 454-465
Credit III	**Experimental Immunology** 1. Gangal S. and Sontakke S. (2013). Textbook of Basic and Clinical Immunology.University Press, India. 2. House R. V. (1998). Therapeutic Manipulation of Cytokines, Biotechnology and SafetyAssessment. Second edition. Taylor & Francis. 81-105. 3. Kindt T. J., Osborne B. A. and Goldsby R. A. (2006). Kuby Immunology. Sixth edition. H. Freeman and Co. 4. Mather J. P. and Roberts P. E. (1998). Introduction to Cell and Tissue Culture Theoryand Technique. Plenum Publishing Corporation, New York. 5. Roitt I., Brostoff J. and Male D. (1993). Immunology. Sixth edition. Mosby & Co.London. 6. Talwar G. P. (1983). Handbook of Immunology. Vikas Publishing Pvt. Ltd. New Delhi. 7. Paul W. E. (2003). Fundamental Immunology. 5th Ed. Lippincott. Williams and Wilkins Publishers.
Credit IV	**Tumor Immunology** 1. Bendelac A., Savage P. B. and Teyton L. (2007). The Biology of NKT Cells. Annu. Rev.Immunol. 25: 297–336. 2. Chatterjee C. C. (1992). Human Physiology Tenth edition Vol. 1 and 2. Medical AlliedAgency, Calcutta. 3. Diwanay S., Gautam M. and Patwardhan B. (2004). Cytoprotection and Imunomodulation in Cancer Therapy. Current Medicinal Chemistry - Anti-Cancer Agents. 4(6): 479-490. 4. Guyton A. C. and Hall J. E. (1996). Text Book of Medical Physiology. Goel Book Agency, Bangalore. 5. Leen A. M., Rooney C. M. and Foster A. E. (2007). Improving T cell therapy forcancer. Annu Rev. Immunol. 25 (1): 243–265. 6. Malati T. (2007). Tumor Markers: An Overview, Indian Journal of Clinical Biochemistry.22(2): 17-31. 7. Patwardhan B. Gautam M. and Diwanay S. (2006). Botanical Immunomodulators and Chemoprotectants in Cancer Therapy. In Drug discovery and development Volume I: Drug Discovery. Ed. Chorghade Mukund S. Wiley- Interscience, John Wiley and SonsInc. USA. 405-424. 8. Stuhler G. and Walden P. 2002. Cancer Immune Therapy - Current and Future Strategies.Wiley-VCH.

MBCT -232-Molecular Biology : Semester III

Core Compulsory Theory Paper

Total: 4 Credits **Workload: -15 hrs /credit**

(Total Workload :- 4 credits x 15 hrs = 60 hrs. in semester)

Credit	Description	Lectures
Credit I	**1. Genomics** a) Gene sequencing, conserved genes, finding base sequences which form genes b) Many proteins from one gene, alternative gene expression: DNA imprinting and Epigenetics. c) Genomic variation -SNPs, SNPS and diseases, SNPS detection and medical therapies. Eukaryotic andprokaryotic SNPs d) Role of genomic variation in aging, Recognition of trades offs associated with genomic variation.	15
Credit II	**2. Genetically modified plants andanimals** a) Genetically modified organisms-social and ethical issues b) Gene augmentation and genetherapy c) Applications in medicine – prevention, early detection and cure of diseases d) Applications of transgenic plants and animals - advantages and disadvantages	15
Credit III	**3. Mobile DNA elements** a) Transposable elements in bacteria, IS elements, composite transposons,Integrons. b) Replicative, nonreplicative transposons, and Mu transposition c) Controlling elements in Tn A, Tn 5and Tn 10 transposition d) Transposons in maize and Drosophila e) Retroviruses and retrotransposon, Ty elements in yeasts SINES, LINES and Alu elements	15
Credit IV	**4. Proteomics** a) Basic concept of proteomics Expression, analysis and characterization of Protein. b) Analysis of protein structure c) Protein interaction. d) Basic concept of Metabolomics with examples and global biochemical networks	15

Suggested References MBCT 232 Molecular Biology : Semester III	
Credit I	**Genomics** 1. Alwi Z. B. (2005). The Use of SNPs in Pharmacogenomics Studies. *Malays J Med Sci.* 12(2):4-12. 2. Brown TA. (2002). Genomes. 2nd edition. Oxford: Wiley-Liss; Chapter 7, Understanding a Genome Sequence. Available from: https://www.ncbi.nlm.nih.gov/books/NBK21136/ 3. Butler J. M. (2012). Single Nucleotide Polymorphisms and Applications In: Advanced Topics in Forensic DNA Typing: Methodology. Academic Press: United States.347-369 4. Isenbarger T.A., Carr C.E., Johnson S.S., et al. (2008). The most conserved genome segments for life detection on Earth and other planets. Orig Life Evol Biosph. 38(6): 517-533. 5. Kaeberlein M. (2013). Longevity and aging. F1000Prime Rep. 5: 5. 6. Lemaître J. F., Berger V., Bonenfant C., Douhard M., Gamelon M., Plard F. and Gaillard J.M. (2015). Early-late life trade-offs and the evolution of ageing in the wild. *Proc Biol Sci.* 7; 282(1806): 20150209. 7. Morris B. J., Willcox B. J and Donlon T.A. (2019). Genetic and epigenetic regulation of human aging and longevity. Biochim Biophys Acta Mol Basis Dis. 1; 1865(7): 1718-1744. 8. Primrose S. B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics, 7th Edition. S. B. Primrose & R. M. Twyman. Blackwell Publishing: U.S. 626 pp. 9. Ramírez-Bello J. and Jiménez-Morales M. (2017). Functional implications of single nucleotide polymorphisms (SNPs) in protein-coding and non-coding RNA genes in multifactorial diseases. Gac Med Mex. 153(2): 238-250. 10. Shaw V., Bullock K. And Greenhalf W. (2016). Single-Nucleotide Polymorphism to AssociateCancer Risk. Methods Mol Biol. 1381: 93-110. 11. Stojanovic N., Florea L., Riemer C., Gumucio D., Slightom J., Goodman M., Miller W., and Hardison R. (1999). Comparison of five methods for finding conserved sequences in multiple alignments of gene regulatory regions, Nucleic Acids Research, 27 (19)1: 3899–3910. 12. Watson J. D., Baker T. A., Gann A., Bell S. P., Levine M. and Losick R .(2014). MolecularBiology of the Gene. 7th Edition. Pearson-USA 13. Yashin A. I., Ukraintseva S. V., Akushevich I. V., Arbeev K. G., Kulminski A. and Akushevich L. (2009). Trade-off between cancer and aging: what role do other diseases play? Evidence from experimental and human population studies. Mech Ageing Dev. 130(1-2): 98-104
Credit II	**Genetically modified plants andanimals** 1. Agnès E. Ricroch, Michèle Guillaume-Hofnung and Marcel Kuntz (2018). The ethical concernsabout transgenic crops. *Biochem J* 475 (4): 803–811. 2. Cotrim A.P. and Baum B. J. (2008). Gene therapy: some history, applications, problems, andprospects. Toxicol Pathol. 36(1): 97-103. 3. Gene Therapy Tools and Potential Applications- Francisco Martin Molina

(2013). Janeza Trdine 9, 51000 Rijeka, Croatia (online book)

4. Glick B. R. and Pasternak J. J. (1998). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington D C, ASM Press. http://library.um.edu.mo/ebooks/b28045804.pdf
5. Maghari B. M. and Ardekani A.M. (2011). Genetically modified foods and social concerns.Avicenna J Med Biotechnol. 3(3): 109-17.
6. Ormandy E.H., Dale J. and Griffin G. (2011). Genetic engineering of animals: ethical issues, including welfare concerns. Can Vet J. 52(5): 544-550.
7. Weaver R. (2007). Molecular Biology. 4th Edition. Mc-Grew Hill Publication
8. Worgall S. and R. G. (2014). Gene Therapy In: Principles of Tissue Engineering (Fourth Edition). Academic Press: United States. Chapter 34. 657-686.

Credit III

Mobile DNA elements

1. Carnell A. M. and Goodman J.I. (2003). The Long (LINEs) and the Short (SINEs) of It:Altered Methylation as a Precursor to Toxicity. Toxicological Sciences. 75(2): 229–235
2. Griffiths A. J. F., Gelbart W. M., Miller J. H., et al. (1999). Modern Genetic Analysis. New York: W. H. Freeman; Ty Elements in Yeast. Available from:https://www.ncbi.nlm.nih.gov/books/NBK21285/
3. Kaminker J.S., Bergman C.M., Kronmiller B. *et al.* (2002). The transposable elements ofthe *Drosophila melanogaster* euchromatin: a genomics perspective. *Genome Biol* **3,** research0084.1 (2002).
4. Konkel M. K., Walker J. A. and Batzer M. A. (2010). LINEs and SINEs of primate evolution.Evol Anthropol. 1; 19(6): 236-249.
5. Kramerov D. A. and Vassetzky N. S. (2011). Origin and evolution of SINEs in eukaryoticgenomes. Heredity (Edinb). 107(6): 487-95.
6. Krastanova O, Hadzhitodorov M. and Pesheva M. (2005). Ty Elements of the Yeast *Saccharomyces Cerevisiae*, Biotechnology & Biotechnological Equipment, 19(2): 19-26
7. Lewin B. (2011). Genes X. Jones and Bartlett Publication.
8. Lodish H. F. (2003). Molecular Cell Biology 5Th Edition. New York: W H and Freeman Company.
9. Reddy, A.R., Peterson, P.A. Transposable elements of maize. *Molec Gen Genet* 192: 21–31
10. Watson J. D., Baker T. A., Gann A., Bell S. P., Levine M. and Losick R. (2014). Molecular Biology of the Gene. 7th Edition.Pearson-USA
11. Weiner A. M. (2002). SINEs and LINEs: The art of biting the hand that feeds you. Current Opinion in Cell Biology. 14(3): 343-350

Credit IV

Proteomics

1. Baidoo E. E. K. (2019). Microbial Metabolomics: A General Overview. Methods Mol Biol.1859: 1-8.
2. Banaei-Esfahani A, Nicod C, Aebersold R, Collins BC. (2017). Systems proteomics approaches to study bacterial pathogens: application to Mycobacterium tuberculosis. Curr Opin Microbiol. 39:64-72.
3. Chen B, Zhang D, Wang X, Ma W, Deng S, Zhang P, Zhu H, Xu N,

Liang S. (2017). Proteomics progresses in microbial physiology and clinical antimicrobial therapy. Eur J Clin Microbiol Infect Dis. 36(3): 403-413.

4. Chen F, Ma R, Chen XL. (2019). Advances of Metabolomics in Fungal Pathogen-PlantInteractions. Metabolites. 15; 9(8): 169.
5. Ekman R., Silberring J., Brinkmalm A. W. and Kraj A. (2009). Mass Spectrometry: Instrumentation, interpretation and applications, John Wiley and Sons. Inc., Canada.
6. Graves P.R. and Haystead T. A. (2002). Molecular biologist's guide to proteomics. MicrobiolMol Biol Rev. 66(1):3 9-63.
7. Kellner R. (2000). Proteomics: Concepts and perspectives. Fresenius J Anal Chem. 366(6-7): 517-524.
8. Figeys D. (Editor). (2005). Industrial Proteomics: Applications For Biotechnology and Pharmaceuticals. Preface. Methods Biochem Anal. 45: vii-viii. PMID: 19235289. https://analyticalscience.wiley.com/do/10.1002/sepspec.10201education/full/
9. Luger K. and Phillips S.E. (2010). Protein-Nucleic acid interactions. Curr Opin Struct Biol. 20(1): 70-72.
10. Nölting B. (2006). Methods in Modern Biophysics. Second Edition, Springer: Germany.
11. Patwaradhan B . and Chaguture R . (2005). An overview of the basics of proteomics. In: Innovative approaches in drug discovery, Academic Press: United States.
12. Ramanathan M., Porter D.F. and Khavari P.A. (2019). Methods to study RNA-proteininteractions. Nat Methods. 16(3): 225-234.
13. Tang J. (2011). Microbial metabolomics. Curr Genomics. 12(6): 391-403.
14. Villas-Bôas S. (2012). Katya Ruggiero Microbial Metabolomics CABI.
15. Webster D. (2000). Protein Structure, Prediction methods and Protocols. Methods in Molecular Biology Vol 143 Humana Press.
16. Wilson K. And Walker J. (2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th Edn., Cambridge University Press, New York.
17. Zhao J., Wang G., Chu J. and Zhuang Y. (2019). Harnessing microbial metabolomics for industrial applications. World J Microbiol Biotechnol. 36(1): 1-8.

