M. C. E. Society's
Abeda Inamdar Senior College
Of Arts, Science and Commerce, Camp, Pune- 1
(Autonomous) Affiliated to Savitribai Phule Pune University
NAAC accredited 'A' Grade

Two Year Degree Program in Microbiology (Faculty of Science &Technology)

Syllabus for M.Sc. (Microbiology) Part-II

Choice Based Credit System Syllabus

To be implemented from Academic Year 2022-2023

Title of the Course:

M.Sc. (Microbiology) Preamble:

The main theme of teaching Microbiology courses is the application of basic principles of life sciences related to upcoming technology. Modern biology combines the principles of chemistry and biological sciences (Molecular biology, Clinical Microbiology, Immunology, Nanobiotechnology) with technological disciplines (engineering, computer science). The objective of the Master's Programme in Microbiology is to equip the students with updated knowledge of Pharmaceuticals like drug designing and drug development, molecular biology and Microbial technology.

The Board of Studies in Microbiology has identified the following thrust areas and prospective plans for syllabi reforms at postgraduate level:

- **Immunology:** It includes recent BRM therapy, tumor and its microenvironment and also immunological tolerance.
- **Clinical Microbiology**: It includes understanding various bacterial, viral, fungal and protozoal diseases with respect to causative agents, general characters, detection methods and prophylaxis.
- **Nanobiotechnology:** It provides a multitude of new tools for applications in various industries.
- **Pharmaceutical Microbiology**: It provides recent advancements in drug discovery and drug development.
- **Microbial Technology**: It provides the knowledge of the latest strategies in fermentation.
- **Research Methodology**: It includes use of search engines for scientific data mining, use of reference management tools, statistical data analysis using software.

To enrich students' knowledge and train them in the above-mentioned areas; we feel certain topics in the present syllabus need to be supplemented and strengthened by inclusion of a few additional topics. Areas that need to be introduced in syllabi have been identified as:

- Immunology
- Clinical Microbiology

- Advanced Molecular Biology Techniques
- Pharmaceutical Microbiology
- Microbial Technology
- Techniques in Bionanotechnology

In addition, we feel that the students should be well acquainted with research methodology which includes different skill developments in scientific writing, data handling and processing, development of research ideas and planning / designing of research projects. The skill sets thus evolved will help the students in overall research. This syllabus aims to give the student a significant level of theoretical and practical understanding of the subject.

Introduction:

With the changing scenario, we feel that the syllabus orientation should be altered to keep pace with developments in the education sector. The need of the hour is proper syllabi that would emphasize on teaching of latest technological aspects as well as its applications in various sectors. Theory supplemented with laboratory expertise and hands-on training will help students to get better job opportunities. Both these aspects i.e theory as well as practical needs to be considered, such that a postgraduate student can start working directly in different industries or institutions, without any additional training.
Thus, the college itself would try to develop trained and skilled manpower. We have restructured the syllabus from this viewpoint. The restructured syllabus will combine the principles of chemistry and biological sciences (molecular and cell biology, genetics, immunology, clinical Microbiology) with technological disciplines to produce goods and services and for wastewater treatment and management.

Microbiology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible aspects.
In addition, students are to be trained to apply this knowledge particularly in day- to-day applications of Microbiology and to get a glimpse of research**.**

Objectives to be achieved:

- To enrich students' knowledge and train them in life sciences
- To introduce the concepts of Nanobiotechnology
- To inculcate research aptitude
- To inculcate a sense of scientific responsibilities
- To help students build-up a progressive and successful career in Microbiology

PROGRAM SPECIFIC OUTCOME

The objectives of PG Microbiology are to get students familiarized to versatile tools and techniques employed in Molecular Biology and nanobiotechnology. They are introduced to the concepts of Clinical Biology. The objective is also to inculcate research aptitude and carry out academic and applied research. They will gain an insight on Clinical Microbiology, Pharmaceutical Microbiology; Molecular biology, Microbial Virus Technology, Advances in Microbial Technology, Industrial waste water treatment and industrial production of vaccines.

Evaluation Pattern:

For each Theory and Practical Course, 50-50 pattern will be followed.

Internal assessment will be of 50 marks for a paper of 100 Marks.

Internal assessment will be of 25 marks for a paper of 50 Marks.

For Continuous Internal Evaluation (CIE), evaluation of theory courses will be done continuously.

