K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2024

NOTIFICATION

Sub :- CBCS Syllabi of M. Sc. in Microbiology (Sem. III & IV)

Ref. :- Decision of the Academic Council at its meeting held on 27/07/2024.

The Syllabi of M. Sc. in Microbiology (Third and Fourth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2023 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2024-25.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

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Khandesh College Education Society's

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SYLLABUS

M.Sc. IIMicrobiology

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. AcademicYear:2024-25]

Preface

Skilled human resources is a prerequisite in higher education, and it is to be acquired through in-depth knowledge of theoretical concepts and hands-on laboratory methods of the subject. The present syllabus of M.Sc. part II in Microbiology has been prepared per the guidelines of UGC, NEP-2020 and the Government of Maharashtra. It aims to cultivate theoretical and practical knowledge of different fields of Microbiology among the students. The contents of the syllabus have been prepared to accommodate the fundamental aspects and advanced developments in various disciplines of Microbiology and to complement the needs of various applied sectors of Microbiology. Besides this, the students will be enlightened with knowledge in the newer areas of, Biomoleculesand microbial metabolism, molecular biology and microbial genetics, virology, immunology,cell biology, environmental microbiology and extremophiles, microbial fermentations, IPR, Patents, bioethics etc. The overall curriculum of one/ two-year also covers various advanced biotechniques and Bioinstrumentations such as bioinformatics, immunotechniqes, tissue culture and biosensors etc. Furthermore, the syllabus is structured to cater to Microbiology's present and future needs in the research field, industrial and environmental sectors, Entrepreneurship,etc., emphasizing imparting hands-on skills. Hence, the curriculum has more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

Program Outcomes (PO) for M.Sc. Program:

Program outcomes associated with an MSc degree are as follows:

1. Student has an in-depth understanding of advanced theories, concepts, and methodologies in their field of study.
2. Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3. Students should be capable of critically analyzing complex problems and synthesizing information from various sources.
4. Students should be proficient in effectively communicating scientific information to both technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and appropriate visual aids.
5. Students should demonstrate leadership qualities and the ability to work effectively as a team.
6. Students should have developed advanced research skills and the ability to independently design and conduct rigorous scientific investigations. They should be able to analyze scientific literature, formulate research questions, develop research plans, collect and analyze data, draw valid conclusions, and learn about IPR.
7. Students should understand and adhere to their field's ethical principles and professional standards.

8. Students should recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

Program Specific Outcome PSO (M.Sc. Microbiology):

After completion of this course, students are expected to learn/understand the:

No.	PSO
1	Advance techniques in microbiology, enzymology andpurification of biomolecules.
2	Biochemistry of microbes concerningthe metabolism of biomolecules and bio-energetics.
3	Molecular biology for DNA replication, central dogma and gene regulation.
4	Concepts in cell biology, microbial genomics and microbial diversity.
5	Principle and applications of various bio-analytical tools and immune techniques.
6	Applications of microbes in food, agriculture, pharmaceutical, fermentation and environmental sectors.
7	Newer and applied areas such as applications of extremophiles, bioinformatics, and biostatistics.
8	Research methodology, IPR, Bioentreprenuership, bioethics and professional development.

Credit distribution structure for two years/one-year PG MSc programme

Level	Sem	Major (Core) Subjects		Minor Subjects	OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)				
6.0	I	DSC-1 (4T) DSC-2 (4T) DSC-3 (4T) DSC-4 (2P)	DSE-1(2T) A/B DSE-2(2P) A/B	RM (4T)		22	First-year PG OR One year PG diploma after 3 years UG
	II	DSC-5 (4T) DSC-6 (4T) DSC-7 (4T) DSC-8 (2P)	DSE-3(2T) A/B DSE-4(2P) A/B		OJT/Int (4)	22	
	Cum. Cr.	28	8	4	4	44	
	Exit option: PG diploma (44 Credits) after three-year UG degree						
6.5	III	DSC-9 (4T) DSC-10 (4T) DSC-11 (4T) DSC-12 (2P)	DSE-5(2T) A/B DSE-6(2P) A/B	--	RP (4)	22	Second-year PG after 3 years UG OR PG degree after 4 years UG
	IV	DSC-13 (4T) DSC-14 (4T) DSC-15 (2P) DSC-16 (2P)	DSE-7(2T) A/B DSE-8 (2P) A/B	...	RP (6)	22	
	Cum. Cr.	54	16		4+10	88	
2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree							

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical,
RM- Research Methodology, **OJT**- On Job Training, **Int**- Internship, **RP**- Research Project,
Cum. Cr. : Cumulative Credits

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	One-year PG Diploma program after 3 Yr Degree	40	44	2	1
6.5	Two-year master's Degree program After 3-Yr UG Or PG Degree after 4- Yr UG	80	88	4	2

Examination Pattern for MSc

Theory Question Paper Pattern:

- **60 (External) +40 (Internal) for 4 credits**
  - External examination will be of three hours duration
  - There shall be 5 questions, each carrying equal marks (12 marks each), while the tentative pattern of question papers shall be as follows;
  - Q1 Attempt any 3 out of 4 sub-questions; each 4 marks
  - Q 2, Q3, Q4 and Q5 Attempt any 2 out of 3 sub-question; each 6 marks.
- **30 (External) +20 (Internal) for 2 credits**
  - External examination will be of 1½ hours duration
  - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
  - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
  - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher can decide which units will be assessed using CCEs and which unit will be assessed based on IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.

The subject teachers must communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours and shall be conducted as scheduled.
- There shall be 05 marks for journal and viva voce. A certified journal is compulsory to appear for practical examination.
- The practical examination will be of a minimum of 3 hours duration and shall be conducted as per schedule for 2 consecutive days in case of practical where incubation conditions and allied aspects are essential.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by the department as per the schedule given.
- For internal practical examination, students must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and department head.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities the faculty assigns during regular practicals. For details, refer to internal theory examination guidelines.
- Finally, 40 (10+30) students' performance will be converted into 20 marks.