MBCT 233 - Clinical Microbiology : Semester III

Core Compulsory Theory Paper

Total: 4 Credits **Workload: -15 hrs. /credit**

(Total Workload: - 4 credits x 15 hrs. = 60 hrs. in semester)

Credit	Credit Title and Content	Lectures
Credit I	**A. Determinants of Microbial Pathogenicity** i. Adhesion ii. Invasion iii. Evasion iv. Toxigenesis (mode of action –In vivo and Invitro assay systems for diphtheria, cholera, tetanus toxoid and endotoxins of Gram negative bacteria) v. Bacterial resistance to host defenses- Phagocytosis, specific and nonspecifichumoral factors) vi. Molecular basis of bacterial pathogenicity – Cytoskeletal modulation of host cell. Virulence genes and pathogenicity islands. **B. Disease Prediction Epidemiological Models:** i. Introduction to epidemiological modeling for infectious disease dynamics ii. Types of Models: a. Susceptible infectious recovered (SIR) b. Susceptible exposed infectious recovered(SEIR) iii A case study: Disease Prediction Epidemiological Models COVID 19	15
Credit II	Bacterial diseases with respect to causative agents, general characters, detection methods, therapeutic agents and prophylaxis. Handling and disposing ofinfectious material i. *Helicobacter pylori* ii. *Campylobacter jejuni* iii. *Mycobactertium tuberculosis* iv. *Acinetobacter boumanii* v. *Actinomycetes bovis/israelli*	15
Credit III	Viral diseases with respect to causative agents, general characters, detection method, therapeutic agents and prophylaxis. Handling and disposing of infectious material. i. Hepatitis B ii. H1N1 iii. HIV iv. Oncoviruses v. Ebola Virus	154

Credit IV	Fungal and protozoal diseases with respect to causative agents, general characters, detection methods, therapeutic agents and prophylaxis. Handling and disposing of infectious material i. *Candida albicans* ii. *Trichophyton metagrophytes* iii. *Aspergillus flavus* iv. *Entamoeba histolytica* v. *Ascaris lumbricoides* vi. *Giardia lamblia*	15

Suggested References MB CT 233 Clinical Microbiology Semester III

Core Compulsory Theory Paper

Credit	References
Credit I	**A. Determinants of Microbial Pathogenicity** 1. Gal-Mor B. and Finlay B. B. (2006). Pathogenicity islands: a molecular toolbox forbacterial virulence. Cellular Microbiology. 8 (11): 1707-1719. 2. Iglewski B. H. (1990). Molecular Basis of Bacterial Pathogenesis, first edition, AcademicPress: United States. 3. Kudva I. T., Cornick N. A., Plummer P. J., Zhang Q., T. L., Bannantine J.P. and Bellaire B. H. (2016). Virulence Mechanisms of Bacterial Pathogens. Fifth Edition, ASM:Washington. 4. Peterson J. W. (1996). Bacterial Pathogenesis In: Medical Microbiology. 4th Edition. Editor by Samuel Baron, Galveston, Texas, Link to the book: https://www.ncbi.nlm.nih.gov/books/NBK8526/ 5. Rosenberg E. (2005). The diversity of bacterial pathogenicity mechanisms. GenomeBiol. doi: 10.1186/gb-2005-6-5-320 6. Schmidt H. and Hensel M. (2004) Pathogenicity islands in bacterial pathogenesis. ClinMicrobiol Rev. 17(1): 14-56. **B. Disease Prediction Epidemiological Models:** 1. Hethcote H. W. (1989). The basic epidemiology models: models, expressions for r0, parameter estimation, and applications mathematical understanding of infectious diseasedynamics. © World Scientific Publishing Co. Pte. Ltd. 1-61 2. Li L., Yang Z., Dang Z., Meng C., Huang J., Meng H., Wang D., Chen G., Zhang J., Peng H. and Shao Y. (2020). Propagation analysis and prediction of the COVID-19. Infect Dis Model, 5: 282-292 3. Siettos C.I. and Russo L. (2013). Mathematical modeling of infectious disease dynamics.Virulence. 4(4): 295-306. 4. Wearing H. J., Rohani P.and Keeling M. J. (2005). Appropriate models for the management of infectious diseases. PLoS Med 2(7): e174 5. Yang Z., Zeng Z., Wang K., Wong S., *et al*., (2020). Modified SEIR and AI prediction ofthe epidemics trend of COVID-19 in China under public health interventions. Journal ofThoracic Disease. 12(3): 165-174

Credit II	1. Asif M., Alvi I.A. and Rehman S.U. (2018). Insight into *Acinetobacter baumannii*: pathogenesis, global resistance, mechanisms of resistance, treatment options, and alternative modalities. Infect Drug Resist. 11:.1249-1260. https://www.intechopen.com/books/mycobacterium-research-and-development/virulence-factors-and-pathogenicity-of-mycobacterium. 2. Delogu G., Sali M. and Fadda G. (2013). The biology of *Mycobacterium tuberculosis* infection. Mediterr J Hematol Infect Dis. 16; 5(1): e2013070. 3. Echeverria-Valencia G., Flores-Villalva S.and Espitia C.I. (2017). Virulence Factors and Pathogenicity of *Mycobacterium*. Chapter 12. Mycobacterium - Research and Development.Editor-Wellman Ribón, IntechOpen. 4. Idowu A., Mzukwa, A., Harrison, U., Palamides P., Haas R., Mbao M., Mamdoo R., Bolon J., Jolaiya T., Smith S., Ally R., Clarke A. and Njom H. (2019). Detection of *Helicobacter pylori* and its virulence genes (*cag*A, *dup*A and *vac*A) among patients with gastroduodenal diseases in Chris Hani Baragwanath Academic Hospital, South Africa. *BMC Gastroenterol*.19:.73. 5. Jianjun S., Champion P. A. and Bigi F. (2019). Cellular and Molecular Mechanisms of *Mycobacterium tuberculosis* Virulence. Frontiers in Cellular and Infection Microbiology.9:.331. 6. Joly-Guillou ML. (2005). Clinical impact and pathogenicity of Acinetobacter. ClinMicrobiol Infect. 11(11):.868-873. 7. Kao C. Y., Sheu B. S. and Wu J. J. (2006). *Helicobacter pylori* infection: An overview ofbacterial virulence factors and pathogenesis. Biomedical Journal. 39(1): 14-23 8. Kusters J. G., van Vliet A. H. and Kuipers E. J. (2006). Pathogenesis of *Helicobacter pylori* infection. Clin Microbiol Rev. 19(3):.449-490. 9. Lee C. R., Lee J. H, Park M., Park K. S., Bae I. K., Kim Y. B., Cha C. J., Jeong B. C.and Lee S. H. (2017). Biology of *Acinetobacter baumannii*: Pathogenesis, Antibiotic Resistance Mechanisms, and Prospective Treatment Options. Front Cell Infect Microbiol. 13: 7:55. 10. Levin R. E. (2007). *Campylobacter jejuni*: A review of its characteristics, pathogenicity, ecology, distribution, subspecies characterization and molecular methods of detection. Food biotechnology. 21(4): .271-347. 11. Misawa N. and Blaser M. J. (2000) Detection and characterization of autoagglutination activity by *Campylobacter jejuni*. Infection and Immunity. 68(11): 6168-6175. 12. Morris F. C., Dexter C., Kostoulias X., Uddin M. I. and Peleg A. Y. (2019). The mechanisms of disease caused by *Acinetobacter baumannii*. Front. Microbiol. 10: 1601. 13. Nyati K. K. (2013). Role of *Campylobacter jejuni* Infection in the Pathogenesis of Guillain-Barré Syndrome: An Update. Biomedical Research Journal. 1-13. 14. Pine L., Howell A. Jr and Watson S. J. (1960. Studies of the morphological, physiological, and biochemical characters of *Actinomyces bovis*. J Gen Microbiol. 23: 403-424. 15. Ricke S. C., Feye K. M., Chaney W. E., Shi Z., Pavlidis H. and Yang Y. (2019). Developments in rapid detection methods for the detection of foodborne *Campylobacter* in the United States. Front Microbiol. 9: 3280.

	16. Sharma S., Hashmi M. F. and Valentino III D. J. (2020). Actinomycosis. In: StatPearls [Internet]. Treasure Island (FL): StatPearls. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482151/ 17. Testerman T. L. and Morris J. (2014). Beyond the stomach: an updated view of *Helicobacter pylori* pathogenesis, diagnosis, and treatment. World J Gastroenterol. 20(36): 12781-12808. 18. Wong D., Nielsen T. B., Bonomo R. A., Pantapalangkoor P., Luna B. and Spellberg B. (2016). Clinical and pathophysiological overview of *Acinetobacter* Infections: a century of challenges. Clinical Microbiology Reviews. 30(1): 409-447.
Credit III	1. Chauhan N., Narang J., Pundir S., Singh S. and Pundir C. S. (2012). Laboratory diagnosis of swine flu: A review. Artificial cells, blood substitutes and immobilizationbiotechnology. 41(3): 189-195 2. Chisari F.V., Isogawa M. and Wieland S.F. (2010). Pathogenesis of Hepatitis B virus infection. Pathol Biol (Paris). 58(4): 258-66. 3. Falasca L., Agrati C., Petrosillo N., Di Caro A., Capobianchi M. R., Ippolito G. and Piacentini M. (2015). Molecular mechanisms of Ebola virus pathogenesis: focus on celldeath. Cell Death Differ. 22(8): 1250-1259. 4. Jilani T. N., Jamil R. T. and Siddiqui A. H. (2020). H1N1 Influenza (Swine Flu) In: StatPearls [Internet]. Treasure Island (FL): StatPearls. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513241/ 5. Kawai Y., Kimura Y., Lezhava A, *et al*. (2012). One-step detection of the 2009 pandemic influenza A (H1N1) virus by the RT-SmartAmp assay and its clinicalvalidation. *PLoS One*. 7(1): e30236. 6. Khalafallah M. T., Aboshady O. A., Moawed S. A. and Ramadan M. S. (2017). Ebola virus disease: Essential clinical knowledge. Avicenna J Med. 7(3): 96-102. 7. Krajden M., McNabb G. and Petric M. (2005). The laboratory diagnosis of Hepatitis Bvirus. Can J Infect Dis Med Microbiol.16 (2): 65-72 8. Ravina R., Dalal A, Mohan H., Prasad M. and Pundir C.S. (2020). Detection methods for influenza A H1N1 virus with special reference to biosensors: a review. Biosci Rep. 40(2): BSR20193852 9. Rewar S., Mirdha D. and Rewar P. (2015). Treatment and prevention of pandemic H1N1 influenza. *Ann Glob Health*. 81(5): 645-653. doi:10.1016/j.aogh.2015.08.014. 10. Simon V., Ho D.D. and Abdool Karim Q. (2006). HIV/AIDS epidemiology, pathogenesis, prevention, and treatment. Lancet. 5; 368(9534):.489-504. 11. Sullivan N., Yang Z.Y. and Nabel G. J. (2003). Ebola virus pathogenesis: implications for vaccines and therapies. J Virol. 77(18): 9733-9737. 12. Wilkins T., Sams R. and Carpenter M. (2019). Hepatitis B: Screening, prevention, diagnosis, and treatment. Am Fam Physician. 99(5): 314-323. 13. Wu C.C., Chen Y.S., Cao L., Chen X.W. and Lu M.J. (2018). Hepatitis B virus infection: Defective surface antigen expression and pathogenesis. World J Gastroenterol. 21; 24(31): 3488-3499.