The 50 marks of Internal Evaluation shall be divided into the following:

a) One Mid-Semester Exams of 15 Marks each

b) Two Class Tests of 15 marks each converted to 15 Marks

c) One Presentation/Seminar/MCQ Test of 5 Marks

d) One Group Discussion/Open Book Test of 5 or 10 Marks

e) Class Assignments of 5 or 10 Marks

f) A compulsory Mock Practical Examination and Viva Voce of practical subjects

g) Internal marks for Journal / project report/ dissertation report completion and certification

Course Structure: Semester III						
Course Type	**Course Code**	**Course Name**	**Credits**	**Assessment**		
				IA	**UE**	**Total**
Core Compulsory Theory Papers	21SMMB231	Immunology and Clinical Microbiology	4	50	50	100
	21SMMB232	Molecular Biology II	4	50	50	100
	21SMMB233	Nanobiotechnology and its applications	4	50	50	100
Choice Based Optional Papers Elective/ Departmental Course	21SMMB234A	Cell Culture Techniques	2	25	25	50
	21SMMB236A	Practicals based on Cell Culture Techniques	2	25	25	50
	OR					
	21SMMB234B	Bioremediation and Biomass utilization	2	25	25	50
	21SMMB236B	Practicals based on Bioremediation and Biomass utilization	2	25	25	50
	OR					
	21SMMB234C	Microbial Virus Technology	2	25	25	50
	21SMMB236C	Practicals based on Microbial Virus Technology	2	25	25	50
Core Compulsory Practical paper	21SMMB235	Immunology, Clinical Microbiology, Molecular Biology and Applied Nanotechnology (Practicals based on compulsory theory credits)	4	50	50	100

Course Structure: Semester IV						
Course Type	**Course Code**	**Course Name**	**Credits**	**Assessment**		
				IA	**UE**	**Total**
Core Compulsory Theory Papers	21SMMB241	Pharmaceutical Microbiology	4	50	50	100
	21SMMB242	Microbial Technology	4	50	50	100
Choice Based Optional Papers Elective/ Departmental Course	21SMMB243A	Quality assurance and validation in Pharmaceutical industry and development of Anti- infectives from plants	2	25	25	50
	21SMMB245A	Practicals based on quality assurance and validation in Pharmaceutical industry and development of Anti-infectives from plants	2	25	25	50
	OR					
	21SMMB243B	Advances in Microbial Technology	2	25	25	50
	21SMMB245B	Practicals based on Advances in Microbial Technology	2	25	25	50
	OR					
	21SMMB243C	Industrial waste water treatment and Industrial production of vaccines	2	25	25	50
	21SMMB245C	Practicals based on Industrial waste water	2	25	25	50

		treatment and Industrial production of vaccines				
	OR					
	21SMMB243D	Bioethics, Biosafety, Quality Control and Quality Assurance	2	25	25	50
	21SMMB245D	Practicals based on Bioethics, Biosafety, Quality Control and Quality Assurance	2	25	25	50
Core Compulsory Practical paper	21SMMB244	Dissertation	4	50	50	100

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MSc II Syllabus Semester III
(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	21SMMB231
Course Code	Immunology and Clinical Microbiology
Semester	III
No. of Credits	4

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To enrich students' knowledge related to basic concepts of Immunology
2.	To give the students' knowledge about host immune response
3.	To make students acquainted with the cell surface receptors present on various cells for signal transduction pathways.

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will understand the concepts of Immunology
2.	Students will be able to study the different effector mechanisms of host immune response
3.	Students will understand the concepts of signal transduction pathways.

21SMMB231: Immunology and Clinical Microbiology

Core Compulsory Theory Paper

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

Credit Number	Credit	Workload
I	**Cell surface molecules and receptors**	**15**
	A. Definition, General structure and mechanism (dimerization and rotation),components of signal transduction (extracellular signaling molecule, receptor proteins, intracellular signaling proteins and target proteins) **B.** Adhesion molecules in immune activation, structure and function of B Cell Receptor, TCR-CD3 complex, Toll-like receptors, Cytokine receptors, G-protein coupled receptors **C.** Signal transduction pathways: IL-2 pathways (JAK/STAT, Ras/MAP Kinase Pathways)	
II	**Regulation of Immune response**	**15**
	A. Negative regulation - Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals), T cell mediated suppression of immune response **B.** Regulation of immune responses by antigen, antigen-antibody complexes, Network theory and its experimental evidence **C.** Cytokines involved in haematopoiesis, Cytokine mediated cross regulation of TH subsets (TH1-TH2) **D.** Regulation of complement system – Classical and alternative pathway **E.** Biological Response Modifiers for cancer therapy and autoimmune disorders	

III	**Determinants of Microbial Pathogenicity**	**15**
	A. Adhesion **B.** Invasion **C.** Evasion **D.** Toxigenesis (Mode of action –In vivo and In vitro assay systems for diphtheria, cholera, tetanus toxoid and endotoxins of Gram-negative bacteria) **E.** Molecular basis of bacterial pathogenicity – Cytoskeletal modulation of host cell. Virulence genes and pathogenicity islands	
IV	**Bacterial/Viral/Protozoal/fungal/algal diseases with respect to causative agents, general characters, detection methods, therapeutic agents and prophylaxis**	**15**
	A. Bacterial infections: Helicobacter pylori, Actinomycetes bovis/israelli **B. Viral infections:** Hepatitis B, Oncoviruses **C. Protozoal infections:** Ascaris lumbricoides, Giardia lamblia **D. Fungal infections:** Candidiasis and Aspergillosis. **E. Algal infections:** Dinoflagellate, Noctiluca scintillans, Fibrocapsa japonica	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	Molecular Biology II
Course Code	21SMMB232
Semester	III
No. of Credits	4