M.Sc. Microbiology Course Structure

Semester	Course Module	Credit	Hours/ week	TH/ PR	Code	TITLE
I	DSC	4	4	TH	MIB-DSC-511	Advanced techniques in microbiology
	DSC	4	4	TH	MIB-DSC-512	Biochemistry of microbes
	DSC	4	4	TH	MIB-DSC-513	Molecular biology
	DSE	2	2	TH	MIB-DSE-514A	Microbial diversity and extremophiles
	DSE	2	2	TH	MIB-DSE-514B	Cell biology
	DSC	2	**4**	**PR**	MIB-DSC-515	Practical course on biochemistry and molecular biology
	DSE	2	**4**	**PR**	MIB-DSE-516A	Practical course on techniques in microbiology
	DSE	2	**4**	**PR**	MIB-DSE-516B	Practical course on cell biology
	DSC	4	4	TH	MIB-RM-517	Research methodology for microbiology
II	DSC	4	4	TH	MIB-DSC-521	Advanced Immunology
	DSC	4	4	TH	MIB-DSC-522	Advanced microbial enzymology
	DSC	4	4	TH	MIB-DSC-523	Applied molecular biology
	DSE	2	2	TH	MIB-DSE-524A	Bioanalytical techniques
	DSE	2	2	TH	MIB-DSE-524B	Microbial genomics
	DSC	2	**4**	**PR**	MIB-DSC-525	Practical on enzymology
	DSE	2	**4**	**PR**	MIB-DSE-526A	Practical course on immune techniques
	DSE	2	**4**	**PR**	MIB-DSE-526B	Practical course on microbial genetics
	DSC	4	**8**	**OJT**	MIB-OJT-527	Internship / On job training
III	DSC	4	4	TH	MIB-DSC-611	Applied and Environmental Microbiology
	DSC	4	4	TH	MIB-DSC-612	Pharmaceutical Microbiology
	DSC	4	4	TH	MIB-DSC-613	Agricultural Microbiology
	DSE	2	2	TH	MIB-DSE-614A	Plant and Animal Tissue Culture
	DSE	2	2	TH	MIB-DSE-614B	Interdisciplinary Concepts in Microbiology
	DSC	2	4	**PR**	MIB-DSC-615	Practicals on Applied and Pharma Microbiology
	DSE	2	4	**PR**	MIB-DSE-616A	Practicals on Plant and animal tissue culture
	DSE	2	4	**PR**	MIB-DSE-616B	Practicals on Interdisciplinary microbiology
	DSC	4	8	**RP**	MIB-RP-617	Research project I
IV	DSC	4	4	TH	MIB-DSC-621	Advances in Fermentation Technology
	DSC	4	4	TH	MIB-DSC-622	Biostatistics and bioinformatics
	DSE	2	2	TH	MIB-DSE-623 A	Entrepreneurship in Microbiology
	DSE	2	2	TH	MIB-DSE-623 B	Food and Dairy Microbiology
	DSC	2	4	**PR**	MIB-DSC-624	Practicals on Biostatistics and Bioinformatics
	DSC	2	4	**PR**	MIB-DSC-625	Practicals on Fermentation Technology
	DSE	2	4	**PR**	MIB-DSE-626A	Practicals on Professional development
	DSE	2	4	**PR**	MIB-DSE-626B	Practicalson Food and Dairy Microbiology
	DSC	6	12	**RP**	MIB-RP-627	Research project II

DSC : Department-Specific Core course
DSE : Department-Specific elective
TH : Theory
PR : Practical
RP : Research project

M.Sc. II (Microbiology)

Semester III

MSc II (Microbiology)
Semester III
MIB-DSC-611: Applied and Environmental Microbiology

Total Hours: 60 **Credits: 4**

Course objectives	• To understand strategies used for microbial analysis of food. • To learn the principles and methods of microbiology of waste management. • To know the aspects of biological conversion of agricultural waste • To impart knowledge about contaminated environment and bioremediation	
Course outcomes	After successful completion of this course, students are expected to: • Acquaint with skills related to microbial analysis of food • Implement microbes-related strategies for waste management • Execute strategy related to biological conversions of lignocellulosic waste • Use of microbes for bioremediation	
Unit	**Contents**	**Hours**
Unit I	**Food Microbiology** • Methods of food sampling (random, representative, attribute) • Importance and preparation of dilutions • Offline and online approaches tothe microbial analysis of food • Detection and enumeration of indicator bacteria, pathogenic and toxigenic microbes • Mycotoxins: sources, mechanism, prevention, extraction and detection • Microbiological examination of specific foods o Meat and meat products, Milk and milk products • Food intoxications: causes, pathogenesis, prevention and control	**15**

Unit II	**Microbiological waste management**
	• Overview of the conventional treatment process: coagulation, flocculation, sedimentation, filtration, disinfection
	• Primary treatments: screen, grit chamber, primary sedimentation or settling
	• Secondary biological treatment process:
	  o Aerobic treatment: (a) Suspended growth - Oxidation lagoons, activated sludge and membrane bioreactor (b) Attached growth TF, RBC, PBR
	  o Anaerobic treatment: (a) Suspended growth - UASB, USB, Clarigester (b) Attached growth (EGSB, AF, FBR)
	  o Disinfection (Clarification, Ozonation)
	• Advanced tertiary process: biological removal of nitrogen and phosphorus,
	• Permissible limits for domestic and industrial waste
	• Anaerobic digestion: methane potential,microbiology and biochemistry of biomethanation, and types of anaerobic digesters.
		15

Unit III	**Biological conversion of Lignocellulosic waste** • Structure and composition of lignocelluloses • Degradation of lignin, cellulose and hemicellulose, impediments of degradation	**15**

	• Pre-treatment of lignocellulosic material: physical, chemical and biological (microbial and enzymatic) and related issues • Fermentation of lignocellulosic biomass: SmF, SSF, SHF, SScF • Applications of lignocellulosic waste for ethanol production • Composting:principle steps, chemistry, microbial succession, technologies of composting	

Unit IV	**Bioremediation and biodegradation of xenobiotics**
	• Biodegradation: concept, mechanism, its measurement andaffecting factors
	• Concepts of bioconversion
	• Bioremediation
	  o Co-metabolism, mineralization, conjugation
	  o Strategies: Ex-situ and in-situ
	  o Treatments: intrinsic, biostimulation, bioaugmentation, rhizostimulation, bioleaching, phytoremediation
	• Methods for microbial treatments of pollution: bioreactors, biopiles, landfilling, bioventing, bio-sparging
	• Limitations to microbial degradation of compounds
	• Biodegradation of xenobiotics
	  o Types and hazards of xenobiotics
	  o Biochemical/ physiological approach
	  o Molecular techniques and monitoring of bioremediation
		15

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MSc II (Microbiology)
Semester III
MIB-DSC-612: Pharmaceutical Microbiology