Credit IV	1. de Lima Corvino D.F. and Horrall S. Ascariasis.(2020). In: StatPearls [Internet]. Treasure Island (FL): StatPearls Available from: https://www.ncbi.nlm.nih.gov/books/NBK430796/ 2. Elewski B.E. (1998). Onychomycosis: pathogenesis, diagnosis, and management. ClinMicrobiol Rev. 11(3): 415-29. 3. Farthing M. J. G. (1993). Pathogenesis of giardiasis. *Transactions of The Royal Society ofTropical Medicine and Hygiene*. 87(3): 17–21. 4. Hedayati M. T., Pasqualotto A. C., Warn P .A., Bowyer P. and Denning D. W. (2007) *Aspergillus flavus*: human pathogen, allergen and mycotoxin producer. *Microbiology*.153(Pt 6): 1677-1692. 5. Hooshyar H., Rostamkhani P., Arbabi M. and Delavari M. (2019) *Giardia lamblia* infection: review of current diagnostic strategies. Gastroenterol Hepatol Bed Bench12(1): 3-12. 6. Jabra-Rizk M. A., Kong E .F., Tsui C., Nguyen M. H., Clancy C. J., Fidel P. L., Jr. and Noverr M. (2016). *Candida albicans* Pathogenesis: Fitting within the Host-Microbe Damage Response Framework. Infect Immun. 84(10): 2724-2739. 7. Kantor M., Abrantes A., Estevez A, Schiller A., Jose Torrent J., Gascon J., Hernandez R. and Ochner C. (2018). *Entamoeba Histolytica*: Updates in clinical manifestation, pathogenesis, and vaccine development. *Can J Gastroenterol Hepatol*. 4601420. 8. Kaufman G., Horwitz B. A., Duek L., Ullman Y. and Berdicevsky I. (2007). Infection stages of the dermatophyte pathogen *Trichophyton*: microscopic characterization and proteolytic enzymes. *Medical Mycology*. 45(2): 149-155. 9. Martins N., Ferreira I., Barros L., Silva S. and Henriques M. (2014). Candidiasis: Predisposing factors, prevention, diagnosis and alternative treatment. Mycopathologia. 177 (5-6): 223-240 10. Petri W. A., Jr. and Singh U. (1999). Diagnosis and Management of Amebiasis. *ClinicalInfectious Diseases*. 29(5): 1117–1125. 11. Rudramurthy S. M., Paul R. A., Chakrabarti A., Mouton J. W. and Meis J. F. (2019). Invasive Aspergillosis by *Aspergillus flavus*: Epidemiology, diagnosis, antifungal resistance, and management. J Fungi (Basel). 5(3): 55 12. Rumsey P. and Waseem M. (2020). *Giardia Lamblia* Enteritis In: StatPearls [Internet]. Treasure Island (FL): StatPearls Available from: https://www.ncbi.nlm.nih.gov/books/NBK531495/ 13. Scott M. (2008). *Ascaris lumbricoides*: a review of its epidemiology and relationship toother infections. Annales Nestlé (English Ed.). 66. 7-22.

MBCP 234: Practicals based on Immunology, Molecular Biology and Clinical Microbiology - Semester III

Core Compulsory Practical Paper

Total: 4 Credits **Workload :-30 hrs. /credit**

(Total Workload: - 4 credits x 30 hrs. = 120 hrs. in semester)

Credit	Description	Lectures
Credit I	**Practicals based on MBCT 231: Immunology** 1. Precipitation reactions of Antigen - Antibody: Single radial diffusion. 2. Rocket Immuno - electrophoresis 3. Agglutination techniques: Determination of iso-antibodies titre to human blood group antigens. 4. Demonstration of Western Blotting 5. Visit to institute/industry for demonstration of ELISPOT/ CFT/FACS/animal inoculation	30
Credit II	**Practicals based on MBCT 232 Molecular Biology** Isolation of Plasmid from Bacteria 1. Study of the process of transformation for thestrain improvement 2. Blue white screening/bacterium E. coli using a gene for green fluorescent protein 3. Study of the process of bacterial conjugationand transfer of the gene of interest	30
Credit III	**Practicals based on MBCT 233: Clinical Microbiology** A. Isolation and identification of (any two bacterial) 1. *Helicobacter pylori* 2. *Campylobacter jejuni* 3. *Mycobacterium spegmatis*	15
	B. Isolation and identification of (any 2) 1 *Candida albicans* 2 *Trichophyton mentagrophytes* 3 *Aspergillus flavus*	15
Credit IV	**Practicals based on MBCT 233: Clinical Microbiology** A. Viral titration by haemagglutination technique(Determination of titre)	15
	B. Demonstration of cultivation of viruses by egg inoculation technique with pock and plaque detection	15

Suggested References MBCP 234: Immunology, Molecular Biology and Clinical Microbiology Semester III	
Credit	**References**
Credit I	1. Axelsen N. H., Kroll J. and Weeke B. (1973). A manual of quantitative immunoelectrophoresis: methods and applications. Scand. J. Immunol. 2(Suppl. 1): 37- 46 2. Galvão de França N.D., Cristovão Poli M.C., Almeida Ramos P.G., Rocha Borsoi C.S. and Colella R. (2011). Titers of ABO antibodies in group O blood donors.Rev Bras Hematol Hemoter. 33: 259–262 3. Kang S.J., Lim Y.A. and Baik S.Y. (2014). Comparison of ABO antibody titers on thebasis of the antibody detection method used. Ann Lab Med. 34: 300–306. 4. Laurell C. B. (1966). Quantitative estimation of proteins by electrophoresis in agarose gelcontaining antibodies. Anal. Biochem. 15: 45–52 5. Vaerman J. P. (1981). Single radial immune diffusion, in methods in enzymology: 73(Langone, J. J. And Van Vunakis, H, Eds.) New York: 291-305.
Credit II	1. Green M. R. and Sambrook J. (2018). The Hanahan Method for Preparation and Transformation of Competent *Escherichia coli*: High-Efficiency Transformation. ColdSpring Harb Protoc. (3): 10. 2. Griffiths A. J. F., Miller J. H., Suzuki D. T., et al. (2000). An Introduction to Genetic Analysis. 7th edition. New York: W. H. Freeman; Bacterial conjugation. https://www.ncbi.nlm.nih.gov/books/NBK21942/ 3. Phornphisutthimas S., Thamchaipenet A. and Panijpan B. (2007). Conjugation in *Escherichia coli*: A laboratory exercise. Biochem Mol Biol Educ. 35(6): 440-445. 4. Sambrook J. and Russell D. (2001). Molecular Cloning: A Laboratory Manual, 3rd edn.Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. **5.** Wilson K. and Walker J. (2005). Principles and Techniques of Biochemistry andMolecular Biology. 6th Edition., Cambridge University Press, New York
Credit III	**A. Isolation and identification of (any two bacterial)** 1. Best C. A. and Best T. J. (2009). *Mycobacterium smegmatis* infection of the hand. Hand (N Y). 4(2): 165–166. 2. Chon JW, Hyeon JY, Yim JH, et al. (2012). Improvement of modified charcoal-cefoperazone- deoxycholate agar by supplementation with a high concentration of polymyxin B for detection of *Campylobacter jejuni* and *C. coli* in chicken carcass rinses. Applied and Environmental Microbiology. 78(5):1624-1626. 3. Ferguson DA Jr, Li C, Patel NR, Mayberry WR, Chi DS, Thomas E. (1993). Isolation of *Helicobacter pylori* from saliva. J Clin Microbiol. 31(10):2802-2804. 4. Gonsalves CC, Borsoi A, Perdoncini G, Rodrigues LB, do Nascimento VP. (2016). *Campylobacter* in broiler slaughter samples assessed by direct count on mCCDA and Campy-Cefex agar. Braz J Microbiol.47(3): 764-769. 5. Thomas J.E., Gibson G.R., Darboe M.K., Dale A. and Weaver LT. (1992) Isolation of Helicobacter pylori from human faeces. *Lancet*. 340(8829): 1194-1195. 6. Yamada H., Yamaguchi M., Igarashi Y., Chikamatsu K., Aono A., Murase Y.,

	Morishige Y., Takaki A., Chibana H. and Mitarai S. (2018) *Mycolicibacterium smegmatis*, basonym *Mycobacterium smegmatis*, expresses morphological phenotypes much more similar to *Escherichia coli* than *Mycobacterium tuberculosis* in quantitative structome analysis and cryoTEM examination. Frontiers in Microbiology. 9: Article 1992 7. Palange P, Narang R, Kandi V. (2016) Evaluation of Culture Media for Isolation of Mycobacterium Species from Human Clinical Specimens. Cureus. 30; 8(8): e757. **8.** Zimhony O., Vilcheze C. and Jacobs W.R.J. (2004) Characterization of *Mycobacterium smegmatis* expressing the Mycobacterium tuberculosis fatty acid synthase I (fas1) gene. J. Bacteriol. 186: 4051-4055
	B. : **Isolation and identification of (any two fungal pathogens)** 1. Baxter M. (1966) Isolation of *Trichophyton mentagrophytes* from British soil. Sabouraudia. 4: 207–209. 2. Joshi K. R. and Gavin J. B. (1974). A simple laboratory method for the rapid identification of *Candida albicans*. Pathology. 6(3): 231-233. 3. Meinhof W., Laschka P. and Scherwitz C. (1975). A synthetic medium for rapid chlamydospore formation in *Candida albicans*. Mykosen. 18(7): 291-298. 4. Gunasekaran M. and Hughes W. F. (1977). A simple medium for isolation and identification of *Candida albicans* directly from clinical specimens. *Mycopathologia*. 61(3): 151-157. 5. Baxter M. (1966). Isolation of *Trichophyton mentagrophytes* from British soil, *Sabouraudia*, 4: 207–209. 5. Sinski J. T., Kelley L. M., Flynt P. M. and Miegel J. (1977). Dermatophyte isolation media: quantitative appraisal using skin scales infected with *Trichophyton mentagrophytes* and *Trichophyton rubrum*. J Clin Microbiol. 5(1): 34-38. **6.** Taber R. A. and Schroeder H. W. (1967). Aflatoxin-producing potential of isolates of the *Aspergillus flavus*- oryzae group from peanuts (*Arachis hypogaea*). Appl Microbiol. 15(1):140-144.
Credit IV	**A. :Viral titration by haemagglutination technique** 1. Alexander D. J. and Chettle N. J. (1977) Procedures for the haemagglutination and the haemagglutination inhibition tests for avian infectious bronchitis virus. Avian Pathology. 6(1):9-17 2. Costabile M. (2010). Determining the reactivity and titre of serum using a haemagglutination assay. JVis Exp. 2010. (35): 1752. Published online 3. Noah D. L., Hill H., Hines D., White E. L. and Wolff M. C. (2009). Qualification of the hemagglutination inhibition assay in support of pandemic influenza vaccine licensure. Clinical and Vaccine Immunology:CVI. 16(4): 558-566. 4. World Health Organization. WHO Collaborating Center for Reference and Research on Influenza Chinese National Influenza Center National Institute for Viral Disease Control and Prevention, ChinaCDC (2013) Laboratory Procedures. (20 December 2013) Serological detection of avian influenza A(H7N9) virus infections by modified horse red blood cells haemagglutination-inhibition assay **B.** :**Visit to institute/industry for demonstration**

MBET: 235 Cell Culture Techniques Semester III Choice based Optional Theory Paper (Elective) Total: 2 Credits Workload: -15 hrs /credit (Total Workload :- 2 credits x 15 hrs = 30 hrs in semester		
Credit	**Credit Title and Contents**	**Lectures**
Credit I	**Animal Cell Culture Techniques:** A. Definition of terms: Primary cell cultures and cell lines, established cell lines, suspension and anchorage dependent cell cultures. B. Transformation of cells in culture, culture media, factors affecting cells in culture.	15
Credit II	**Commonly used cell culture systems and cell lines in immunological studies:** A. Cell culture systems and their applications: primary lymphoid cell culture cloned lymphoid cell lines, hybridlymphoid cell lines. B. Immuno-modulation	15

Suggested References MBET: 235 Cell Culture Techniques Semester III Choice based Optional Theory Paper (Elective)	
Credit	**References**
Credit I	**Animal Cell Culture Techniques:** 1. Freshney R. I. (2005). Culture of Animal Cells: A Manual of Basic Technique.5th Ed. John Wiley and Sons, Inc. 2. Masters J. R. W. (2000). Animal Cell Culture – A Practical Approach. 3rd Ed. Oxford University Press. **3.** Mather J. P. and Penelope E. R. (1998). Introduction to Cell and Tissue Culture Theory and Technique. Plenum Press, New York
Credit II	**Commonly used cell culture systems and cell lines in immunological studies:** 1. Kindt T. J., Goldsby R. A., Osborne B. A. and Kuby J. (2007). Kuby Immunology. 6th Ed. W. H. Freeman and Co. **2.** Patwardhan B., Diwanay S.and Gautam M. (2006). Botanical immunomodulators and chemoprotectants in cancer therapy. In Drug Discovery and Development Volume I: Drug Discovery. Ed. Chorghade Mukund S. Wiley Interscience, John Wiley and Sons Inc. USA. 405-424.