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To enrich students' knowledge related to Molecular Biology
2.	To inculcate the concepts of cell and Molecular Biology of cancer
3.	To make students acquainted with the concepts of RNA interference and RNA splicing

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will understand the concepts of Molecular Biology
2.	Students will be able to understand the concept of Metabolomics.
3.	Students will understand the concept and applications of transgenic plants and transgenic animals

21SMMB232 Molecular Biology II

Core Compulsory Theory Paper

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

Credit No.	Credit	Workload
I	**Cell and Molecular Biology of Cancer**	**15**
	A. The genetics of normal and malignant cells Normal chromosomal structure/function, gene transcription, DNA repair mechanisms; gene polymorphisms, mini and microsatellites; genome instability, gene amplification and deletion. **B. Normal and aberrant mechanisms of cell growth control** Control of normal cell growth and behaviour; Altered expression, function and control of these mechanisms in malignancy; Role of mitotic kinases; Gene promoters and their activity in normal and malignant cells. **C. Using gene therapy and immunotherapy to treat cancer** Biomarkers of response to therapy: using circulating cells and DNA, biopsies, surrogate tissues, body fluids, non-invasive imaging	
II	**Genetically modified plants and animals** **A.** Genetically modified organisms- social and ethical issues **B.** Gene augmentation and gene therapy **C.** Applications in medicine – prevention, early detection and cure of diseases **D.** Applications of transgenic plants and animals - advantages and disadvantages	**15**

	E. Transgenic model with CRISPR/Cas9 system	
III	**RNA splicing and RNA interference**	**15**
	A. RNA splicing: ● Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, Cis- and Trans- splicing reactions, tRNA splicing, alternate splicing. ● Regulation of translation, co-and post-translational modifications of proteins, Dipeptide assay, Tripeptide assay, In vitro translation. **B. RNA interference**: ● The concept of RNAi (RNA interference) and discovery, Gene silencing, Gene activation, Biogenesis and Regulatory roles of non-coding RNAs - miRNA, siRNA, piRNA, lncRNA. RNAi-mediated gene silencing - Components and Mechanism, RISC and Proteins.	
IV	**Metabolomics**	**15**
	A. Introduction to metabolomics: Metabolome, Metabonomics, Metabolite profiling, Metabolome fingerprinting, Role of Biomarker in metabolomics, Tools of metabolome studies: NMR, MS, GC, LC, IR and its application. **B.** Metabolome projects of plant and human, Future perspective of metabolomics	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	Nanobiotechnology and its applications
Course Code	21SMMB233
Semester	III
No. of Credits	4

Aims & Objectives of the Course:

Sr. No.	Objectives
1.	To introduce the concepts of Nanobiotechnology
2.	To make students learn the concepts of nanoparticles and their uses in depth
3.	To give students the knowledge of the applications of nanobiotechnology in different industries.

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will be acquainted with the concepts of Nanobiotechnology
2.	Students will understand the applications of nanobiotechnology in various fields
3.	Students will get knowledge of nano carriers, nano sensors and their uses in different fields.

21SMMB233: Nano biotechnology and its applications

Core Compulsory Theory Paper

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

Credit No.	Credit	Workload
I	**Nanobiotechnology in Medical Science**	**15**
	A. Concept of Nanobiotechnology in Nanomedicine **B.** Two main branches in nanomedicine: Diagnostics and Therapeutics **C.** Different Nanoparticles and their Medical applications	
II	**Nanobiotechnology in Food Industry**	**15**
	A. Food Safety a) Nanoencapsulation b) Food processing c) Bio-security - Food analysis and contaminant detection **B**. Food Packaging (Nanoscience in Food Packaging) Nanopackaging for enhanced shelf life - Smart/Intelligent packaging	
III	**Nanobiotechnology in Agriculture**	**15**
	A. Various types of nanomaterial utilized in agriculture, Soil health-Different Indicators (Assays) for determining soil health. **B.** Use of Nanomaterials to Promote Plant Growth and Stress Tolerance **C.** Nanoformulations of agrochemicals for applying Nanopesticides and Nanourea and mixed fertilizers for crop improvement. Nano fungicides, Nano herbicides **D.** Nanosensors for early detection of plant diseases	