Total Hours: 60 **Credits: 4**

Course objectives	• To introduce knowledge about antimicrobial agents. • To impart information related to regulatory aspects in the pharma industry • To familiarize the students with aspects of laboratory practices • To learn about variousbiopharmaceutical productions	
Course outcomes	After successful completion of this course, students are expected to: • Get in-depth knowledge ofthe mechanisms of different antimicrobial agents • Understand quality control and regulatory aspects used in pharmaceuticals • Infer and apply appropriate good laboratory practices • Apply knowledge of biopharmaceuticals for industrial production	
Unit	**Contents**	**Hours**
Unit I	**Antibiotics and Synthetic antimicrobial agents** • Mechanism of action, microbial resistance, therapeutic/prophylactic usage and adverse reactions o Antibiotic and synthetic antimicrobial agents: beta-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides o Antifungal antibiotics: Griseofulvin, fluconazole o Antiviral drugs: Amantidines, Nucleoside analogues o Peptide antibiotics o Synthetic antibiotics: Sulphonamides, Chloramphenicol, o Quinolones, Metronidazole o Anticancer drugs	**15**
Unit II	**Regulatory aspects and quality assurance in pharmaceuticals** • Regulations for the pharmaceutical industry • General Lab designconsiderations: sample collection, testing, equipment, utility and service, air supply, contaminants, laboratory safety • Laboratory management : Training, quality, safety, LIMS • GMP in pharmaceuticals o GMP: Key aspects, compliance, rules, Risk management and documentation o US Food and Drug Administration (FDA) and European Union (EU GMP) • Design of sterile product manufacturing unit: Class A and clean room • Quality control in pharmaceuticals: In-process and final product control (antibiotics, immune sera, vaccines, biopharmaceuticals) • ICH process • Sterilization control and sterility validation • In vitro and in vivo testing for pyrogens and endotoxin	**15**

Unit III	**Microbiology laboratory techniques**
	• Good laboratory practice (GLP), laboratory safety and aseptic technique
	• Pharmacopeia and microbiological tests
	• Microbiological examination of nonsterile products:
	  o TVC: Bioburden determination, method validation, media growth promotion, sample preparation, test methods (membrane filtration, pour / spread plate, MPN)
	  o Tests for specified organisms and specification limits
	  o Measurement of cell concentration in suspension by optical density
	  o Sterility testing
	  o Environmental monitoring and water analysis
		15

Unit IV	**Production of Biopharmaceuticals**
	• Asparaginase and Clinical dextran
	• Vaccines: multivalent subunit, bacterial, DNA vaccines
	• Viral vaccines: Live (attenuated, recombinant), Inactivated,Virion subunit vaccines, production of viruses for vaccines, Virus-like particles, synthetic peptide vaccines
	• Immunosera and monoclonal antibodies
	• Rational drug design
	  o Concept and steps of drug design
	  o Lead drug and Pro-drug with examples
	  o Structure-based and combinatorial approach
	  o Computer-aided drug design and software
	  o Strategies for drug discovery and clinical trial
		15

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MSc II (Microbiology)
Semester III
MIB-DSC-613: Agricultural Microbiology

Total Hours: 60 **Credits: 4**

Course objectives	• To introduce various attributes of microbial ecology • To study the microbial interaction with plant root • To know the pathogenic interaction of microbes with plants • To learn the mechanism of plant defence and its biocontrol	
Course outcomes	After successful completion of this course, students are expected to: • Understand microbial ecology • Comparevarious plant-microbe interactions for applications • Describe the mechanism of plant and pathogen interactions • Categorise various approaches for biocontrol plant disease	
Unit	**Contents**	**Hours**

Unit I	**Microbial Ecology**
	• Basic microbial ecology and its components
	• Microbial interactions: positive and negative
	• Microbial communities: concepts, elements and methods of analysis: CLPP, PLFA, DGCE, SSCP, ARDRA, FISH
	• Methods for quantitative microbial ecology
	• Indicators of soil health
	• Applications of microbial ecology for bioremediation
	  o Integrated Plant Nutrition through biofertilizers
	  o Phytoremediation: Rhizodegradation
	  o Microbial reclamation of saline and sodic soils
		15

Unit II	**Microbial interactions with plant roots** • Rhizosphere and Rhizosphere engineering • Mycorrhizae: VAM, ericoid and orchid mycorrhiza, Ectomycorrhiza • Plant Growth Promoting Rhizobacteria (PGPR) • Strategies for rhizosphere and mycorrhizae community study • **Microbial interaction with aerial plant structure** Phylloplane, Stems/ flowers, leaf buds Strategies for Aerial Plant Structure Study • **Leguminous root nodules** Nodulation process and mechanism of nitrogen fixation, *nif*operon Strategies to study the infection process	**15**
Unit III	**Pathogenic interactions with plants** • Plant defence mechanisms (structural, biochemical, HR, SAR) • Microbial pathogenicity mechanisms in viruses, bacteria, and fungal pathogens • Genetic basis of plant-pathogen interactions • Region-specific plant diseases (aetiology, symptoms and control): Red rot of sugarcane, Sigatoka disease of banana, Powdery mildew, Smut and Rust	**15**

Unit IV	**Microbial Biocontrol of Plant Disease** • Methods of plant disease detection: traditional and innovative • Plant disease control: general strategies and principles of IDM • Bio pesticides: BT, Siderophore and *Trichodermca,Pseudomonas*, NPV, *Beauveriabassiana* • Biocontrol of post-harvest diseases • Control of plant pathogens by genetic engineering • Genetically modified crops	**15**

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MSc II (Microbiology)
Semester III
MIB-DSE-614A: Plant and animal tissue culture

Total Hours: 30 **Credits: 2**

Course objectives	• To acquaint basic knowledge about Plant tissue culture • To apprise basic knowledge about Animal tissue culture	
Course outcomes	After successful completion of this course, students are expected to: • Relate information required for PTC laboratory • Infer techniques require for Animal tissue culture	
Unit	**Contents**	**Hours**
Unit I	**Introduction to plant tissue culture** • Laboratory organization of PTC and aseptic techniques • Basic structure and growth of a plant • Benefits and application of plant tissue culture • Definition: Ex-plant, callus, differentiation, re-differentiation, Totipotency • Culture media composition • Basic techniques of plant tissue culture • In vitro germplasm conservation and Cryopreservation.. • Methods in Plant tissue culture o Callus culture and Cell culture o Protoplast: Isolation, culture and regeneration o Somatic hybridization: mechanism of protoplast fusion, selection of hybrid cells, cybrids, applications and limitation o Organ culture (In vitro production of haploid plants): Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture).	**15**
Unit II	**Introduction to Animal Cell and Tissue Culture** • Animal tissue culture laboratory: facilities, aseptic condition and risk • Advantages and limitationsof animal tissue culture • Cultural media: Physicochemical properties and composition • Cell lines: types (finite and continuous), monoculture • Primary culture: Techniques of disaggregation – (mechanical enzymatic) • Cultured cells: o Characteristics o Cell adhesion, proliferation and differentiation o Initiation and development of cell culture • Senescence and apoptosis • Transformation in animal cells o Cell transformation - In vitro culture of oocytes/embryos, DNA microinjection, Cell/embryo cryopreservation • Scaling up of Animal Cell Culture	**15**