MBEP: 235 Cell Culture Techniques : Semester III Choice based Optional Practical Paper (Elective) Total: 2 Credits Workload: -30 hrs./credit (Total Workload) :- 2 credits x 30 hrs = 60 hrs in semester		
Credit	**Credit Title and Contents**	**Lectures**
Credit I	**Practicals based on Animal Cell Culture Techniques:** A. Density gradient based separation of peripheral lymphocytes(1) B. Preparation of Lymphocyte culture (1) C. Effect of immunomodulators on lymphocyte proliferation (Stimulatory and inhibitory effect) (2)	30
Credit II	**Practicals based on Commonly used cell culture systems and cell lines in immunological studies:** A. Chick embryo fibroblast cell culture (1)	30

Suggested References MBEP: 235 Cell Culture Techniques : Semester III Choice based Optional Practical Paper (Elective)	
Credit	**References**
Credit I	**Practicals based on Animal Cell Culture Techniques:** 1. Freshney R. I. (2005). Culture of Animal Cells: A Manual of Basic Technique, 5th Ed., John Wiley and Sons, Inc **2.** Masters J. R. W. (2000). Animal Cell Culture – A Practical Approach. 3rd Ed. Oxford University Press.
Credit II	**Practicals based on Commonly used cell culture systems and cell lines in immunological studies:** 1. Mather J. P. and Penelope E. R. (1998). Introduction to Cell and Tissue Culture Theory and Technique. Plenum Press, New York **2.** Hernandez R. and Brown D.T. (2010). Growth and maintenance of chick embryo fibroblasts (CEF). Curr Protoc Microbiol.17: A.4I.1–A.4I.8

MBTE: 236 Bioremediation and Biomass Utilization : Semester III Choice Based Optional Theory Paper (Elective) Total: 2 Credits Workload: -15 hrs /credit Total Workload: - 2 credits x 15 hrs. = 30 hrs. in semester		
Credit	**Credit Title and Contents**	**Lectures**
Credit I	**Bioremediation** A. Microbial Degradation of xenobiotics, B. Engineered bio- degradative pathways: Camphor, octane, xylene, naphthalene degradation pathway C. Aromatic compound degradation: Manipulation by plasmid transfer Manipulation by gene alteration	15
Credit II	**Biomass utilization** A. Utilization of starch and cellulose; B. Isolation of the prokaryotic and eukaryotic cellulase genes, manipulation of the cellulase gene, advantages of using *Zymomonas mobilis* C. Alcohol, fructose, and silage production;advantages of each D. Improvisation of the processes of alcoholproduction E. Improvisation of the processes of fructoseproduction F. Commercial production processes of alcoholand fructose	15

Suggested References MBTE: 236 Semester III Bioremediation and Biomass Utilization Choice Based Optional Theory Paper (Elective)	
Credit	**References**
Credit I	**Bioremediation** 1. Glick B. R., Pasternak J. J., Cheryl L. and Patten C. L. (1998). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington DC, ASM Press 2. Jaiswal S., Singh D. K. and Shukla P. (2019). Gene Editing and Systems Biology Tools for Pesticide Bioremediation: A Review. Front Microbiol. 10:87 3. Karpouzas D. G. and Singh B. K. (2006) Microbial degradation of organophosphorus xenobiotics: metabolic pathways and molecular basis. AdvMicrob Physiol. 51: 119-185. 4. .Ramos J. L., González-Pérez M. M. and Caballero A., van Dillewijn P. (2015). Bioremediation of polynitrated aromatic compounds: plants and microbes put up afight. Curr Opin Biotechnol. 16(3): 275-281. 5. Weaver R. (2007). Molecular Biology. 4th Edition. Mc-Grew Hill Publication

Credit II	**Biomass Utilization** 1. Glick B. R., Pasternak J. J., Cheryl L. and Patten C. L. (1998). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington DC, ASM Press 2. Gupta G. V. (2016). New and Future Developments in Microbial Biotechnologyand Bioengineering. *Aspergillus* System Properties and Applications. Elsevier Book Publication. 3. Lal P .B., Wells F. M., Lyu Y., Ghosh I. N., Landick R. and Kiley P. J. (2019). A markerless method for genome engineering in *Zymomonas mobilis* ZM4. Front Microbiol. 10: 2216 4. Sarris, D.and Papanikolaou S. Biotechnological production of ethanol: Biochemistry, processes and technologies. Engineering Life Sciences. 16: 307-329 5. Weaver R. (2007) Molecular Biology. 4th Edition. Mc-Grew Hill Publication

MBEP: 236 Bioremediation and Biomass Utilization : Semester III

Choice Based Optional Practical Paper

Total: 2 Credits Workload: -30 hrs /credit

(Total Workload) :- 2 credits x 30 hrs = 60 hrs in semester

Credit	Credit Title and Contents	Lectures
Credit I	**Bioremediation** 1. Degradation of para nitrophenol using *Pseudomonas putida* 2. Low density plastic/bioplastic degradation using bacterial isolates 3. Demonstration of DNA finger-printingtechnique	30
Credit II	**Biomass utilization** 1. Biodiesel production using micro-algae 2. Isolation of bio-emulsifier producing organisms for degradation of aromaticcompounds	30

Suggested References MBEP: 236 Semester III

Bioremediation and Biomass Utilization

Choice Based Optional Practical Paper

Credit	References
Credit I	**Bioremediation** 1. Arora P. K., Srivastava A., and Singh V. P. (2014). Bacterial degradation of nitrophenolsand their derivatives.J Hazard Mater. 266: 42-59. 2. Bánfalvi G and Antoni F. (1990). DNA-based diagnosis. Orv Hetil. 131(18): 953-964. 3. Kulkarni M. and Chaudhari A. (2006). Biodegradation of p-nitrophenol by *P. putida*.Bioresour Technol. 97(8): 982-988. 4. Kumar Khanna V. (2007). Existing and emerging detection technologies for DNA (Deoxyribonucleic Acid) finger printing, sequencing, bio- and analytical chips: a multidisciplinary development unifying molecular

	biology, chemical and electronicsengineering. Biotechnol Adv. 25(1): 85-98. 5. Li J., Kim H. R., Lee H. M. and Yu H. C., Jeon E., Lee S. and Kim D. (2020). Rapid biodegradation of polyphenylene sulfide plastic beads by *Pseudomonas* sp. Sci TotalEnviron. 720: 137616. 6. Qiu X., Wu P., Zhang H., Li M. and Yan Z. (2009). Isolation and characterization of *Arthrobacte*r sp. HY2 capable of degrading a high concentration of p-nitrophenol. Bioresour Technol. 100(21): 5243-5248 7. Bano K. R., Kuddus M., Zaheer M. R., Zia Q., Khan M. F., Ashraf G. M., Gupta A. and Aliev G. (2017). Microbial enzymatic degradation of biodegradable plastics. Curr PharmBiotechnol. 18(5): 429-440. 8. Sangeetha Devi R., Ramya R., Kannan K., Robert Antony A. and Rajesh Kannan V. (2019). Investigation of biodegradation potentials of high density polyethylene degrading marine bacteria isolated from the coastal regions of Tamil Nadu, India Mar Pollut Bull. 138: 549-560. **9.** Wilkes R. A. and Aristilde L. (2017). Degradation and metabolism of synthetic plastics and associated products by *Pseudomonas* sp.: capabilities and challenges. J Appl Microbiol. 123(3): 582-593.
Credit II	**Biomass utilization** 1. Larkum A. W., Ross I. L., Kruse O. and Hankamer B. (2012). Selection, breeding and engineering of microalgae for bioenergy and biofuel production.Trends Biotechnol. 30(4): 198-205. 2. McGinn P. J., Dickinson K. E., Bhatti S., Frigon J. C., Guiot S. R. and O'Leary S. J. (2011). Integration of microalgae cultivation with industrial waste remediation for biofuel and bioenergy production: opportunities and limitations. Photosynth Res. 109(1-3): 231-247. 3. Muhonja C. N., Makonde H., Magoma G. And Imbuga M. (2018). Biodegradability of polyethylene by bacteria and fungi from Dandora dumpsite Nairobi-Kenya. PLoS ONE13(7): e0198446. 4. Parmar A., Singh N. K., Pandey A., Gnansounou E. and Madamwar D. (2011). Cyanobacteria and microalgae: a positive prospect for biofuels. Bioresour Technol.102(22): 10163-10172. **5.** Viramontes-Ramos S., Cristina Portillo-Ruiz M., Ballinas-Casarrubias Mde L, Torres-Muñoz J. V., Rivera-Chavira B. E. and Nevárez-Moorillón G. V. (2010). Selection of biosurfactan/bioemulsifier-producing bacteria from hydrocarbon-contaminated soil. Braz J Microbiol. 41(3): 668-675.

MBET: 237 Microbial Virus Technology : Semester III

Choice based Optional Theory Paper (Elective)

Total: 2 Credits Workload: -15 hrs. /credit

(Total Workload) :- 2 credits x 15 hrs = 30 hrs in semester

Credit	Topic	Lectures
Credit I	A. **Isolation and characterization of bacteriophages** i. Abundance of bacteriophages in theenvironment ii. Bacteriophage Lifecycle-Lytic,Lysogeny and chronic cycle. Genetic basis of lytic and lysogeny cycles	05
	B. **Isolation of bacteriophages from various environmental samples-(Differentmethods)** i River, Intestine, Lakes, Tooth plaque, Ponds, High temp.env. Cockroaches, Raw vegetables, Activated sludge, Fecal matter, Sewage , Soil, Flies, Sewage Treatment plant	03
	C. **Bacteriophage growth kinetics** i. Concept and calculations of EoP, MOI ii. Adsorption rate constant iii. One step growth curve-(Latent peroid,Eclipsed period, Rise period, Plateau, burst size	05
	D. Phage based bacterial detection:Phage typing	02
Credit II	**A. Bacteriophage as biocontrol agent** i. Phage based technology for decontamination of water (drinking water,recreational water, medical waste water) ii. Phage based technology for pathogencontrol in aqua systems iv. Bacteriophages for the biocontrol ofbiofilms on medical devices v. Bacteriophage based technology forpathogen control in Poultry	05
	B. Bacteriophage Therapy i. Use of bacteriophages as therapeutic agent ii. Phage lysine therapy and prohylaxis	04
	C. Mycoviruses: A new dimension inMicrobiology i. Occurrence ii. Taxonomy of Mycoviruses iii. Mycovirus-host interactionmechanisms iv. Characterization Technoiques v. Mycoviruses as biocontrol agentsagainst fungal plant pathogens	05
	D. Introduction of algal viruses	01

Suggested References MBET: 237 Microbial Virus Technology : Semester III Choice based Optional Theory Paper (Elective)	
Credit	**References**
Credit I	**A** 1. Ahiwale S. (2013). Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies. PhD thesis, University of Pune, Pune, Maharashtra 2. Rohwer F., Youle M., Maughan H. and Hisakawa N. (2014). Life in Our Phage World. A centennial field guide to the Earth's most diverse inhabitants. Illustrations by Leah L Pantéa and BenjaminDarby (Book) 3. Hobbs Z. and Abedon S. T. (2016). Virology Diversity of phage infection types and associated terminology: the problem with Lytic or lysogenic. Minireview. FEMS Microbiology Letters, 363, , fnw047 doi: 10.1093/femsle/fnw047, 2016
	B 1. Ahiwale S. (2013) .Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies. PhD thesis, University of Pune, Pune, Maharashtra 2. Azeredo J. and Sillankorva S. Editors. (2018) Bacteriophage Therapy from Lab to Clinical Practice. In Methods in Molecular Biology. Walker J. M. Series Editor. Humana Press Book. Springer. **3.** Clokie M. R. J. and Kropinski A. M. Editors (2009). Bacteriophages: Methods and Protocols. Volume1: Isolation, Characterization and Interactions. Springer Book
	C 1. Clokie M. R. J. and Kropinski A. M. Editors (2009). Bacteriophages: Methods and Protocols. Volume1: Isolation, Characterization and Interactions. Springer Book Effect of bacterial growth rate on bacteriophage population growth rate, Dominik Nabergoj, Petra Modic, Ales Podgornik, Wiley Microbiology open, 2017
	D 1. Schofield D.A., Sharp N.J. and Westwater C. (2012). Phage-based platforms for the clinical detection ofhuman bacterial pathogens. Bacteriophage. 2(2): 105-283
Credit II	**A. i.** 1. Ahiwale S. (2013) Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies. PhD thesis, University of Pune, Pune, Maharashtra 2. McLaughlin M. R. and Brooks J. P. (2008) EPA worst case water microcosms for testing phage biocontrolof *Salmonella*. J Environ Qual. 37: 266-271 3. Sharma S., Soumya Chatterjee S., Datta S., Rishika Prasad R., Dubey D., Prasad R. K. and Vairale M.G. (2017). Bacteriophages and its applications: an overview. Folia Microbiol. 62(1):17-55

4. Singh M.K., Maurya A. and Kumar S. (2020). Bioaugmentation for the treatment of waterborne pathogen contamination water. Waterborne Pathogens. 189–203.