IV	**Nanobiotechnology in Waste management**	**15**
	A. Nanobiotechnology for E-waste management **B.** Nanobiotechnology for waste water management **C.** Nanobiotechnology for solid waste management	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Cell Culture Techniques**
Course Code	21SMMB234A
Semester	III
No. of Credits	2

21SMMB234A Cell Culture Techniques

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 No.	Credit	Workload
I	**Animal Cell Culture Techniques:**	**15**
	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.	
II	**Commonly used cell culture systems and cell lines in immunological studies:**	**15**
	A. Cell culture systems and their applications: primary lymphoid cell culture cloned lymphoid cell lines, hybrid lymphoid cell lines. **B.** Immuno-modulation	

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Course/ Paper Title	**Practicals based on Cell Culture Techniques**
Course Code	21SMMB236A
Semester	III
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students aware about the different Cell Culture Techniques
2.	To make them understand the applications of Cell Culture Techniques
3.	To teach them Chick embryo fibroblast cell culture

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	To make the students understand the methods of Cell Culture Techniques
2.	To make them understand the techniques used for Chick embryo fibroblast cell culture

21SMMB236A Practicals based on Cell Culture Techniques
Optional Practical Paper (Elective)

Total: 2 Credits Workload: -30 hrs /credit

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

Credit No.	Credit	Workload
I	**Animal Cell Culture Techniques:**	**15**
	A. Density gradient-based separation of peripheral lymphocytes **B.** Preparation of Lymphocyte culture **C.**Effect of immunomodulators on lymphocyte proliferation (Stimulatory and inhibitory effect)	
II	**Commonly used cell culture systems and cell lines in immunological studies:**	**15**
	A. Chick embryo fibroblast cell culture	

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1. Freshney R. I. (2005) Culture of Animal Cells: A Manual of Basic Technique.5th Ed. John Wiley and Sons, Inc.
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(CBCS- Autonomy 21 Pattern)

Course/ Paper Title	**Bioremediation and Biomass utilization**
Course Code	21SMMB234B
Semester	III
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To introduce the concepts of bioremediation
2.	To make students learn the concepts of biomass utilization
3.	To make them understand the concepts of microbial degradation

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students develop an interest in the field of bioremediation
2.	They understand the concepts of biomass utilization
3.	Students understand the concepts and use of microbial degradation

21SMMB234B Bioremediation and Biomass utilization 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 No.	Credit	Workload
I	**Bioremediation**	**15**
	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	
II	**Biomass utilization**	**15**
	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 alcohol production **E.** Improvisation of the processes of fructose production **F.** Commercial production processes of alcohol and fructose	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Practicals Based on Bioremediation and Biomass utilization**
Course Code	**21SMMB236B**
Semester	III
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To introduce the concepts of bioremediation
2.	To make students learn the concepts of biomass utilization
3.	To make them understand the concepts of microbial degradation

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students develop an interest in the field of bioremediation
2.	They understand the concepts of biomass utilization
3.	Students understand the concepts and use of microbial degradation

21SMMB236B Practicals Based on Bioremediation and Biomass utilization
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 No.	Credit	Workload
I	**Bioremediation**	**15**
	A. Degradation of para nitrophenol using *Pseudomonas putida* **B.** Low density plastic/bioplastic degradation using bacterial isolates **C.** Demonstration of DNA finger-printing technique	
II	**Biomass utilization**	**15**
	A. Biodiesel production using micro-algae **B.** Isolation of bio-emulsifier producing organisms for degradation of aromatic compounds	

References:

1.Glick B. R., Pasternak J. J., Cheryl L. and Patten C. L. (1998) Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington D C, 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

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	Microbial Virus Technology
Course Code	21SMMB234C
Semester	III
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students acquainted with the concept of isolation and characterization of bacteriophages.
2.	To inculcate various concepts of bacteriophage growth kinetics.
3.	To teach them about Phage typing.

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students understand the concepts of isolation and characterization of bacteriophages.
2.	Students understand the various concepts of bacteriophage growth kinetics
3.	Students learn about Phage typing.

21SMMB234C Microbial Virus Technology
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 No.	Credit	Workload
I	**A. Isolation and characterization of bacteriophages:** i) Abundance of bacteriophages in the environment. ii) Bacteriophage life cycle: Lytic, Lysogeny and chronic cycle. iii) Genetic basis of lytic and lysogenic cycles. **B. Isolation of bacteriophages from various environmental samples:** i) Water ii) Soil iii)Clinical samples **C. Bacteriophage growth kinetics:** i) Concept and calculations of EoP, MOI ii) Adsorption Kinetics iii) One step growth curve **D. Phage based bacterial detection: Phage typing**	**15**
II	**A. Applications of bacteriophages:** i) Bacteriophages as biocontrol agents ii) Phage therapy iii) Phage lysine therapy (with any one example) iv) Phage display v) CRISPR-CAS-9 **B.** Phage based technology for pathogen control in aqua systems **C.** Bacteriophages for biocontrol of biofilms on medical devices **D.** Bacteriophage based technology for pathogen control in poultry	15