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MSc II (Microbiology)
Semester III
MIB-DSE-614B: Interdisciplinary Concepts in Microbiology

Total Hours: 30 **Credits: 2**

Course objectives	• Introduce students to the fundamentals of nanotechnology Biosensor • Understand the importance of medical coding in healthcare documentation.	
Course outcomes	After successful completion of this course, students are expected to: • Explore the applications of nanomaterials and Biosensors. • Acquire essential knowledge and guidelines of various coding systems	
Unit	**Contents**	**Hours**
Unit I	**Nano technology** • Historical development and critical milestones in nanobiotechnology. • Overview of nanoscale phenomena relevant to microbiology. • Principles of nanosensors and nanoprobes for microbial detection. • Mechanisms of interaction between nanomaterials and microbial cells. • Impact of nanomaterial properties on microbial adhesion, growth, and behaviour. • Applications of nanobiotechnology in agriculture, food safety, bioremediation, rapid diagnostics and biosensing, environmental monitoring and remediation of microbial pollutants,nanoparticles as drug delivery vehicles, and microbial biofilms. **Biosensors** • Definition, scope, components and sensing principle of biosensor. • Classification of biosensors based on transduction mechanisms. • Overview of optical, electrochemical, and piezoelectric biosensors. • Factors influencing biosensor design: sensitivity, selectivity, stability • Strategies for surface functionalization and biomolecule immobilization. • Overview of fabrication methods for biosensors: microfabrication, thin-film deposition, etc. • Applications of biosensors in medical diagnostics and monitoring, environmental sensing and pollution monitoring, food safety, agriculture, and bioprocessing.	**15**
Unit II	**Medical coding** • Definition and importance of medical coding in healthcare. • Introduction to coding systems: ICD-10-CM, CPT, and HCPCS. • Understanding the structure and format of code sets. • Fundamentals of medical terminology: Prefixes, roots, and suffixes. • Common medical terms related to anatomy, physiology, and diseases relevant to medical coding. • Principles and guidelines for accurate medical coding. • Application of coding conventions, modifiers, and placeholders. • Case studies and coding exercises to apply learned concepts.	**15**

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MSc II (Microbiology)
Semester III
MIB-DSC-615: Practicals on Appliedand PharmaMicrobiology

Total Hours: 60 **Credits: 2**

Course objectives	• To impart training about aspects of microbiological quality control inthe pharmaceutical industry • To familiarize quality activities required in the pharmaceutical industry • To understand the methods of saccharification of lignocellulosic biomass	
CourseOutcomes	After successful completion of this course, students are expected to: • Undertake various quality control tests of pharmaceutical products and media • Carry out sterility testing of pharma products and perform the validation of LAF • Experiment with lignocellulosic saccharification. • Understand various methods used for saccharification of lignocellulosic biomass	
Sr. No.	**Contents**	**Hours**
1	Validation of autoclave using chemical and biological indicator	4
2	Validation of efficiency of laminar air flow	4
3	Survival curve for Ultraviolet light/Heat /ethylene oxide and D, Z, F value determination	4
4	Environmental monitoring of samples from production areas and personnel.	4
5	Evaluation of disinfectant using Phenol coefficient (Rideal Walker Test/ Chick Martin Test)	4
6	Sterility testing of in-process materials and finished products	4
7	Microbial Limit Test: analysis of water/ raw material/ finished product/ packaging material/ Excipients)	4
8	Evaluation of quality of media/reagents for growth promotion tests.	4
9	Evaluation of carcinogenicity using the Ames test	4
10	Endotoxin/ pyrogen using LAL (water/ in-process/ final product)	4
11	Evaluation of microbial spoilage of refrigerated and canned food	4
12	Lignocellulosic saccharification using SSF/SHF/SScF and its assessment	4
13	Production of biogas using feedstock and detection using water displacement method/ GC	4
14	Estimation of sewage wastewater: BOD,COD/salinity, acidity, alkalinity	4
15	Estimation of chemical parameters of compost: C:N ratio, P, K	4

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MSc II (Microbiology)
Semester III
MIB-DSE-616A: Practicals on Plant and Animal Tissue Culture

Total Hours: 60 **Credits: 2**

Course objectives	• To understand methods in tissue culture • To know tissue culture media and inoculation • To learn about advanced techniques associated with tissue culture	
CourseOutcomes	After successful completion of this course, students are expected to: • Acquaint knowledge about tissue culture laboratory setup • Learn about media used in tissue culture • Acquaint knowledge about micropropagation,endosperm culture root and callus induction	
Sr. No.	**Contents**	**Hours**
1	Acquaintance with plant / animal tissue culture laboratory plan	4
2	Acquaintance with plant / animal tissue culture laboratory equipment	4
3	Preparation and sterilization of MS/ATC medium, stocks and explants	4
4	Induction of callus using suitable explant.	4
5	Induction of Root tip culture using suitable explant.	4
6	Induction of shoots tip culture using suitable explant.	4
7	Development of Endosperm/ Meristem / Anther / Pollen culture using suitable plant material.	4
8	Effect of plant growth regulators on callus induction	4
9	Isolate the protoplast from given explant	4
10	Development of somatic embryo from suitable tissue	4
11	Quantitiativedetection of phytochemicals / secondary metabolite from callus (alkaloids, phenols, glycosidesetc)	4
12	Micropropagation of suitable explant	4
13	Isolation and separation of animal cells with a suitable method	4
14	Preparation of primary animal cell culture and its maintenance	4
15	Estiation of viable cells of animal cell culture by using trypan blue	4

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MSc II (Microbiology)
Semester III
MIB-DSE-616B: Practicals on Interdisciplinary Microbiology