A. ii.

1. Culot A., Grosset N. and Gautier M. (2019). Overcoming the challenges of phage therapy for industrial aquaculture: A review. Aquaculture. Elsevier. 513:734423.
2. Kutter E. and Sulakvelidze A. Editors. (2004). Bacteriophages: Biology and Applications. Edition-illustrated. Publisher-CRC Press.
3. Nakai T. and Park S. C. (2002). Bacteriophage therapy of infectious diseases in aquaculture. Mini-review.Research in Microbiology. 153: 13–18
4. Vinod M. G., Shiva M.M., Umesha K.R., Rajaveera B.C., Krohne G. and Karunasagar J. (2006). Isolation of *Vibrio harveyi* bacteriophage with potential for biocontrol of luminous vibriosis in hatchery environments. Aquaculture. 55: 117-124

A. iii.

1. Ahiwale S. S. (2011). *In vitro* management of hospital *Pseudomonas aeruginosa* biofilm using indigenous T7-like lytic phage. Curr. Microbiology. 62: 335-340
2. Haradaa L. K., Silvaa E.C., Camposa W. F., Del Fiola F. S., Vilaa M., Dąbrowskab K., Krylovc V. N. and Balcão V. M. (2018). Applications of bacteriophages: State of the art, Review article. Microbiol Res. 212- 213: 38-58
3. Lu T. K. and Collins J. J. (2007). Dispersing biofilms with engineered enzymatic bacteriophage. Proceedings of National Academy of Science. 104: 11197-11202

A. iv.

1. Gorski A., Miedzybrodzki R. and Borysowski J. (Editors). (2019). Phage Therapy: A Practical Approach.Springer International Publishing
2. Żbikowska K, Michalczuk M. and Dolka B. (2020). The Use of Bacteriophages in the Poultry Industry.Review. Animals (Basel).10(5): 872

B. Bacteriophage Therapy

1. Eric E. C. and Adhya S. L. (2015). Phage Therapy: Current Research and Applications. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America. 61(1): 141–142
2. Gorski A., Miedzybrodzki R. and Borysowski J. (Editors). (2019). Phage Therapy: A Practical Approach. Springer International Publishing
3. Hyman P. and Abedon S. T. Editors. (2012). Bacteriophages in Health and Disease. Volume 24 of Advances in molecular and cellular microbiology. Contributor C.A.B. International. Edition- illustrated.Publisher CABI.
4. Kutter E. and Sulakvelidze A. Editors. (2005). Bacteriophage Therapy in Humans. Chapter 14.Bacteriophages, biology and applications. CRC Press.
5. Principi N., Silvestri E. and Esposito S. (2019). Advantages and Limitations of Bacteriophages for the Treatment of Bacterial Infections. Front. Pharmacol. 10: 513
6. Vázquez R., García E. and García P. (2018). Phage lysins for fighting bacterial respiratory infections: a new generation of antimicrobials. Mini review article. Front. Immunol. 9: 2252

	C. Mycoviruses: A new dimension inMicrobiology 1. Abbas J. (2016) A Review Paper Mycoviruses. Journal of Plant Pathology and Microbiology. 7 (12): 1-4 2. Abid M., Khan M., Mushtaq S., Afzaal S., and Haider M. (2018). A comprehensive review on mycoviruses as biological control agent. World Journal of Biology and Biotechnology, 3(2): 187-192. 3. Kondo H., Chiba S., Toyoda K. and Suzuki N. (2013).Evidence for negative-strand RNA virus infection in fungi. Virology, 435: 201–209 4. Niu Y., Yongze Yuan Y., Mao J., Yang Z., Cao Q., Zhang T., Wang S. and Liu D. (2018) Characterization of two novel mycoviruses from *Penicillium digitatum* and the related fungicide resistance analysis. Scientific Reports. 8: 5513 5. Zoll J., Verweij P. E. and Melchers W. J. G. (2018): Discovery and characterization of novel *Aspergillus fumigatus* mycoviruses. PLoS ONE 13(7): e0200511.
	D. Introduction of algal viruses 1. Coy S. R., Gann E. R., Pound H. L., Short S. M. and Wilhelm S. W. (2018). Viruses of eukaryotic algae: Diversity, Methods for detection and future directions. Viruses. 10 (9): 487

MBEP: 237 Practicals based on Microbial Virus Technology : Semester III

Choice based Optional Practical Paper (Elective)

Total: 2 Credits Workload: -30 hrs /credit

(Total Workload) :- 2 credits x 30 hrs = 60 hrs in semester

Credit	Description	Lectures
Credit I	A. Isolation and purification of lytic bacteriophages from various environmental samples (Phages specific for E.coli /Salmonella SPP./Klebsiella Spp.). B. Isolation and enumeration of actinophages from soil sample C. Isolation of phyco viruses from various sources in nature D. Determination of Adsorption Rate Constant for phage and One step growth Curve Experiment	30
Credit II	A. Negative staining (Sample preparation) for electron microscopic studies (Demonstration) B. Biocontrol of any plant pathogen using plant Bioassay technique C. In-vitro use of lytic bacteriophages specific against Klebsiella spp. biofilm (Micro- titre plate experiment) D. In-vitro use of lytic bacteriophages for decontamination of water sample (Microcosm Studies). E. Bacteriophage Formulation technique-Carrier based phage formulation and their shelf-life study(3 months)	30

Suggested References MBPE: 237

Practicals based on Microbial Virus Technology Semester II

Credit	References
Credit I	1. Ackerman H. W. (2009). Phage classification and characterization. In: Clokie MRJ, Kropinski AM (Eds) Bacteriophages: methods and protocols, Volume: Isolation, characterization and interactions, Vol. 501. Humana Press, New York. 2. Ahiwale S. (2013). Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies PhD thesis, University of Pune,Pune, Maharashtra. 3. Marei E .M. and Elbaz R. M. (2013) Isolation and molecular characterization of three virulent actinophages specific for S*treptomyces flavovirens*. Journal of Virology Research. 2(1): 12-17 4. Coy S. R., Gann E. R., Pound H. L., Short S. M. and Wilhelm S. W. (2018). Viruses of eukaryotic algae: Diversity, Methods for detection and future directions.Viruses.10: 487. 5. Lanning S. and Williams S.T. (1982). Methods for the direct isolation and enumeration of Actinophages in soil. Journal of General Microbiology, 128: 2063-2071 6. Nabergoj D., Modic P. and Podgornik A. (2018). Effect of bacterial growth rate on bacteriophage population growth rate. Microbiology Open, 7, e00558.

Credit II	1. Ahiwale S.S. (2011). *In vitro* management of hospital *Pseudomonas aeruginosa* biofilm using indigenous T7-like lytic phage. Curr. Microbiology. 62: 335-340 2. Balan A. and Padilla G. (1997). New thermal inducible phages isolated from tropical soils. Brazilian Journal of Genetics. 20: 4 3. Ahiwale S. (2013) Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies PhD thesis, University of Pune, Pune, Maharashtra. 4. McLaughlin M.R. and Brooks J.P. (2008). EPA worst case water microcosms for testing phage biocontrol of *Salmonella*. J Environ Qual. 37: 266-271 5. Umrao P. D., Kumar V. and Kaistha S. D. (2021). Biocontrol potential of bacteriophage -sp1 against bacterial wilt-causing Ralstonia solanacearum in Solanaceae crops Egyptian Journal of Biological Pest Control 31:61 https://doi.org/10.1186/s41938-021-00408-3 6. Vinod M. G., Shiva M. M., Umesha K. R., Rajaveera B. C., Krohne G. and Karunasagar J. (2006). Isolation of *Vibrio harveyi* bacteriophage with potential for biocontrol of luminous vibriosis in hatchery environments. Aquaculture. 55: 117-124

Savitribai Phule Pune University
Syllabus reconstructing 2020
M.Sc. Microbiology II Semester IV

MBCT 241: Pharmaceutical Microbiology Semester IV **Core Compulsory Theory Paper** **Total: 4 Credits** **Workload :-15 hrs /credit** **(Total Workload :- 4 credits x 15 hrs = 60 hrs in semester)**		
Credit	**Description**	**Lectures**
Credit I	**General introduction to medicinal chemistry** A. Definition and explanation of terms used in medicinal chemistry (HITS, Lead compound, Toxicity studies, HTS, ADME). Nomenclature of drugs B. Historical perspectives, significance of medicinalchemistry C. Introduction to modern drug discovery, rational drug design, molecular modeling, gene and DNA technology in chemotherapy D. Classification of drugs based on therapeutic classes, target, mechanism of action, chemistry, etc.	15
Credit II	**Drug development** A. Lead optimization: lead likeness, drug likeness, determination of biological, biochemical properties of drug, pharmacovigilance. B. Drug designing: Ligand based receptor based drug design. (Protein Crystallography, molecular docking) C. Drug development: Preclinical development. Toxicity testing – acute, sub acute, chronic. D. Clinical development: Clinical trials (aims, objectives and conduct). Clinical trials I, II, III and IV.	15
Credit III	**Biopharmaceuticals: Regulations and sources** A. Regulatory authorities and its role: FDA, WHO and CLSI B. Introduction to pharmacopeia: IP, USP, and BP C. Formulation of following pharmaceutical preparation as per IP: i. Antibiotics (with any one example) ii. Antipyretics (with any one example) iii. Steroids (with any one example) iv. Injectables (Distilled water, Saline) v. Vitamins (with any one example	15

Credit IV	**Physicochemical properties of drug and drug metabolism** A. Passage of molecules through biological barriers. Membrane transport (paracellular, transcellular). B. Drug absorption: Drug dosages, from gastric emptying to gastric permeability to drug, first pass effect, bioavailablity. C. Drug distribution: Drug-plasma/ serum binding, blood brain barrier, accumulations in tissues. D. Drug elimination: Drug excretion, Drug biotransformation, Biotransformation reactions, Functionalization, Conjugation reaction, Reactions leading to toxic metabolites	15

Suggested References MBCT 241: Pharmaceutical Microbiology-Semester IV

Core Compulsory Theory Paper

Credit	Reference
Credit I	**General introduction to medicinal chemistry** 1. Agarwal S. S. and Paridhavi M. (2007). Herbal drug technology. UniversitiesPress (India) Pvt. Ltd 2. Altreuter D. and Clark D. S. (1999) Combinatorial Biocatalysis: Taking the lead from nature. Curr. Opin. Biotechnol. 10: 130-136 3. Burn J. H. (1957) Principles of Therapeutics. Blackwell Scientific Pub. O. Ltd.Oxford. 4. Chatwal G. P. (2003) Bio-pharmaceutics and Pharmacokinetics. Himalaya Publishing House, Mumbai. 5. Committee for the Purpose of Control and Supervision on Experiments on Animals (CPCSEA). www.cpcsea.com 6. Dewick P. M. (2002). Medicinal natural products: A biosynthetic approach, 2nd Ed., John Wiley and Sons 7. Erhardt P. W. (2006). Medicinal Chemistry in the New Millennium: A Glance into the Future, Ed. Chorghade M. S. in Drug discovery and Development Volume I: Drug Discovery. Wiley-Interscience, John Wiley and Sons Inc. USA. 17-102. 8. Graly J. O. and Joubert P.H. (1997). Handbook of Phase I /II clinical drug trials, CRC Press 9. Iyengar M. A. (1993). Pharmacology of Powdered Crude Drugs. Iyengar series. Manipal, India 10. Micheles P. S., Khmelnitsley Y. L., Dordick J. S. and Clark D. S. (1998). Combinatorial biocatalysis, a natural approach to drug discovery. Trends in Biotechnol. 16(5): 210-215 11. Rawlins E. A., (Ed). (2002). Bentley's Textbook of Pharmaceutics. 8th Ed. Bailliere Tindall, London 12. Satoskar R. S. and Bhandarkar S. D. (1991). Pharmacology and Pharmacotherapeutics. 12th Ed., Vol. 1 and 2. Popular Prakashan, Mumbai. 13. Vyas S. P and Dixit V. R. (2002). Pharmaceutical Biotechnology, CBS Publishers and Distributors, New Delhi