	E. Bacteriophages in food preservation **F.** Introduction of Mycoviruses **G.** Introduction to algal viruses	

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1.Ahiwale Sangeeta (2013) Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies. PhD thesis, University of Pune, Pune, Maharashtra

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(CBCS – Autonomy 21 Pattern)

Course/Paper Title	Practicals based on Microbial Virus Technology
Course Code	21SMMB236C
Semester	III
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students acquainted with the concept of isolation, purification and preservation of bacteriophages
2.	To inculcate various concepts of bacteriophage growth kinetics
3.	To teach them about applications of bacteriophages

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students understand the concepts of isolation, purification and preservation of bacteriophages
2.	Students understand the various concepts of bacteriophage growth kinetics
3.	Students learn about applications of bacteriophages

21SMMB236C Practicals Based on Microbial Virus Technology
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 No.	Credit	Workload
I	**Isolation, Purification and Preservation of phages:**	**15**
	A. Isolation of bacteriophages from Soil/ water/ clinical sample **B.** Isolation of algal viruses (Phycoviruses) **C.** Isolation of fungal viruses (Mycoviruses) **D.** Purification & preservation of the isolated phage	
II	**Bacteriophage kinetics and Applications:**	**15**
	A. Determination of adsorption kinetics of phage and EoP (If cross reactive) **B**. One step growth curve **C**. Determination of phage stability considering pH and temperature **D**.In-vitro application of phages as biocontrol agent	

References:

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 Sangeeta (2013) Bacteriophages against enteric bacterial pathogens and their potential for bioremediation of pathogen infested water bodies PhD thesis, University of Pune,Pune, Maharashtra.

3. Ahiwale S.S. (2011) In vitro management of hospital Pseudomonas aeruginosa biofilm using indigenous T7-like lytic phage. Curr. Microbiology. 62:335-340

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5. Nabergoj D., Modic P. and Podgornik A. (2018). Effect of bacterial

growth rate on bacteriophage population growth rate. Microbiology Open, 7, e00558.
6. Marei E.M. and Elbaz R.M. (2013) Isolation and molecular characterization of three virulent actinophages specific for Streptomyces flavovirens. Journal of Virology Research. 2(1):12-17
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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	Immunology, Clinical, Molecular Biology and applied nanobiotechnology (Practicals based on compulsory theory credits)
Course Code	21SMMB235
Semester	III
No. of Credits	4

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students aware about Molecular Biology techniques
2.	To make them familiar to Immunology and Clinical Microbiology
3.	To teach them applications of nanobiotechnology

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will learn about Molecular Biology techniques
2.	Students will be made familiar to Immunology and Clinical Microbiology
3.	Students will be acquainted with applications of nanobiotechnology

21SMMB235 Immunology, Clinical, Molecular Biology and Applied Nanotechnology (Practicals based on compulsory theory credits)

Core Compulsory Practical Paper

Total: 4 Credits Workload: -30 hrs /credit

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

Credit No.	Credit	Workload
I	**Practicals based on 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 CFT/FACS/animal inoculation	
II	**Practicals based on Clinical Microbiology:** 1. Isolation and identification of A. *Helicobacter pylori* B. *Actinomycetes* C. *Candida albicans* D. *Aspergillus flavus.* 2. Viral titration by haemagglutination technique (Determination of titre)	
III	**Practicals based on Molecular Biology II**	
	1.Isolation of Plasmid from Bacteria 2. Study of the process of transduction 3. Study of the process of DNA damage by comet assay. 4. Study of the process of bacterial conjugation and transfer of the gene of interest	

IV	**Practicals based on Applied Nanobiotechnology**	
	1. Use of nanoparticles for biofilm inhibition 2.Removal of dyes by nanoparticles 3.Use of nanoparticles in medicine 4.Use of nanoparticles in food preservation	

References:

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Semester IV
(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Pharmaceutical Microbiology**
Course Code	21SMMB241
Semester	IV
No. of Credits	4

Aims & Objectives of the Course

Sr. No.	**Objectives**
1.	To enrich students' knowledge related to basic concepts in drug discovery and drug development.
2.	To inculcate the knowledge regarding the drug designing , pharmacokinetics and pharmacodynamics
3.	To make students acquainted with the concepts of pharmaceuticals.