Total Hours: 60 **Credits: 2**

Course objectives	• To introduce Interdisciplinary concepts related to microbiology • To learn experiments with nanotechnology • To understand biostatistics and other related topics	
Course Outcomes	After successful completion of this course, students are expected to: • Plan microbiological experiments with an interdisciplinary approach • Perform experiments with nanotechnology • Explore the interdisciplinary nature of microbiology	
Sr. No.	**Contents**	**Hours**
1	Synthesis of Au/Ag metal nanoparticles by chemical route.	4
2	Optical properties of Au/Ag nanoparticles by using UV-Vis spectroscopy.	4
3	To calculate the absorption coefficient and optical band gap using UV-Vis. Spectroscopy.	4
4	Analysis of CNTs / nanoparticlesby UV-Vis.	4
5	Analysis of CNTs / nanoparticles by FTIR spectroscopy.	4
6	Determination of antimicrobial properties of silver nanoparticles.	4
7	Biosensing by nanozymes using UV-Vis spectroscopy.	4
8	Synthesis of metal nanoparticles using plant extracts and characterization	4
9	Practical based on sampling and biostatistics	4
10	Four probe methods determine the electrical conductivity of metals/alloys.	4
11	Electrochemical sensing of glucose	4
12	Hall effect - Determination of Hall coefficient.	4
13	Determination of metal ion content using AAS.	4
14	Mixing/ cleaning/ degassing/ cell disruption/ sample preparation using ultrasonicator	4
15	Visit to Physics/ electronics research laboratory for instrumentation	4

References

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MSc II (Microbiology)
Semester III
MIB-RM-617: Research Project I

Hours: 120 **Credits: 4**

Course objectives	1. To give exposure to the students to research culture and technology 2. To introduce students to how to select a research topic, plan, perform experiments, collect and analyze the data **3.** To foster self-confidence and self-reliance in the students as they learn to work and think independently	
Course outcomes	After successful completion of this course, students are expected to: • Conceive a problem based on published research and conduct a comprehensive literature survey. • Learn handling of instruments, use of chemicals and how to conduct the experiments • Learn how to present the project in PowerPoint and answer the queries to examiners and the science of writing.	
Unit	**Contents**	**Hours**

Credit distribution (1 credit for each unit)

- Identification of a research topic, formulation of research problem, objectives, sample size and hypothesis, etc
- Preparation of Outline
- Review of literature
- Bibliography

The systematic approach towards the execution of the project should be as follows: (Wherever applicable)

1. The complete tenure of the research project should be one year. It should be allotted during the third semester and completed in the fourth semester.
2. Weekly 8 hours should be allotted to the research project in a regular timetable.
3. In the third semester, students will be evaluated based on a credit distribution mentioned above. In the fourth semester, students should perform further research work, collect and analyze the data, compile the results and prepare and submit the final dissertation.
4. Students may be given an opportunity to participate in ongoing research activities in the respective Departments/Schools/Supervisors' laboratories. This will familiarize them with the literature survey and give them a fundamental understanding of designing and executing a research project.
5. Students may work individually or in groups (not more than 3 students) to be decided by the concerned department/supervisor.
6. Each research group should have a different research topic with some possible level of novelty.
7. The student should select the topic relevant to priority areas of concern or allied subjects with the guidance of supervisor/ head of the department.
8. Students are encouraged to work on multidisciplinary and applied projects, but it is not mandatory criteria.
9. At the beginning, students should submit the outline of the research work to be carried out in the project. (Writing in order: Title, Aim and objectives, Literature to be collected, Experimental plan or method design, expected outcome etc.)
10. Write and submit a Literature Review Report and Research outline

Tentative order for review: Title of the Project, Certificates, Acknowledgment, Abstract and Keywords, Contents, Introduction, Literature Review, Aim of the Project, Materials and Methods, Bibliography/reference etc.

Tentative order for research outline: Title page, introduction, background and significance of study, problems to be investigated, objective, hypothesis, chapter scheme, bibliography.

11. At the end of the third semester, each student should submit a detailed Literature Review Report and research outline.
12. An appropriate and essentialconclusive statement must be drawn at the end of the study.
13. Students should maintain lab notebooks, and the Supervisor may ask them to submit the mid-semester progress report.
14. For documents related to project submission: Font- Times New Roman, Heading Font Size-14, Normal Text Size-12, spacing-1.5, both sides justified and 1 inch margin on all side, both side printing on A-4 size.
15. Three copies of the Literature Review Report, research outline should be prepared (one copy for each department, guide, and student).
16. At the end of the semester, the candidate should prepare and present research work using a PowerPoint presentation with modern ICT tools and present the same in front of his/ her respective department during the Internal Examination.
17. For external examination the candidate will have to present the research work and face viva voce.
18. Students may present their research work in Avishkar/Webinars/Conferences.
19. Students should note that plagiarism is strictly prohibited.

Internal examination (40 marks): Components of continuous internal assessment:

- Draft Research Outline (10 marks)
- Draft Review of literature (10 marks)
- Working Bibliography (10 marks)
- PowerPoint presentation, and oral examination (10 marks)

External examination (60 marks)and Components of external assessment:

- Final submitted review report, research outline in bound form at the time of examination **(40 marks)**
- Overall presentation reflecting the contribution of work, response to questions **(20 marks)**

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M.Sc. II (Microbiology)

Semester IV

MSc II (Microbiology)
Semester IV
MIB-DSC-621: Advances in Fermentation Technology

Total Hours: 60 **Credits: 4**

Course objectives	• To introduce upstream processing in microbial fermentation • To learn about bioreactors • To familiarize with recovery techniques used for fermentation products • Tointroduce the microbial processes for the production of various metabolites	
Course outcomes	After successful completion of this course, students are expected to: • Implement upstream processes at the industry • Get knowledge about bioreactor configuration and operation • Justify relevant recovery process for microbial products • Plan the production process for microbial products.	
Unit	**Contents**	**Hours**
Unit I	**Upstream processing** • Overview of typical microbial fermentation process (sterilization, inoculum, sampling, aeration, control system, cleaning) • Microbial growth: kinetics, measurement • Inoculum: o Criteria for suitable inoculum (purity, stage of growth, physiology, quantity, quality) o Acclimatization, seed media o Development of inoculum for following processes with one example: Yeast, Mycelial, Bacterial. o Aseptic inoculation of fermenter • Media for industrial fermentation: o Types (synthetic and natural) o Formulation and Optimization • Fermentation- kinetics of batch and continuous culture • Strain improvement: mutation, recombination, Parasexual Cycle, Protoplast fusion and rDNA technique	**15**
Unit II	**Bioreactor (Design and Application) and its operation** • Design and construction materials of bioreactor • Types of Bioreactor: continuous stirred tank, airlift, tower, fluidized and packedbed, photobioreactor, Bubble Column Bioreactors • Sterilization: Del factor, batch and continuous sterilization and air(heat, filtration) • Maintenance of aseptic condition • Fermentation Process Parameters and Monitoring: aeration and agitation system, sterility, pH, temperature, foam, DO, Pressure andinlet& exit gas analysis. and process of automation • Solid state fermentation: concept, bioreactor, advantages and disadvantage	**15**