Credit II	**Drug development** 1. Franklin T. J. and Snow G. A. (1975). Biochemistry of Antimicrobial Action.Chapman and Hall, London. 1-22 and 160-174 2. Gale E. F., Cundliffe E., Reynolds P. E., Richmond M. H. and Waring M. J. (1972). The molecular basis of antibiotic action. John Wiley and Sons. London 3. Goldstein A., Aronow L., and Kalman S. M. (1969). Principles of Drug Action. The Basis of Pharmacology. Harper international edition New York. 4. Lorian V. (1986). Antibiotics in laboratory medicine. 2nd Ed. Williams & Wilkins Publication 5. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 1997. Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4. Villanova, PA: **6.** National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 2002.Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1). Villanova, PA
Credit III	**Biopharmaceuticals: Regulations and sources** 1. Blondelle S. E., Perez Paya E. and Houghten R. A. (1996). Synthetic Combinatorial Libraries: Novel Discovery Strategy for Identification of Antimicrobial Agents. Antimicrobial Agents and Chemotherapy. 1067–1071 2. Holliger M. A. (2008). Introduction to Pharmacology. 3rd Ed. CRC Press. Taylor and Francis. 3. Indian Pharmacopoeia (IP 2018). 8th Edition. Four Volumes with addendum 2019. Published by the Indian Pharmacopoeia Commission (IPC) on behalf of the Government of India, Ministry of Health and Family Welfare. 4. Kokate C. K., Purohit A. P., Gokhale A. B. (2000). Pharmacology. 4th Ed., Nirali Prakashan. 5. Micheles P. S., Khmelnitsley Y. L., Dordick J. S. and Clark D. S. (1998). Combinatorial biocatalysis, a natural approach to drug discovery. Trends in Biotechnol. 16(5): 210-215 6. Osol A. (1980). Remington's Pharmaceutical Sciences, 16th Ed., Easton, Pennsylvania: Mack Publishing Company. 7. Satoskar R. S. and S. D. Bhandarkar (1991). Pharmacology and Pharmacotherapeutics. 12th Edition. Vol. 1 and 2. Popular Prakashan, Mumbai. 8. Vyas S. P. and Dixit V. R. (2002). Pharmaceutical Biotechnology. CBS Publishers and Distributors, New Delhi **9.** Walsh G. (2006). Biopharmaceuticals: Biochemistry and Biotechnology. 2nd edition. Wiley (E-Book, 2013).
Credit IV	**Physicochemical properties of drug and drugmetabolism** 1. Holliger M. A. (2008). Introduction to Pharmacology. 3rd Ed. CRC Press. Taylor and Francis. 2. Kokate C. K., Purohit A. P., Gokhale A. B. (2000). Pharmacology. 4th Ed. Nirali Prakashan. 3. Micheles P. S., Khmelnitsley Y. L., Dordick J. S. and Clark D. S. (1998). Combinatorial biocatalysis. A natural approach to drug discovery. Trends in biotechnol. 16(5): 210-215

MBCT 242: Microbial Technology semester IV

Core Compulsory Theory Paper

Total: 4 Credits **Workload: -15 hrs /credit**

(Total Workload :- 4 credits x 15 hrs = 60 hrs in semester)

Credit	Credit Title and Contents	Lectures
Credit I	**Bioreactor design and operation** A. Designing of bioreactors Design aspects CSTRs: The dimensional ratios of the outer shell, and the operational aspects such as working volume, baffles and impellers. B. The configuration (placement) of impellers in a vessel and the different types of impellers (types of turbines and propellers, and their combinations) C. Immobilized cell reactors and air-lift reactors– Design and operation. D. Batch, Fed-batch and Continuous operation: Applications, advantages and limitations of each type.	15
Credit II	**Process Variables and Monitoring** **A. Process Variables**: i. Aeration Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR;Ccrit), determination of KLa. ii. Agitation Functions of agitation. Flow patterns with different types of impellers. a) Fermentation broth rheology and powerrequirements for agitation – Concept ofNewtonian and non Newtonian fluids, b) Effect of broth rheology on heat, nutrient andoxygen transfer, c) Reynold's number, Power number, Aeration number: working out examples using differentsoftware. **B. Monitoring of process variables**: i. Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and DCO2) ii. Basic principles of operation, types of biosensors	15
Credit III	**Microbial Fermentation Processes:** Upstream, Fermentation and Downstream Processing for the following: i. Antibiotics (Rifamycin) ii. Microbial enzymes (Chitinase) iii. Exopolysaccharides (Pullulan) iv. Use of immobilized cells / enzymes for bioconversion v. Use of fungi in agriculture and environmental applications	15

Credit IV	**Principle concepts of IPR, ISO and Validation Process:** A. Intellectual Property Rights (IPR): i. Basic concepts of IPR ii. Introduction to forms of IPR – Patents and Designs B. The concept of ISO Certification. C. Preparation of SOPs D. Validation protocols for methods in: i. Quality Control ii. Process validation The above should be discussed within WHO Norms. Exercises on preparation of SOPs, operation and validation for analytical methods	15

Suggested References MBCT 242: Microbial Technology Semester IV

Core Compulsory Theory Paper

Credit	References
Credit I	**Bioreactor design and operation** 1. BIOTOL series. (1992). Bioreactor Design and Product Yield. Butterworths Heinemann. 2. Doran P. M. (1995). Bioprocess Engineering Principles. Imprint-Academic Press.Copyright-Elsevier. 3. Lydersen B. K., D'Elia N. A. and Nelson K. M. (Eds.) (1993). Bioprocess Engineering: Systems, Equipment and Facilities. JohnWiley and Sons Inc. 4. Maiti B. R. (2018). Principles of Bioreactor Design. Publisher: Viva books 5. McDuffie N. G. (1991). Bioreactor Design Fundamentals 1st Edition, Elsevier:eBook ISBN: 9781483221083 6. Ratledge C. and Kristiansen B. eds. (2001). Basic Biotechnology. 2nd Ed. Cambridge Univ. Press. Cambridge 7. Singh L., Mahapatra D. and Yousuf A. (2019). Bioreactors: Sustainable Design and Industrial Applications in mitigation of GHG emissions. Elsevier. ISBN-0128212640, 9780128212646
Credit II	**Process Variables and Monitoring** 1. Aiba S., Humphrey A. E. and Millis N. F. (1982). Biochemical Engineering. Second Edition. Academic Press. 2. Chand S. (1998). Fermentation Biotechnology: Industrial Perspectives. Industrial Perspectives: Proceedings of the Symposium on Biotech Industry - a Challenge for 2005 A.D. -with Special Reference to Fermentations. November4-6, 1998. Publisher: All India Biotech Association 3. Jozala A. F. (2017). Fermentation Processes. Publisher-BoD. Books on Demand. ISBN-9535129279, E-Book 9789535129271 4. Mandenius C-F. (2016). Bioreactors: Design, Operation and Novel Applications. Reprint. Publisher-John Wiley & Sons. ISBN 3527683372 E-Book- 9783527683376 5. Larroche C., Sanroman M., Du G. and Pandey A. (Editors). (2016). Current Developments in Biotechnology and Bioengineering: Bioprocesses,

	Bioreactors and Controls. Publisher-Elsevier, ISBN 0444636749, E- Book-9780444636744 6. Lydersen B. K., D' Elia N. A. and Nelson K. M. (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities. John Wiley and Sons Inc. 7. BIOTOL series. (1992). Operational Modes of Bioreactors Butterworths – Heinemann. 8. Stanbury P., Whitaker A. and Hall S. (2016). Principles of Fermentation Technology. 3rd Edition Imprint: Butterworth-Heinemann
Credit III	**Microbial Fermentation Processes:** 1. Arora D. K. (2005). Fungal Biotechnology in Agricultural, Food and Environmental Applications (Mycology), Marcel Dekker, Inc. New York. Basel 2. Belter P. A., Cussler E. L. and Hu W. S. (1994). Bioseparations Downstream processing for Biotechnology. John Wiley and Sons. N.Y. ISBN: 978-0-471-12113-8 3. Crueger W. and Crueger A (1990). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Sinauer associates, Inc 4. Klegerman M. E. and Groves M. J. (1992). Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove, Illinois 5. Meshram S. U. and Shinde G. B. (2009). Applied Biotechnology. I.K. International Pvt. Ltd. 6. Mishra C. S. K. (Editor) and Pascale Champagne (Associate editor). (2009) . Biotechnology applications. I. K. International Pvt. Ltd. 7. Peppler H. J. and Perlman D. (1970). Microbial Technology. Volume 1and 2. Academic Press, New York. 8. Ponkhshe S. (1988). Management of Intellectual Property, Bhate and Ponkhshe Prakasham, Pune 9. Reed G. (Editor). Prescott and Dunn's Industrial Microbiology. 4th Ed., CBSPub. New Delhi. 10. Van Damme E. J. (1984.) Biotechnology of Industrial Antibiotics. Marcel Dekker Inc., New York. 11. Wiseman A. (1985). Topics in Enzyme and Fermentation Biotechnology. Vol. 1and 2. John Wiley and Sons, New York
Credit IV	**Principle concepts of IPR, ISO and ValidationProcess:** 1. Calnan N., Redmond A. and O'Neill S. (2009). The FDA's draft process validation Guidance A perspective from industry. Process Validation Guidance. Pharmaceutical Engineering. GMP Publishing. 7(4): 1-17 2. Supplementary Training Modules on Good Manufacturing Practice. Validation WHO Technical Report Series, No.937, 2006, Annex 4.

M.Sc. Microbiology Part II Semester IV
Guidelines for MBCP: 243
Semester IV: Dissertation

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than two students.
2. The dissertation report will be prepared as per the thesis format.
3. Submission of the dissertation report will be at least ten days before the date of examination.
4. One copy of the report will be preserved in the department, in college.
5. If there are more than one student carrying out a single dissertation, a single report can be submitted to the department and these students will be assessed based on single oral presentation.
6. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
7. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not bepresent.
8. Presentation should be carried out to in the presence an audience comprising of examiners appointed by the university, departmental teaching staff andthe postgraduate students of the department (M.Sc. I and II).
9. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector.
10. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question and answer session of 5 to 8 minutes. The audience can participate in this session.
11. **The assessment of the dissertation is for total of 100 marks (IA-30 and UA-70) out of which the university examinations assessment – end semester will be for 70 marks and the in semester assessment will be for 30 marks.**
12. The assessment of first 30 marks (in semester) will be carried out by the guide(s) who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format of the mark sheet. Head of the department should communicate this point wise assessment system to the dissertation supervisor, well in advance. Guide(s) will give appropriate marks, point-wise and submit it in a sealed envelope(s) to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.
13. Assessment of remaining 70 marks (end semester examination for both courses) will be carried out for individual student at the time of examination jointly by Internal and External examiners by the means of oral presentation. The assessment will be carried out on the basis of the points as per the accompanied format of the mark sheet.
14. Students should be made aware of the assessment parameters, on which they will be assessed throughout the semester and at the end of the fourth semester.

Note: The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation, and submit the mark lists to the Coordinator of the M. Sc. Examination Panel for that examination or directly to SPPU.

SAVITRIBAI PHULE PUNE UNIVERSITY

Practical Examination in M. Sc. Microbiology

Course MBCP 243- (Dissertation)

Name of the center:

Name of the student:

Examination No.:

Sr. No.	Points for Evaluation	Max. Marks	Evaluation
1	Intellectual potential – Understanding of the research problem by the student (topic selection)	5	
2	Research aptitude –		
	a) Depth of literature survey for the proposed work.	3	
	b) Inputs of student in development of plans and protocols for the experimentation (methodology)	5	
	c) Ability to analyze data and formulate a solution (statistical analysis)	5	
	d) Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	5	
3	Motivation – punctuality, meeting dead-lines and seriousness (attendance)	2	
4	Ability to work with others	2	
5	Communication skill – oral and written (conferences, oral, ppt., publication)	3	
Total		30	

Point wise mark sheet – to be filled in by the **Guide** (Based on the evaluation carried out throughout the period of dissertation

Place of work:

Name of the Guide:

Date and Signature:

SAVITRIBAI PHULE PUNE UNIVERSITY

Practical Examination in M. Sc. Microbiology

Course MB CP 243 (Dissertation)

Name of the center:

Name of the student:

Examination No.:

Sr. No.	**Points for Evaluation**	Max. Marks	Evaluation
1	Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, statistical analysis etc., use of scientific language	10	
2	Research potential of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work towards society	10	
3	The dissertation report preparation (scientific writing) and its contents	5	
4	Abilities of satisfactory responses to the queries from the audience (defense)	10	
Total		35	

Point wise mark sheet – to be filled in by External examiner (Based on oral presentation and *viva voce* of the dissertation as end semester evaluation)

Place of work:

Name of the External Examiner:

Signature:

Date:

SAVITRIBAI PHULE PUNE UNIVERSITY

Practical Examination in M. Sc. Microbiology

Course MB CP 243 (Dissertation)

Name of the center:

Name of the student:

Examination No.:

Point wise mark sheet – to be filled in by Internal Examiner (Based on oral presentation and *viva voce* of the dissertation as end semester evaluation)

Sr. No.	Points for Evaluation	Max. Marks	Evaluation
1	Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, statistical analysis etc., use of scientific language	10	
2	Research potential of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work towards society	10	
3	The dissertation report preparation (scientific writing) and its contents	5	
4	Abilities of satisfactory responses to the queries from the audience	10	
Total		35	

Place of work:

Name of the Internal Examiner:

Signature:

Date:

MBET 244: Semester IV

Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti Infectives from plants

Choice based Optional Theory Paper (Elective)