Expected Course Specific Learning Outcome

Sr. No.	**Learning Outcome**
1.	Students will understand the concepts of drug discovery and drug development.
2.	Students will be able to understand pharmacokinetics and pharmacodynamics.
3.	Students will understand the recent trends for MDR therapy

21SMMB241: Pharmaceutical Microbiology

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

Credit No.	Credit	Workload
I	**Drug Discovery**	**15**
	A. Definition and explanation of terms used in medicinal chemistry (HITS, Lead compound, Lead optimization, Candidate, HTS) **B.** Nomenclature and Physicochemical properties of drugs **C.** Introduction to modern drug discovery, rational drug design: Ligand based and receptor-based drug design. (molecular docking)	
II	**Drug Development**	**15**
	A. Classification of drugs based on therapeutic classes, target, mechanism of action, chemistry, etc. **B.** Preclinical development. Toxicity testing – acute, sub acute, chronic. **C.** Clinical development: Clinical trials (aims, objectives and conduct). Clinical trials I, II, III and IV	
III	**Recent trends in combating MDRs**	**15**
	A. Introduction to Recent trends in combating MDRs **B. Alternative treatments** 1.AMPS 2.Nanoparticles 3.Antivirulence (QS inhibitors) 4.New Molecules **C. Drug Repurposing** 1.Anticancerous 2.Antipsychotics 3.Antihelminthic 4.Anti inflammatory 5.Statins	

IV	**Pharmacokinetics and Pharmacodynamics**	**15**
	Pharmacokinetics: **A. Drug absorption:** Drug dosages, from gastric emptying to gastric permeability to drug, first pass effect, bioavailability. **B. Drug distribution:** Drug-plasma/ serum binding, blood brain barrier, accumulation in tissues. **C. Drug Metabolism:** Phase I Phase II Phase III **D. Drug elimination** :Drug excretion, Drug biotransformation, **Pharmacodynamics:** **A.** Biochemical, physiological and molecular effects of drugs on the body. **B.** Therapeutic Effect, Neutral and Adverse Drug Reactions	

References:

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Microbial Technology**
Course Code	21SMMB242
Semester	IV
No. of Credits	4

Aims & Objectives of the Course

Sr. No.	**Objectives**
1.	To make students aware of microbial technology.
2.	To make them familiar with various techniques in fermentation.
3.	To teach them applications of microorganisms in various industries.

Expected Course Specific Learning Outcome

Sr. No.	**Learning Outcome**
1.	Students will learn about microbial technology and its applications
2.	Students will learn about various process control methods in fermentation.
3.	Students will be acquainted with the applications of microorganisms in different industries.

21SMMB242 Microbial Technology

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

Credit No.	Credit	Workload
I	**Bioreactor Design and Operation**	**15**
	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.	
II	**Process Variables and Monitoring**	**15**
	A. Aeration: Theory of Oxygen transfer in bubble aeration, Oxygen transfer kinetics (OUR, OTR, Ccrit) Determination of KLa **B.** Agitation: Functions, Flow patterns and different types of impellers. **C.** Fermentation Broth Rheology and Power requirements for agitation, Concept of Newtonian and Non Newtonian fluids. **D.** Reynolds Number, Power Number, Aeration Number. **Monitoring of process variables**: A. Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and DCO2) B. Basic principles of operation, types of biosensors	

III	**Microbial Growth characteristics and product formation**	**15**
	A. Control of primary (growth associated) and secondary (growth non-associated) metabolites. **B.** Kinetics of growth and product formation (growth rate, yield coefficient, efficiency) **C.** Effect of type of growth on fermentation: Different types of growth (mycelial form, free cell, cells producing exopolysaccharides) **D.** Effect of mass transfer of nutrients, oxygen and heat on fermentation.	
IV	**Applications of fungi in various fields.**	**15**
	A. Agriculture and environmental applications. **B.** Food Industry **C.** Biosensors **D.** Fuel cells. **E.** Use of Immobilized yeast cells.	

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(CBCS – Autonomy 21Pattern)

Course/ Paper Title	**21SMMB243A**
Course Code	Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti-infectives from plants
Semester	IV
No. of Credits	2

21SMMB243A: 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 No.	Credit	Workload
I	**Quality Assurance and Validation in Pharmaceutical Industry**	**15**
	A. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the 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. Sterility Testing ii. Pyrogenicity testing iii. Mutagenicity and Carcinogenicity testing	

	iv. Teratogenicity testing	
II	**Development of Anti-infectives:**	**15**
	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	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Practicals based on Quality Assurance and Validation in Pharmaceutical Industry and Development of Anti-infectives from plants**
Course Code	21SMMB245A
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students aware of Quality Assurance in Pharmaceutical Industry.
2.	To inculcate the concepts of validation in Pharmaceutical Industry.
3.	To give students the knowledge of development of anti- infectives from plants

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will have knowledge of Quality Assurance in the Pharmaceutical Industry.
2.	Students will understand Validation in the Pharmaceutical Industry.
3.	Students will be acquainted with the knowledge of development of anti- infectives from plants