	• Scale-up of fermentation:Major factors involved, Sale-up window, methods • Mass and Heat transfer during fermentation	

Unit III	**Downstream processing**
	• Biomass harvesting and removal of solid matter:
	  o Criteria for choice of recovery
	  o Methods: centrifugation, filtration, flocculation
	• Cell disruption: mechanical,physical, chemical and enzymatic methods
	• Product concentration: evaporation, liquid–liquid extraction, supercritical fluid extraction, ultrafiltration/membrane filtration, precipitation, three-phase partitioning,
	• Product purification and characterization: chromatography-adsorption, size exclusion, affinity, ion exchange, reverse phase, HPLC
	• Formulation: Drying (spray drying, freeze drying)
	• Biosafety: Handling infectious and Recombinant microorganisms
	• Production economics: cost (capital, operating), factors affecting
		15

Unit IV	**Microbial Products** • Enzymes: Protease, Penicillin acylase • Organic acids: Gluconic acid • Amino acids: L glutamic acid • Polysaccharides: Polysaccharides (Alginate and Hyaluronic acid) • Others: Probiotics and Yoghurt, • Antibiotics: Rifamycin • Ethanol: 1st, 2nd and 3rd generation • Nucleotides: IMP, GMP • Heterologous protein production with example • Mammalian cell products: Monoclonal antibodies and vaccines • Heterologous protein: INF, tissue plasminogen activator (TPA), GMCSF	**15**

References

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MSc II (Microbiology)
Semester IV
MIB-DSC-622: Biostatistics and Bioinformatics

Total Hours: 60 **Credits: 4**

Course objectives	• To impart an understanding of elementary aspects of bio-statistics • To learn various statistical techniques applicable to biology • To introduce an overview of bioinformatics • To analyse the output data to predict a biologically relevant function	
Course outcomes	After successful completion of this course, students are expected to: • Apply basic biostatistical techniques for biological data • Practice biostatistics for interpretation of experimental data • Use fundamentals of bioinformatics for analysis of database • Access and interpretthe information from databases	
Unit	**Contents**	**Hours**
Unit I	**Sampling and central tendency (theoretical concepts)** • Applications of biostatistics to biological database • **Concepts**: population, sample, probability, central tendency, dispersion, variance • **Sampling** types: simple random, stratified, systematic, cluster • **Data**: collection (primary and secondary), classification and tabulation of data • Graphical techniques: one-dimensional, two-dimensional, pictograms • Graphical presentation of data: histogram, frequency polygon, frequency curve, ogive curve • **Measures of Central tendency**: Mean, Mode, Median • **Measures of dispersion:** range, mean deviation, standard deviation, coefficient of variation, skewness	**15**
Unit II	**Correlation, Regression, probability, ANOVA (theoretical concepts)** • **Correlation**: definition, types, methods of measuring • **Regression**:definition, equation, coefficient,Simple linear regression, • **Analysis of Variance:** One and two-way analysis of variance, Intro experiments, Multivariate statistical analysis • **Probability:** Definition, concepts: experiment, event (simple, compound, mutually exclusive, independent, dependent) • **Discrete distributions**: Bernoulli, Binomial, Poisson. Continuous distributions: Normal, Exponential, sigma limits, and probability coverage. • Concepts: Hypothesis testing, t-test, F test, Chi-square test, Design of experiments, multivariate statistics	**15**
Unit III	**Overview of Bioinformatics** • Concept of Bioinformatics: definition, scope, application and limitations • Introduction to biological databases	**15**

	• Primary (GenBank, EMBL, SWISS-PROT) • Secondary (PROSITE, pfam) • Specialized (GenBank EST and Microarray Gene Expression) • UNIPROT database • Structural databases: PDB, MMDB • Sequence retrieval system - SRS, ENTREZ, Expasy • Software for Data Visualization: CN3D, Rasmol, Chimera, SWISS PDB Viewer • Application of programming Language in Biology: Bioperl, Biojava and R Programming • Protein structure prediction: Secondary structure (Globular, Transmembrane), 3D Structure prediction (X-ray Crystallography,NMR Spectroscopy) • Classification of protein Structure: SCOP	
Unit IV	**Sequence analysis and phylogeny** • Sequence analysis: Concept of % Identity, Twilight Zone and mid-night zone • Concept of homology, analogy, othology and paralogy • Sequence alignment: pairwise (local, global) and multiple sequences (Clustal W editing and interpretation) • Alignment Algorithms: Dot Matrix and Dynamic Programming, Gap Penalties • Introduction to scoring matrices-PAM and BLOSSUM • Database similarity searching: BLAST(Variants and statistical Significance) FASTA (statistical Significance) • Phylogenetic analysis: Definition, Choice of Molecular Markers • Phylogenetic tree: Terminology, construction methods (maximum Parsimony, Maximum Likelihood), Evaluation (Bootstrapping and Jackknifing, Phylogenetic Programs).	**15**

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MSc II (Microbiology)
Semester IV
MIB-DSC-623A: Entrepreneurship in Microbiology

Hours: 30 **Credits: 2**

Course objectives	• To impart an understanding of business management and entrepreneurship • To understand the basics of business ethics, safety and IPR	
Course outcomes	After successful completion of this course, students are expected to: • Understand fundamental business, management, marketing, operation and HRM • Address the issues related to business ethics and understand the concept of safety and IPR	
Unit	**Contents**	**Hours**

Unit I	**Introduction to Business and Management**
	• Management: Definition, concept, importance
	  o Levels, Functions and Skills
	  o Decision making
	  o Strategic management: characteristics, importance
	  o SWOT analysis
	• Production and operation management, concept of TQM
	• Marketing and Marketing research
	• Financial management: Concept of capital budgeting and working capital
	• Human resource management and planning
	Business development and skills for bio-entrepreneurship
	• Characteristics for being an entrepreneur in microbiology.
	• Factors affecting microbiology/ biotechnology business:
	• Role of government and schemes and Financial institutions.
	• Personality, attitude, organizational behavior, leadership
	• Principles of effective communication.
	  o Body language, public speaking, presentations
	• Business proposal writing.
	• Case studies of successful and unsuccessful bio-entrepreneurship.
		15