Total: 2 Credits Workload :-15 hrs /credit

(Total Workload :- 2 credits x 15 hrs = 30 hrs in semester

Credit	Description	Lectures
Credit I	**Quality Assurance and Validation inPharmaceutical Industry** A. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. B. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Safety in microbiology laboratory. C. Safety profile of drugs: i. Strerility Testing ii. Pyrogenicity testing iii. Mutagenicity and Carcinogenicity testing iv. Teratogenicity testing	**15**
Credit II	**Development of Anti infectives:** Therapeutic ratio, MIC and MBC Susceptibility Testing: A. Use of liquid and solid media B. Factors affecting susceptibility testing,CLSI guidelines C. Diffusion methods – agar dilution technique, gradient plate techniques,E-test, Kirby Bauer, Stokes method D. Susceptibility testing for: i. Anti-mycobacterial agents ii. Anti-fungal agents iii. Anti-protozoan agents iv. Anti-viral agents	**15**

Suggested References MBET 244: Semester IV
Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti-Infectives from plants
Choice based Optional Theory Paper (Elective)

Credit	References
Credit I	1. Blondelle S. E., Pérez-Payá E. and Houghten R. A. (1996). Synthetic combinatorial libraries: novel discovery strategy for identification of antimicrobial agents. Antimicrobial Agents and Chemotherapy. 1067–1071 2. Holliger M. A. (2008). Introduction to Pharmacology.Third Ed., CRC Press. ISBN9781420047417 3. Kokate C. K., Purohit A. P. and Gokhale A. B. (2000). Pharmacology, 4th Edition. NiraliPrakashan. 4. Maron D. M. and Bruce N. A. (1983). Revised methods for the Salmonella mutagenicity test. Mutation Research. 113: 173-215 5. Osol A. and Hoover J. E. (1975). Remington's Pharmaceutical Sciences, 15th Ed., MackPub. Co., Pennsylvania. 6. Vyas S. P and Dixit V. R. (2002). Pharmaceutical Biotechnology, CBS Publishers andDistributors, New Delhi
Credit II	1. Franklin T. J. and Snow G. A. (1975). Biochemistry of Antimicrobial Action. Chapman and Hall, London. 1-22 and 161-200. 2. Gale E. F., Cundliffe E., Reynolds P. E., Richmond M. H. and Waring M. J. (1972). The molecular basis of antibiotic action, John Wiley and Sons, London 3. Goldstein A., Aronow L., and Kalman S. M. (1969) Principles of Drug Action, TheBasis of Pharmacology, Harper international edition New York. 4. Lorian V. (1986). Antibiotics in laboratory medicine. 2nd Ed, Williams & WilkinsPublication 5. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 1997. Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4.Villanova, PA. 6. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 2002. Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1). Villanova, PA

MBEP 244: Semester IV

Practical's based on Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti Infectives from plants

Choice based Optional Practical Paper (Elective)

Total: 2 Credits Workload :-30 hrs /credit

(Total Workload :- 2 credits x 30 hrs = 60 hrs in semester

Credit	Description	Lectures
Credit I	**Sterility testing of following pharmaceuticalpreparations as per IP:** i. Oral preparations preparation: Antipyretic or antibiotic tablets ii. Liquid preparation: water soluble vitamin or cough syrup or ophthalmic drops iii. Bulk preparation: (any two) Surgical Cotton rolls/ gauze/ surgical sutures/ disposable syringes.	30
Credit II	**Detection and isolation of anti-infectives from plant** i. Extraction of bioactive principles from plant and activity fractionation ii. Estimation of its antimicrobial activity using standard guidelines (CLSI)	30

Suggested References MBEP 244: Semester IV

Practicals based on Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti Infectives from plants

Choice based Optional Practical Paper(Elective)

Credit	References
Credit I	**Sterility testing of following pharmaceuticalpreparations as per IP** 1. Holliger M. A. (2008). Introduction to pharmacology. 3rd Edition. CRC Press 38 2. Indian Pharmacopoeia. (2007). Government of India, Ministry of Health and Family Welfare. The Indian Pharmacopoeia commission. Ghaziabad. 1:53 3. Knudsen L. F. (1949). Sample size of parenteral solutions for sterility testing. JAmer Pharm Assoc**.** 38: 332–337. 4. McGuire J. and Kupiec T.C. (2007). Quality-control analytical methods: the quality of sterility testing. Intl J Pharm Compounding. 11(1): 52–55. 5. Madsen R. E. (1994). US vs. Barr Laboratories: a technical perspective. PDA JPharm Sci Tech. 48(4): 176–179. 6. Moldenhauer J. and Sutton S.V.W. (2004). Towards an improved sterility test.PDA J Pharm Sci Tech. 58 (6): 284–286. 7. Moldenhauer J. (2006). Viability-based rapid microbiological methods for sterility testing and the need for identification of contamination. PDA J Pharm SciTech. 60(2): 81–88.

	8. Schroeder H. G. (2005). Sterility failure analysis. PDA J Pharm Sci Tech. 59(2):89–95. **9.** Sykes G. (1956). The technique of sterility testing. J Pharm Pharmacol. 8: 573
Credit II	**Detection and isolation of anti infectives from plant** 1. Lorian V. (1986). Antibiotics in laboratory medicine. 2nd Ed. Williams and WilkinsPublication 2. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 1997. Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4.Villanova, PA. 3. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). NCCLS: 2002. Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1). Villanova, PA.

MBET 245: Advances in Microbial Technology Semester IV

Choice based Optional Theory Paper (Elective)

Total: 2 Credits Workload: -15hrs /credit

(Total Workload :- 2 credits x 15hrs = 30 hrs in semester

Credit	Credit Title and Contents	Lectures
Credit I	Microbial Growth characteristics and product formation i. Concept of primary (growth associated) and secondary (growth on associated) metabolites and their control, ii. Kinetics of growth and product formation (growth rate, yield coefficient, efficiency etc.) iii. Effect of type of growth on fermentation: The type of growth (mycelia pellet form, mycelia filamentous form, free cell, cells producing exopolysaccharides) affects mass transfer of nutrients, oxygen and heat; as also cell proliferation can be affected by shearing of cells. At least one example of each type may be explained to show these effects in any suitable fermentation.	15
Credit II	i. Animal cell culture technology to produce: ii. Recombinant forms of natural proteins (insulin, erythropoietin), iii. Recombinant vaccines (protein: HIV, hepatitis B and DNA: HIV, malaria), Recombinant enzymes(lipase, restriction endonuclease), iv. Monoclonal antibodies v. Nucleic acid based products (introduction to gene therapy	15

Suggested References MBET 245: Advances in Microbial Technology Semester IV Choice based Optional Theory Paper (Elective)	
Credit	**References**
Credit I	1. Gupta V. K., Schmoll M., Maki M., Tuohy M. and Mazutt M. A (Editors). (2013) Applications of Microbial Engineering. CRC Press 2. Rao D. G., (2010) Introduction to Biochemical Engineering. Tata Mcgraw Hill Education 3. Stanbury P. F. (2009) Principles of Fermentation Technology. 2 Edition. Elsevier (A Division of Reed Elsevier India Pvt. Limited).
Credit II	1. Moo Young M. ed. (1985). Comprehensive Biotechnology Vol: III and IV, Pergamon Press. N. Y 2. Ratledge C. and Kristiansen B. (ediyors). (2001) Basic Biotechnology. 2nd Ed.Cambridge Univ. Press. Cambridge 3. Satyanarayana U. (2005). Biotechnology. Books and Allied (p) limited.

MBEP 245: Practicals based on Advances in Microbial Technology Semester IV **Choice based Optional Practical Paper(Elective)** Total: 2 Credits Workload :-30 hrs/credit (Total Workload :- 2 credits x 30 hrs = 60 hrs in semester		
Credit	**Credit Title and Contents**	**Lectures**
Credit I	A **Bioconversion** Bioconversions using immobilized systems (cells / enzyme) Parameter testing: i. Effect of gel concentration ii. Effect of cell / enzymeconcentration B. **Laboratory scaleproduction** Laboratory scale production and media optimization for: exopolysaccharide / bioemulsifier production	30
Credit II	**Animal Cell CultureTechnology** A. Preparation of Hybridomafrom tumour cell lines. B. Production of monoclonal antibodies from hybridoma of tumour cell lines	30

Suggested References MBEP 245: Semester IV Practicals based on Advances in Microbial Technology **Choice based Optional Practical Paper(Elective)**	
Credit	**References**
Credit I	**A. Bioconversion:** 1. Arana-Peña S., Rios N. S., Carballares D., Mendez-Sanchez C., Lokha Y., Gonçalves L. and Fernandez-Lafuente R. (2020). Effects of enzyme loading and immobilization conditions on the catalytic features of lipase from *Pseudomonas fluorescens* immobilized on octyl-agarose beads. Frontiers in bioengineering and biotechnology. 8: 36. 2. Brena B, González-Pombo P and Batista-Viera F. (2013). Immobilization of enzymes: a literature survey.Methods Mol Biol. 1051: 15-31. 3. Gedam P. S., Raut A. N. and Dhamole P. B. (2019). Effect of operating conditions and immobilization on butanol enhancement in an extractive fermentation using non-ionic surfactant. Appl Biochem Biotechnol. 187: 1424–1436 4. Mahajan R., Gupta V. K. and Sharma J. (2010). Comparison and suitability of gel matrix for entrapping higher content of enzymes for commercial applications. Indian J Pharm Sci. 72(2): 223-228.
	B. **Laboratory scale production** 1. Biswas J. and PaulA. K. (2017). Optimization of factors influencing exopolysaccharide production by *Halomonas xianhensis* SUR308 under batch culture. AIMS Microbiology, 3(3): 564–579. 2. Hereher F., El-fallal A. and Abou-Dobara M. (2018). Cultural optimization

	of a new exopolysaccharide producer. "*Micrococcus roseus*". Beni-Suef University Journal of Basic and Applied Sciences. 7(4): 632-639 3. Maia P., Santos V., Ferreira A., Luna M., Silva T., Andrade R. and Campos T. G. (2018). An efficient bioemulsifier-producing *Bacillus subtilis* UCP 0146 isolated from mangrove sediments. Colloids and Interfaces. 2. 58. 10.3390/colloids2040058 4. Rosero Neira-Gladys; Pimienta Astrid-Lorely.; Dugarte F. and Carvajal Fredy-Gonzalo. (2003). Parameters examination of a biosurfactant production at laboratory scale. C.T.F Cienc. Tecnol. Futuro [online]. 2(4): 35-42
Credit II	**Animal Cell CultureTechnology** Carvalho L. S., da Silva O. B., de Almeida G. C., de Oliveira J.D., Parachin N. S. and Carmo T. S. (2017). Production Processes for Monoclonal Antibodies. Fermentation Processes, Angela Faustino Jozala. IntechOpen. Chapter 10: 181-198 Greenfield E. A. (2014). Generating Monoclonal Antibodies. Chapter 7. Antibodies: A laboratory Manual. 2nd edition. Cold Spring Harbour Laboratory Press. New York. 629-644 Kavyasudha C., Joel J. P. and Devi A. (2018). Differential expression of nucleostemin in the cytoplasm and nuclei of normal and cancerous cell lines. Turk J Biol. 42: 250-258 Pandey S. (2010) Hybridoma technology for production of monoclonal antibodies. PharmaceuticalSciences Review and Research. 1(2): Article 017. 88-94

MBET 246: Semester IV

Industrial waste water treatment and Industrial production of vaccines

Choice based Optional Theory Paper (Elective)

Total: 2 Credits Workload: -15 hrs. /credit

(Total Workload :- 2 credits x 15hrs = 30 hrs in semester

Credit	Description	Lectures
Credit I	A. **Concept and Introduction** to Primary, Secondary and Tertiary treatment of Wastewater. B. **Biological Treatment**- Aerobic and Anaerobic, Suspended and Attached growth processes. C. Activated Sludge treatment and analysis (reactions and Kinetics, mass balance analysis, Hydraulic characters) Critical Operating parameters like DO, Hydraulic retention time, Mean cell retention time, F/M ratio. D. **Current industrial wastewater treatment processes:** Composition, physico-chemical properties and various effluents treatment methods with reference to: i. Dairies ii. Food processing iii. Dyeing industry / Dye-house effluents iv. Paper and pulp industry: Effluent Disposal and Reuse	15
Credit II	**Industrial production of vaccines** A. **Introduction to vaccines** B. **Types**: Inactivated, Attenuated, Toxoid, Subunit, Conjugate, Experimental, Valence, Heterotypic C. **Production** i. Pilot and Industrial scale production ii. Excipients iii. Role of Adjuvants and preservatives D. **Production of viral, bacterial and protozoal vaccines** – Generations of vaccines: i. First generation vaccines– Live attenuated (BCG, MMR) and Inactivated (Pertussis, Tetanus toxoids) ii. Second generation vaccines(synthetic) protein/ peptide/ polysaccharide):- a. Subunit vaccines (Hep B) b. Recombinant (Rotavirus), Hapten-Conjugate vaccines (diphtheria) iii. Third generation vaccines – DNA/RNA and Idiotype vaccines (Malaria) iv. Next generation vaccines using OMICs approach: SARS.	15