21SMMB245A: Practicals based on Practicals 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 No.	Credit	Workload
I	**Quality Assurance and Validation in Pharmaceutical Industry**	**15**
	Sterility testing of following pharmaceutical preparations as per IP: **A. Oral preparations**: Antipyretic or antibiotic tablets **B. Liquid preparations:** Water soluble vitamin or cough syrup or ophthalmic drops **C. Bulk preparations:** (any two) Surgical Cotton rolls/ gauze/ surgical sutures/ disposable syringes	
II	**Development of Anti-infectives:**	**15**
	Detection and isolation of anti- infectives from plant **A.** Extraction of bioactive principles from plant and activity fractionation **B.** Estimation of its antimicrobial activity using standard guidelines (CLSI)	

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Course/ Paper Title	**Advances in Microbial Technology**
Course Code	21SMMB243B
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students aware about Advances in Microbial Technology
2.	To make them familiar with various techniques used for animal cell culture technology.
3.	To teach them applications of animal cell culture technology.

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will learn about Advances in Microbial Technology
2.	Students will learn about applications of animal cell culture technology
3.	Students will be acquainted with the latest techniques and their applications.

21SMMB243B: Advances in Microbial Technology

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 No.	Credit	Workload
I	**Polysaccharides:**	**15**
	A. Introduction and Nature of Polysaccharides. **B.** Mechanism of synthesis a) Bacterial polysaccharides b) Fungal polysaccharides c) Yeast polysaccharides Commercially produced polysaccharides	
II	**Animal cell culture technology to produce**	**15**
	A. Recombinant forms of natural proteins (Insulin, erythropoietin), **B.** Recombinant vaccines (protein: HIV, hepatitis B and DNA: HIV, malaria) **C.** Nucleic acid-based products (introduction to gene therapy).	

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Course/ Paper Title	**Practicals based on Advances in Microbial Technology**
Course Code	21SMMB245B
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	**Objectives**
1.	To make students aware about Advances in Microbial Technology
2.	To make them familiar with various techniques used for animal cell culture technology.
3.	To teach them applications of animal cell culture technology.

Expected Course Specific Learning Outcome

Sr. No.	**Learning Outcome**
1.	Students will learn about Advances in Microbial Technology
2.	Students will learn about applications of animal cell culture technology.
3.	Students will be acquainted with the latest techniques and their applications.

21SMMB245B: Practicals based on Advances in Microbial Technology
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 No.	Credit	Workload
I	**Polysaccharides**	**15**
	Laboratory scale production and media optimization for: exopolysaccharide / bioemulsifier production	
II	**Animal cell culture technology to produce**	**15**
	A. Preparation of Hybridoma from tumour cell lines. **B.** Production of monoclonal antibodies from hybridoma of tumour cell lines	

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1.Biswas J. and Paul A. K. (2017). Optimization of factors influencing exopolysaccharide production by Halomonas xianhensis SUR308 under batch culture. AIMS Microbiology, 3(3), 564–579.

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(CBCS – Autonomy 21Pattern)

Course/ Paper Title	Industrial Waste Water Treatment and Industrial Production of Vaccines
Course Code	21SMMB243C
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students study the concepts of Industrial Waste Water Treatment
2.	To make them understand about sludge treatment
3.	To make students learn about the Industrial Production of Vaccines

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students understand the concepts of Industrial Waste Water Treatment
2.	Students learn about sludge treatment
3.	Students get acquainted with the concepts of Industrial Production of Vaccines

21SMMB243C 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 15 hrs = 30 hrs in semester)

Credit No.	Credit	Workload
I	**Concept and Introduction**	**15**
	A.Primary, Secondary and Tertiary treatment of Wastewater. Aerobic and Anaerobic, Suspended and Attached growth processes. **B.** Activated Sludge treatment and analysis (reactions and Kinetics, mass balance analysis, Hydraulic characters) **C.** Critical Operating parameters like DO, Hydraulic retention time, Mean cell retention time, F/M ratio. **D.** Advanced treatments: SAFF, MBR , MBBR, RBC.	
II	**Current industrial wastewater treatment processes**	
	A. Composition, physico-chemical properties and various effluents treatment methods with reference to: a. Dairies b. Food processing c. Dyeing industry / Dye-house effluents d. Paper and pulp industry e.Pharmaceutical Industries **B.**Sludge treatment and disposal	

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	**Practicals based on Industrial Waste Water Treatment and Industrial Production of Vaccines**
Course Code	21SMMB245C
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students study the concepts of Industrial Waste Water Treatment
2.	To make them understand about sludge treatment
3.	To make students learn about the Industrial Production of Vaccines

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students understand the concepts of Industrial Waste Water Treatment
2.	Students learn about sludge treatment
3.	Students get acquainted with the concepts of Industrial Production of Vaccines