Unit II	**Ethics, regulation and safety** • Business ethics: meaning, principals &Ethical dilemmas in Bioindustry • Current regulatory bodies and laws/regulations for industry • Biologics License Application (BLA) • Safety and precautionsBiological, Chemical and Personal • Biosafety: levels (BL 1, 2, 3, 4), GMOs and risks **Intellectual property and IPR** • IPR- Concept, Forms of IPR, patentable and non-patentable items • Legislations covering IPR's in India • Steps in filing a patent, provisional and complete specification • Valuation of patent and business concerns	**15**

	• Protection of biotechnological inventions • Overview of GATT, WTO, TRIP and Indian Patent Act • Protection of plant varieties and farmer's rights	

References

- Mehta, S. S. (2008) Commercializing successful biomedical technologies: basic principles for the development of drugs, diagnostics and devices. Cambridge University Press.
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MSc II (Microbiology)
Semester IV
MIB-DSE-623B: Food and Dairy Microbiology

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce the basics of milk microbiology • To impart an understanding of food spoilage and preservation	
Course outcomes	After successful completion of this course, students are expected to: • Understand the fundamentals of milk spoilage and preservation • address the issues related to food spoilage and preservation	
Unit	**Contents**	**Hours**
Unit I	**Microbiology of milk** • Definition and composition of milk • Sources of microorganisms in milk (farm, transport and manufacturing) • Desirable and undesirable changes carried out by microorganisms in milk. • Spoilage- gas production, proteolysis, repines, changes in milk fat, alkali production, flavour and colour changes, spoilage and at different temperature • Preservation: Asepsis, microbial removal, use of high and low temperatures, drying, condensation, and use of preservatives. • Types and pathogens of bovine and human origin • Microbiological examination of milk – SPC, DMC reductase tests, Pasteurization, phosphatase test, sterilization of milk. • Cheese – microbiology, types and production.	**15**
Unit II	**Food Microbiology** • Scope of Food Microbiology • Factors affecting the growth and survival of microbes in food • Intrinsic and extrinsic factors • General principle of food spoilage o Meat: microbial invasion of tissue, Microbial growth, Types of spoilage – aerobic and anaerobic o Fish and poultry: Defects and changes during storage in egg, Microbial and non-microbial changes in egg, bacterial spoilage of poultry o Vegetables and fruits: general microbial spoilage types, spoilage of fruit and vegetable juice o Sugar and sugar food: sucrose, honey, candy • Overview of food preservation o Heat, irradiation, high pressure, chilling, freezing, and chemical preservation.	**15**

References

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MSc II (Microbiology)
Semester IV
MIB-DSC-624: Practicals on Biostatistics and Bioinformatics

Total Hours: 60 **Credits: 2**

Course objectives	• To impart training about elementary aspects of statistics used in microbiology • To introduce a variety of computational methods for predicting functional behaviour of a biological system • To analyse the output data to predict a biologically relevant function	
Course Outcomes	After successful completion of this course, students are expected to: • Able to analyse experimental data with central tendency, its dispersion and presentation graphically • Access biological databases, interpret structural aspects • Familiar with statistical and bioinformatics software	
Sr. No.	**Contents**	**Hours**
1	Calculate the mean, median, mode, range, variance, standard deviation, standard error, and confidence interval using MS Excel/suitable software	4
2	Plot straight Lines (Linear Least squares) using the LINEST Function of MS Excel/ suitable software	4
3	Plot-line, scatter graphs, bar graphs, and error bars using MS Excel/ suitable software	4
4	Determine linear regression, Correlation and their coefficients using MS Excel/ suitable software	4
5	Compute F-test (paired and unpaired), t-test using MS-Excel/ suitable software	4
6	Compute ANOVA, Chi 2-test using MS-Excel/ suitable software	4
7	Demonstrate multivariate analysis of process parameters using statistical tools.	4
8	Exploring Biological databases –Genbank& Protein Data Bank	4
9	Exploring data retrieval systems –Entrez and SRS	4
10	Structural prediction of protein using ExPASy software	4
11	Primary and tertiary structure analysis of protein/ DNA using BLAST	4
12	Multiple sequence alignments using Clustal W	4
13	Phylogenetic tree analysis using MEGA	4
14	Primer designing using biological software	4
15	Determination of primary/ secondary structure of amino acid sequence using SOPM/GOR/ChauFasman, etc. software	4

References

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MSc II (Microbiology)
Semester IV
MIB-DSE-625:Practicalson Fermentation Technology

Total Hours: 60 **Credits: 2**

Course objectives	• To know generalconsiderationsfor the fermentationprocess • To learn statistical applications in process optimization • To produce the fermentative product ina laboratory	
Course Outcomes	After successful completion of this course, students are expected to: • Use the knowledge of laboratory fermentations • Perform the optimization of the fermentation process • Demonstrate various fermentative production of microbial products	
Sr. No.	**Contents**	**Hours**
1	Fermentor: demonstration of parts, cleaning, sterilization and assembling	4
2	Aseptic techniques in inoculation of fermenters and Aseptic sampling from fermentors	4
3	Calibration of fermentatorelectrodes/probes	4
4	Production and quantification of biomass (yeast/ Fungal /algae)	4
5	Laboratory-scale fermentation of antibiotics/enzyme	4
6	Down Stream processing with an enzyme: filtrations, centrifugation, TFF	4
7	Optimization of fermentation parameters using one factor at a time (OFAT) design	4
8	Screening of fermentation parameters using a statistical method	4
9	Application of response surface methodology for statistical optimizations of factors.	4
10	Production of fermentation products using chemically defined and crude economical raw material (molasses, agro-waste, food/dairy industry)	4
11	Production of probiotics/yoghurt/curd/buttermilk	4
12	Production, application and efficacy determination of biofertilizer /siderophore (Pseudomonas biofertilizer in talc powder/ Azo/Rhizo)	4
13	Culturing and characterization of actinomycetes used in the pharmaceutical industry	4
14	Laboratory production of edible mushroom	4
15	Production of fermented products from SSF	4

References

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- Sharma Kanika, Manual of Microbiology Tools and Techniques, 2nd Ed. 2007, Ane's Book India, New Delhi
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MSc II (Microbiology)
Semester IV
MIB-DSE-626A: Practical on Professional development

Total Hours: 60 **Credits: 2**

Course objectives	• Develop effective communication skills for scientific presentations • Enhance career planning and job search strategies. • Learn the essentials of project writing, business skill	
Course Outcomes	After successful completion of this course, students are expected to: • Write concise scientific reports and deliver informative presentations. • Create professional and targeted CVs and cover letters • Be well-prepared to advance in their professional careers	
Sr. No.	**Contents**	**Hours**
1	Prepare the MS PowerPoint-based presentations.	4
2	Demonstrate the working of the MS Word application.	4
3	Preparation of table and graph using MS Excel.	4
4	Preparation of standard operating procedure for the instrument.	4
5	Preparation ofCurriculum Vitae.	4
6	To learn the interview techniques through a mock activity.	4
7	Discussion of a topic through group discussion activity	4
8	Preparation of application letter for interview/ leave etc.	4
9	To learn the process of report writing / Effective scientific writing	4
10	Practical based on Grammar / Vocabulary/plagiarism	4
11	To learn the technique of communication skills- Speaking / public speaking	4
12	Practical based on Self-assessment/goal setting/career planning	4
13	Practical based on Marketing skill: advertisement/ video making and selling product	4
14	Practical based on team building/management/leadership skill	4
15	Case study / analytical -logicalthinking skills	4

References

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- Day, R. A., &Gastel, B. (2011). How to Write and Publish a Scientific Paper. Cambridge University Press.

MSc II (Microbiology)
Semester IV
MIB-DSE-626 B: Practicals on Food and Dairy Microbiology

Total Hours: 60 **Credits: 2**

Course objectives	• To learn various milk and food testing procedures • To know food-associatedpathogens and spoilage • To be aware about food safety	
Course Outcomes	After successful completion of this course, students are expected to: • Examine milk and food samples • Infere about the quality of various food samples • Apply good practices for food safety	
Sr. No.	**Contents**	**Hours**
1	Estimation of carbohydrate and protein content of food material	4
2	Estimation of the fat content of food material	4
3	Microbiological examination of milk – SPC and DMC	4
4	MBRT tests for the quality of milk	4
5	Pasteurization of milk and determination of efficacy using alkaline phosphatase test	4
6	Estimation of mycotoxin in food samples by TLC	4
7	Isolation of microorganisms from	4
8	Isolation of food-borne bacteria/ fungi from food products/ Canned food. (*Salmonella/ E. coli/ S. aureous/ coliform* etc.)	4
9	Isolation of microorganisms from spoiled bread.	4
10	Isolation of bacteria/ fungi from spoiled fruits and vegetables.	4
11	Effect of temperature on the spoilage of food products	4
12	Study of strategies for food/milk sampling –liquid/ solid	4
13	Isolation of bacterial probiotics from curd and development of probiotics in vitro	4
14	Description of standard practices for food safety in Hazard analysis criteria control points	4
15	Field visit/study tour to milk/ food industry/bakery	4

References

- Aneja, K. R. (1996) Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation, 2nd Ed., WishwaPrakashan, New Delhi (New Age International, Pvt. Ltd.).
- Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi
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- Reddy M. G., Reddy M. N., Saigopal D. V. R. andMallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Anuradha De,(2014) Practical and Applied Microbiology, 5th Ed., National Book Depot, Mumbai

MSc II (Microbiology)
Semester IV
MIB- 627: Research Project II

Hours: 180 **Credits: 6**

Course objectives	1. To give exposure to the students to research culture and technology 2. To introduce students to how to select a research topic, plan, perform experiments, collect data and analyze the data **3.** To foster self-confidence and self-reliance in the students as they learn to work and think independently
Course outcomes	After successful completion of this course, students are expected to: • Conceive a problem based on published research and carry out a comprehensive survey of the literature • Learn handling of instruments, use of chemicals and how to conduct the experiments • Learn how to present the project in PowerPoint and answer the queries to examiners as well as the science of writing

The systematic approach towards the execution of the project should be as follows: (Wherever applicable)

The complete tenure of the research project should be one academic year. It should be allotted during the third semester and completed in the fourth semester.

1. Weekly 12 hours should be allotted to the research project in a regular timetable.
2. In the fourth semester, students should perform further experimental work, analyze the data and compile the results.
3. Students may be given an opportunity to participate in ongoing research activities in the respective Departments/Schools/Supervisors' laboratories. This will familiarize them with the literature survey and give them a fundamental understanding of designing and executing a research project.
4. Students may work individually or in groups (not more than 3 students) to be decided by the concerned department/supervisor.
5. Each research group should have a different research topic with some possible level of novelty.
6. The student should select the topic relevant to priority areas of concern or allied subjects.
7. Students are encouraged to work on multidisciplinary and applied projects, but it is not mandatory criteria.
8. Students are expected to work in line with the research outline and literature review,which was submittedin the third semester.
9. Students are expected to learn how to execute the research work systematically and overcome the hurdles. Students will get the opportunity to learn about practical aspects of many characterization techniques or models and further how to effectively employ them in the research work. Students should be able to critically evaluate the literature on the topic, identify the research gaps, plan and perform the experiments, interpret the results, understand the limitations of the work and draw conclusions.
10. At the end of the semester, each student should submit a detailed Research Report.
11. The format of the final research report shall be as per the guidelines of respective department. (**Example**:Title of the Project, Certificates, Acknowledgment, Abstract and Keywords, Contents, Introduction, Literature Review, Aim and objective, Materials and Methods, Result, Data analysis and Discussions, conclusion, limitations, suggestion, future scope, Bibliography,

Appendix etc.)

12. An appropriate and essential conclusive statement must be drawn at the end of the study.
13. Students should maintain lab notebooks, and the supervisor may ask them to submit the mid-semester progress report.
14. For documents related to project submission: Font- Times New Roman, Heading Font Size-14, Normal Text Size-12, spacing-1.5, both sides justified and 1 inch margin on all side, both side printing on A-4 size.
15. Three copies of the dissertation should be prepared (one copy for each department, guide, and student).
16. At the end of the semester, the candidate should prepare and present research using a PowerPoint presentation using modern ICT tools during the Internal and External Examination.
17. Besides writing a dissertation, students are encouraged to write a manuscript/patent if the results obtained are worthy of publication.
18. Students may present their research work in Avishkar/Webinars/Conferences.
19. Students should note that plagiarism is strictly prohibited.

Internal examination (60 marks): Components of continuous internal assessment:

- Literature collected, methodological planning, analysis of data, design and work, progress reports etc (30 marks)
- Presentation in Webinars/Conferences/publication and departmental presentationetc(20 marks)
- Oral examination (10 marks)

External examination (90 marks)and Components of external assessment:

- Evaluation of dissertation submitted in bound form at the time of examination **(60 marks)**
- Presentation (PPT format) **(15 marks)**
- Overall presentation reflecting the contribution of work, Response to questions **(15 marks)**