MBET 246: Semester IV

Industrial waste water treatment and Industrial production of vaccines

Choice based Optional Theory Paper (Elective)

Credit	References
Credit I	1. Abdallh M. N., Abdelhalim W. S. and Abdelhalim H. S. (2016). Industrial wastewater treatment of food industry using best techniques. International Journalof Engineering Science Invention, 5(8): 15-28. 2. Ali Z. and Rahman M. (2008) Physico-chemical characteristics of pulp and papermill effluent. Research in Environment and Life Sciences.1 (2): 59-60. 3. Ashtekar S., Bhandari V. M., Shirsath S. R., Sai Chandra P. L. V. N. and Jolhe P. D. (2013). Dye wastewater treatment: removal of reactive dyes using inorganic and organic coagulants. Journal of Industrial Pollution Control, 30(1): 33-42 4. Bajpai P. and Bajpai P. K. (1994). Mini review: Biological colour removal of pulpand paper mill wastewaters. Journal of Biotechnology. 33: 211-220. 5. Bajpai P. (2001). Microbial degradation of pollutants in pulp mill effluents. Advances in Applied Microbiology.48: 79-134. 6. Catalkaya E.C. and Kargi F. (2006). Color, TOC and AOX removals from pulp milleffluent by advanced oxidation processes: A Comparative Study. Journal of Hazardous Materials. 139 (2): 244-253 7. Metcalf and Eddy (Eds.). (1991). 3rd Edition, Tata Mac Graw Hill Publishing Co. Ltd. NewDelhi. 8. Patwardhan A. D. (2008). Industrial wastewater treatment. © Prentice – Hall of India Pvt. Ltd., New Delhi. ISBN 978-81-203-335 9. Tchobanoglous G. and Burton F. L. (1991) Wastewater engineering, treatment, disposal and reuse. 3rd Edition, Metcalf and Eddy (Eds.), Tata Mac Graw Hill Publishing Co. Ltd. New Delhi.
Credit II	1. Casida L. E. (1984). Industrial Microbiology.Wiley Easterbs, New Delhi 2. Patel A. H. (1985). Industrial Microbiology, Macmillan India Ltd. 3. Soma Marla S., Bonthala V. S., München H. Z., Suresh., Gaur V. S. and Gohar Taj G. (2012). Biotechnology in Medicine and Agriculture Principles and Practices. Publisher: I.K International Publishing House pvt.ltd, Editors: Anil Kumar, Ashwani Pareek, and Sanjay Mohan Gupta. 739-759 4. Stanbury P. F. and Whittaker A. (1984). Principles of Fermentation Technology.Pergamon press. 5. https://www.slideshare.net/adammbbs/pathogenesis-3-rd-internal-updated-43458567 6. https://www.bio.fiocruz.br/en/images/stories/pdfs/mpti/2013/selecao/vaccine-process- technology.pdf 7. https://www.dcvmn.org/IMG/pdf/ge_healthcare_dcvmn_introduction_to_pd_for_vaccine_ production_29256323aa_10mar2017.pdf 8. https://www.sciencedirect.com/science/article/pii/B9780128021743000059 https://www.researchgate.net/publication/313470959_Vaccine_Scale-up_and_Manufacturing

MBEP 246: Semester II

Practicals based on Industrial Waste Water Treatmentand Industrial Production of Vaccines

Choice based Optional Practical Paper (Elective)

Total: 2 Credits Workload :-30 hrs /credit

(Total Workload :- 2 credits x 30 hrs = 60 hrs in semester

Credit	Description	Lectures
Credit I	**Practicals based on industrial waste watertreatment:** i. Estimation of pollution load of a natural sample (e.g. river water / industrial waste water) ii. Setting up a laboratory experiment to assess degradability of synthetic wastewater	30
Credit II	**Practicals based on industrial production of vaccines** i. Checking the potency of a toxoid based vaccine by immune diffusion assay ii. Preparation of *Salmonella* O and H antigen and estimation with known antibodies	30

Suggested References MBEP 246: Semester IV

Practicals based on Industrial Waste Water Treatmentand Industrial Production of Vaccines

Choice based Optional Practical Paper (Elective)

Credit	References
Credit I	1. Barthwal R. R. (2002). Environmental Impact Assessment, New Delhi (India). New AgeInternational (P) Limited Publishers. 2. Eaton A. D. (2005). Standard methods for the examination of water and wastewater. American Public Health Association. American Water Works Association. Water Environment Federation. Publisher: Washington, D.C.: APHA-AWWA-WEF. National government publication: English: 21st edition 3. Glasson J., Therivel R. and Chadwick A. (2012). Rutledge-Taylor and Francis Introduction toEnvironmental Impact Assessment. 4th Edition. 416 pages **4.** Srivastava A. K. (2003). Environment Impact Assessment, (A.P.H. Publishing. Corporation, Delhi,ISBN-817648-4423
Credit II	1. Cruickshank R. (1982). Medical Microbiology, 12th Edition, P.403.2. Felix A. (1942) Brit. Med. J. 11: 597. 2. Roitt L. (1994). Essential Immunology. 8th edition. Blackwell Scientific. Oxford, UK.114- 115. 3. Vaerman J. P. (1981). Single radial immune diffusion, in methods in enzymology. 73 (Langone, J. J.And Van Vunakis, H, Eds.) New York. 291-305.

MBET 247: Bioethics, Biosafety, Quality Control and Quality Assurance Semester VI

Choice based Optional Theory Paper (Elective)

Total: 2 Credits Workload :-15 hrs /credit

(Total Workload :- 2 credits x 150 hrs = 30 hrs in semester

Credit		Lectures
Credit I	**Bioethics and Biosafety** **A. Bioethics** i. Concept of ethics and bioethics with respect to microbiological research ii. Principles of bioethics. iii. Ethical conflicts in microbiological and biotechnological research iv. Biological Diversity Act: conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of utilization of genetic resources **B. Biosafety** Regulatory bodies (Role and functions) i. Advisory Committee: Recombinant DNA Advisory Committee (RDAC) ii. Regulatory / Approval Committees: a. Genetic Engineering Appraisal Committee (GEAC) b. Review Committee on Genetic Manipulation (RCGM) c. SIRO (DSIR) d. Institutional Biosafety Committee (IBSC): Importance of Biosafety Institutional Biosafety Committees (IBSCs) Laboratory associated infections and hazards Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions iii. Monitoring Committees: a. State Biotechnology Coordination Committee (SBCC) b. District Level Committee (DLC)	15
Credit II	Quality Control and Quality Assurance A. Quality Control: Assessment of suitability of components and products Evaluation of the performance of the manufacturing process B. Quality Assurance reviewing and approval of procedures, reviewing records and performing audits C. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) D. Regulatory bodies (Role and functions): i. The Central Drugs Standard Control Organization (CDSCO) ii. National Accreditation Board for Testing and Calibration Laboratories (NABL)	15

	iii. Food Safety and Standards Authority of India (FSSAI): Food and water Laboratories iv. International Standard ISO/IEC 17025:2017(E). v. Bureau of Indian Standards -IS 14648 (2011): Methods of Test for Microbiological Examination of Industrial Product (examples Cosmetics And Cosmetic Raw Materials) vi. The Central Pollution Control Board (CPCB)- Prevention and control of water and air pollution and improvement of the quality of air.	

MBET 247: Semester VI

Bioethics, Biosafety, Quality Control and Quality Assurance

Choice based Optional Theory Paper (Elective)

Credit	References
Credit I	1. Biotechnology: A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nded) ISBN- 10 3527304320. 2. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748. 2. Thomas J.A. and Fuch R. L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press. 3. Notification from Department of Biotechnology, Ministry of Science and Technology, India. (2020) Revised simplified procedures/guidelines on Import, Export and Exchange of GE organisms and product thereof for R& D purpose. File no. BT/BS/17/635/2015-PID. dated-17/01/2020 4. https://ibkp.dbtindia.gov.in/ 5. Ministry of Law And Justice (Legislative Department) New Delhi, the 5th February, 2003/Magha 16, 1924 (Saka) published for general information: The Biological Diversity Act, 2002 No. 18 of2003 [5th February, 2003]
Credit II	1. Draft Manual on method of microbiological testing (2016) microbiology of foods. Food safety and Food Standards. https://old.fssai.gov.in/Portals/0/Pdf/Microbiological_Testing_Foods_Draft_Manual_06_09_2016.pdf 2. Eleftheriadou M. and Tsimillis K. C. (Eds), Eurachem guide: Accreditation for Microbiological Laboratories, Second edition (2013), ISBN: 978-91-87017-92-6. Available from www.eurachem.org. 3. https://archive.fssai.gov.in/home/food-testing/food-testing- manual.html. 4. https://cdsco.gov.in/opencms/opencms/en/About-us/Functions/ 5. https://cdsco.gov.in/opencms/opencms/en/Home/ 6. https://cpcb.nic.in/functions/ 7. https://www.iso.org/obp 8. International Standard ISO/IEC 17025:2017(E). General requirements for the competence of testing and calibrationLaboratories. Third edition. 2017-11 9. IS 14648 (2011): Methods of Test for Microbiological Examination of Cosmetics and Cosmetic Raw Materials. https://law.resource.org/pub/in/bis/S11/is.14648.2011.pdf 10. Manual for Good Food Laboratory Practices (GFLPs). 2018. Food Safety and Standards Authority of India (FSSAI), Ministry Of Health and Family Welfare Government Of India, New Delhi 11. Manual of Methods for Analysis of Water 2016. Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare Government of India, New Delhi 12. National Accreditation Board for Testing and Calibration Laboratories (NABL). (2019) Specific Criteria for Accreditation. NABL 112. Issue No: 04. Issue Date -11-Feb-2019

MBEP 247: Semester IV

Practicals based on Bioethics, Biosafety, Quality Control and Quality Assurance

Choice based Optional Practical Paper (Elective)

Total: 2 Credits **Workload :-30 hrs /credit**

(Total Workload :- 2 credits x 30 hrs = 60 hrs in semester

Credit	Description	Lectures
Credit I	**A. NABL norms for Calibration of:** i. Autoclave- Calibration of pressure gauge and temperature by thermal mapping, sterility testing, SOP preparation. ii. Laminar Air Flow- checking the functioning of UV light by colony count method and sterility checking by blood agar media plate method, SOP preparation.	15
	B. Food Safety and Standards Authority of India (FSSAI) Regulations Test Methods for Drinking Water i. Detection of sulphite-reducing anaerobes (Clostridia) ii. Detection of viruses	15
Credit II	**A. Food Safety and Standards Authority of India (FSSAI) Regulations Test Methods for Water/butter/cheese/milk product for Processed Food Industry:** (perform any two) i. Proteolytic Plate Count ii. Lipolytic Plate Count iii. Thermophillic Bacterial Count (for Dairy Industry-Processing) iv. Slime Forming Bacteria (for Dairy industry-Hot water	15
	B. Food Safety and Standards Authority of India (FSSAI)Regulations for Microbiological Testing of food: i. Detection and Confirmation of *Listeria monocytogenes* in Foods ii. Fermentation Test (Incubation test for Cans, Tetrapacks, Standy pouches).	15

Suggested References MBEP 247: Semester IV

Practicals based on Bioethics, Biosafety, Quality Control and Quality Assurance

Choice based Optional Practical Paper (Elective)

Credit	References
Credit I	**A. NABL norms for Calibration of** National Accreditation Board for Testing and Calibration Laboratories (NABL). (2019)Specific Criteria for Accreditation. NABL 112. Issue No: 04 Issue Date:11-Feb-2019

	B. Food Safety and Standards Authority of India (FSSAI) **Regulations Test Methods for Drinking Water** Manual of Methods for Analysis of Water 2016. Food Safety and Standards Authority of India (FSSAI), Ministry Of Health and Family Welfare Government of India, New Delhi
Credit II	**A. Food Safety and Standards Authority of India (FSSAI) Regulations Test Methods for Water/butter/cheese/milk product for Processed Food Industry:** Manual of Methods for Analysis of Water 2016. Food Safety and Standards Authority of India (FSSAI), Ministry Of Health and Family Welfare Government of India, New Delhi
	B. Food Safety and Standards Authority of India (FSSAI)Regulations for Microbiological Testing of food: 1. Draft manual on method of microbiological testing (2016) microbiology of foods. Food safety and Food Standards. Available at:https://old.fssai.gov.in/Portals/0/Pdf/Microbiological_Testing_Foods_Draft_Manual_06_09_2016.pdf 2. https://archive.fssai.gov.in/home/food-testing/food-testing-manual.html. 3. Manual for Good Food Laboratory Practices (GFLPs). 2018. Food Safety and Standards Authority of India (FSSAI), Ministry Of Health and Family Welfare Government of India, New Delhi

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