21SMMB245C: Practicals based on Industrial Waste Water Treatment and 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 No.	Credit	Workload
I	**Concept and Introduction**	**15**
	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.	
II	**Current industrial wastewater treatment processes**	**15**
	Analysis of physicochemical and microbial parameters of dairy industry 1.pH 2. Temperature 3. BOD 4. COD 5.TS,TDS TSS	

References:

1.Barthwal R. R. (2002) Environmental Impact Assessment, New Delhi (India). New Age International (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

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(CBCS – Autonomy 21 Pattern)

Course/ Paper Title	Bioethics, Biosafety, Quality Control and Quality Assurance
Course Code	21SMMB243D
Semester	IV
No. of Credits	2

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To make students study the concepts of Quality Assurance reviewing and approval of procedures, reviewing records and performing audits
2.	To make them understand about ethical conflicts in microbiological and biotechnological research
3.	To learn about Biosafety Regulatory bodies (Role and functions)

Expected Course Specific Learning Outcome

Sr. No.	Learning Outcome
1.	Students will learn about Quality Assurance reviewing and approval of procedures, reviewing records and performing audits
2.	Students will learn about Ethical conflicts in microbiological and biotechnological research
3.	Students will be acquainted with Biosafety Regulatory bodies (Role and functions)

Credit No.	Credit	Workload
I	**Bioethics and Biosafety**	**15**
	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)	
II	**Quality Control and Quality Assurance**	
	Quality Control: **A.** 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) 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.	

References:

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) ISBN10: 0028657748. 2. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.

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15. https://cdsco.gov.in/opencms/opencms/en/Home/
16. https://cpcb.nic.in/functions/
17. https://www.iso.org/obp

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21SMMB245D: 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 No.	Credit	Workload
I.	**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 **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**
II.	**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. Thermophilic Bacterial Count (for Dairy Industry-Processing) iv. Slime Forming Bacteria (for Dairy industry-Hot water **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**

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1. National Accreditation Board for Testing and Calibration Laboratories (NABL). (2019)Specific Criteria for Accreditation. NABL 112. Issue No: 04 Issue Date:11-Feb-2019

2. 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

3. 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

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Available at:https://old.fssai.gov.in/Portals/0/Pdf/Microbiological_Testing_Foods_Draft_Manual_06_09_2016.pdf

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21SMMB244: Dissertation

Guidelines for MBCP-4 Semester IV: Dissertation

1. A dissertation can be carried out by a single student or by a 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 a single oral presentation.
6. In such a case, the 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 will be present; the dissertation guide may or may not be present.
8. Presentation should be carried out to in the presence an audience composed of examiners, departmental teaching staff and the 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 a question and answer session of 5 to 8 minutes. The audience can participate in this session.
11. The assessment of the dissertation is for a total of 100 marks (IA-50 and EA-50) out of which end semester will be for 50 marks and the in semester assessment will be for 50 marks.
12. The assessment of the first 50 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, the Head of the department will hand over these unopened envelopes to the examiners.
13. Assessment of remaining 50 marks (end semester examination for both courses) will be carried out for individual students 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.

15. 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.

Practical Examination in M. Sc. Microbiology

Month **Year**

Course MBCP-4 (Dissertation)

Name of the Center:
Name of the Student:
Exam No.:

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

Sr. No.	Points for Evaluation	Max. Marks	Evaluation
1.	Intellectual potential – Understanding of the research problem by the student (topic selection)	8	
2.	Research aptitude –		
	a) Depth of literature survey for the proposed work.	5	
	b) Inputs of student in development of plans and protocols for the experimentation (methodology)	8	
	c) Ability to analyze data and formulate a solution (statistical analysis)	8	
	d) Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	8	
3.	Motivation – punctuality, meeting dead-lines and seriousness (attendance)	4	
4.	Ability to work with others	4	
5.	Communication skill – oral and written (conferences, oral, ppt., publication)	5	
	Total	50	

Place of work :
Name of the Guide:
Date and Signature **:**

Practical Examination in M. Sc. Microbiology

Month **Year**

Course MBCP-4 (Dissertation)

Name of the Center:

Name of the Student:

Exam 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	7	
2.	Research potential of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work towards society	7	
3.	The dissertation report preparation (scientific writing) and its contents	4	
4.	Abilities of satisfactory responses to the queries from the audience (defense)	7	
	Total	25	

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 :

Practical Examination in M. Sc. Microbiology

Month **Year**

Course MBCP-4 (Dissertation)

Name of the Center:

Name of the Student:

Exam 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	7	
2.	Research potential of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work towards society	7	
3.	The dissertation report preparation (scientific writing) and its contents	4	
4.	Abilities of satisfactory responses to the queries from the audience (defense)	7	
	Total	25	

Place of work:

Name of the Internal Examiner:

Signature:

Date: