SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Microbiology

Programme code: SMSMCB

M.Sc.-II Microbiology

(Choice Based Credit System with effect from the year 2018-2019)

Programme Outline: M.Sc.-II Microbiology (SEMESTER III)

Course code	Unit No	Name of the Unit	Credits
SMSMCB301		TOOLS AND TECHNIQUES: RESEARCH METHODOLOGY	4
	1	Research Fundamentals and Terminology	
	2	Defining Research problem and Data Collection	
	3	Sampling and Sampling Distributions.	
	4	Data Analysis and Report Writing	
SMSMCB302		FOOD MICROBIOLOGY	4
	1	Microbes in Food	
	2	Uses of Microbes in Food	
	3	Control of Microbes in Food	
	4	Microbial Detection and Food Safety	
SMSMCB303		ADVANCES IN BIOTECHNOLOGY	4
	1	Plant and Agricultural Biotechnology	
	2	Animal Biotechnology	
	3	Nano Biotechnology	
	4	Medical Biotechnology	
SMSMCB304		APPLIED AND ENVIRONMENTAL MICROBIOLOGY	4
	1	Microbial Diversity	
	2	Techniques in Microbial Ecology	
	3	Soil, Marine & Agricultural Microbiology	
	4	Advanced Food & Water Microbiology	
SMSMCBP3		PRACTICALS	
SMSMCBP301		Literature Survey and Research project proposal	2
SMSMCBP302		Food Microbiology	2
SMSMCBP303		Advances in Biotechnology	2
SMSMCBP304		Applied and Environmental Microbiology	2

Programme Outline: M.Sc.-II Microbiology (SEMESTER IV)

Course code	Unit No	Name of the Unit	Credits

SMSMCB401		TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS	4
	1	Spectroscopic techniques	
	2	Chromatographic techniques	
	3	Molecular Biology techniques	
	4	Nanotechnology techniques.	
SMSMCB402		PHARMACEUTICAL MICROBIOLOGY	4
	1	Principles and Applications of GMP in Pharmaceuticals and Cosmetics.	
	2	Quality Management and Regulatory Aspects	
	3	Analytical Aspects for Pharmaceutical and Cosmetic Products	
	4	Drug Discovery	
SMSMCB403		ADVANCES IN BIOTECHNOLOGY	4
	1	Pharmaceutical Biotechnology	
	2	IPR and ethics in Biotechnology	
	3	Marine Biotechnology	
	4	Advances in Molecular Biotechnology	
SMSMCB404		APPLIED AND ENVIRONMENTAL MONITORING & MANAGEMENT	4
	1	Bioremediation, Biodegradation & Waste Disposal	
	2	Biofilm Management	
	3	Environmental Pollution & Monitoring	
	4	Environmental & Natural Resources Management and safety standards	
SMSMCBP4		PRACTICALS	
SMSMCBP401		Dissertation based on Research Project and poster presentation	2
SMSMCBP402		Pharmaceutical Microbiology	2
SMSMCBP403		Advances in Biotechnology	2
SMSMCBP404		Applied And Environmental Monitoring & Management	2

PREAMBLE:

The M.Sc program at Sophia College (Autonomous) is open to both female and male students. The M.Sc course is an extension of the undergraduate curriculum dealing with all the branches of Microbiology at a considerable depth and blends the upcoming fields as well as advances in the subject. Research is an integral aspect of the curriculum and includes planning and execution of a dissertation. The outcomes of a number of the dissertations have been published in peer reviewed

journals. Participation and presentations - both oral and posters in conferences, workshops and research meets is encouraged. Field projects, Educational visits and short-term internships are also included. The students who complete the postgraduate programme in Microbiology are well trained in the subject and find employment in areas like Quality control, Research and Development, Clinical Research, Teaching etc.

Program Objectives

PO1	To provide in depth knowledge to the learners in the conventional and emerging areas of Microbiology.
PO2	To help learners plan and execute research projects.
PO3	To train the learners to communicate the findings of the research projects effectively.
PO4	To create awareness among the learners about regulatory requirements and compliance, IPR and ethics.

PROGRAMME SPECIFIC OUTCOMES

PSO1	The learner will gain and apply knowledge about recent developments in Genetics, Virology, Cell Biology, Microbial Biochemistry, Medical Microbiology and Immunology, Environmental Microbiology, Food and Dairy Microbiology etc in order to solve problems affecting mankind.
PSO2	The learner will acquire knowledge about research methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively.
PSO3	The learner will be able to communicate their findings by virtue of doing poster /oral presentations in conferences/workshops, writing thesis, research papers, reports etc
PSO4	The learners will gain knowledge of regulatory compliance in various fields like clinical research, IPR and ethics by attending value added courses/seminars/webinars etc which may lead to employability.

SEMESTER 3

NAME OF THE COURSE	TOOLS AND TECHNIQUES: RESEARCH METHODOLOGY
CLASS	MSc-II
COURSE CODE	SMSMCB301

NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To educate about the process of research, types of research and research design.
CO 2	To understand the detailed methodology involved in writing a research proposal.
CO 3	To analyze the different types of sampling methods, sampling designs and variables. To learn about methods of data collection, interpretation and report writing.
CO 4	To develop skills in scientific writing and understand ethics in research and publication.
CO 5	To use ICT as a tool to assist in writing research proposals and research outcomes

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the process of research and differentiate between types of research.
CLO 2	The learner will be able to design a research plan.
CLO 3	The learner will be able to use appropriate methods of sample collection, methods of carrying out research and write a report on the same.
CLO 4	The learner will be able to write a research proposal, use anti plagiarism software to check if the proposal follows all principles of ethics in research and publication.
CLO 5	The learner will write a report for presentation in written and oral format using ICT.

UNIT 1	Research Fundamentals and Terminology (15 Lectures)
1.1	Meaning and objective of research, features of a good research study, scientific method (05L)
1.2	Study designs and variations: basic, applied, historical, exploratory, experimental, ex post facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design,. (10L)
UNIT 2	Defining Research problem and data collection (15 Lectures)

2.1	Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification elements, classification, function of theory; scientific laws and principles (05L)
2.2	Methods and techniques of data collection: types of data, methods of primary data collection (Observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study, methods), methods of secondary data collection (internal/ external), schedule method (10L)
UNIT 3	Sampling and sampling distributions (15 Lectures)
3.1	Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and statistical population in the laboratory(10L)
3.2	Variables: Nominal, ordinal, discontinuous, continuous, derived (05L)
UNIT 4	Data analysis and report writing (15 Lectures)
4.1	Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing (05L)
4.2	Report writing and presentation: types of research reports, guidelines for writing a report, report format, appendices, Miscellaneous information, poster and oral presentations (10L)

REFERENCES:
SMSMCB301

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4. Kumar, R. (2005). Research Methodology-A Step-by-Step Guide for Beginners, 2nd.edn, *Singapore, Pearson Education.*
5. Bhattacharya, D.K. (2006). Research Methodology, 2nd.edn, *New Delhi, Excel Books.*

6. Panneerselvam R. (2012). Research Methodology, *New Delhi, PHI Learning Pvt. Ltd.*
7. Khan, Irfan Ali. (2008). Fundamentals of Biostatistics, *Ukaaz Publications.*
8. Rosner B.A. (2011). Fundamentals of Biostatistics, *Cengage Learning*
9. Katz J.M. (2009). From Research to Manuscript: A guide to scientific writing, USA, *Springer Science*
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NAME OF THE COURSE	FOOD MICROBIOLOGY	
CLASS	MSc-II	
COURSE CODE	SMSMCB302	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To list microorganisms that are commonly associated with certain groups of foods
CO 2	To outline the process for making fermented dairy and vegetable foods products
CO 3	To emphasize the health benefits of probiotic bacteria.
CO 4	To outline various types of traditional and advanced methods of food preservation, their principles and their commercial applications.
CO 5	To give an overview of methods available for microbiological analysis of food and compare the methods in terms of advantages and disadvantages.
CO 6	To highlight the importance of control at source and the HACCP system with respect to food safety and quality.
CO7	To educate about the prevailing food safety standards and agencies involved in establishing and monitoring food safety regulations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify the sources of microbial contamination of food, relate specific microorganisms to spoilage of foods or certain foodborne illness.
CLO 2	The learner will be able to illustrate the steps in bread, cheese, idli & sauerkraut production.
CLO 3	The learner will be able to describe the properties of probiotic cultures and their possible health benefits.
CLO 4	The learner will be able to list and describe the applications of organic and inorganic food preservatives.
CLO 5	The learner will be able to give an overview of nonthermal methods of food preservation
CLO 6	The learner will be able to compare the conventional and rapid methods of detection of pathogens
CLO 7	The learner will be able to explain the basis of immunological, nucleic acid, and biochemical methods for detection of food borne pathogens.
CLO 8	The learner will be able to prepare food samples for determination of microbial load and choose appropriate sampling plans as per case number, also understand why some sampling plans are more stringent than others.
CLO 9	The learner will be able to outline the basic concepts of GMPs, recognize its limitations and explain the need for control at source.
CLO 10	The learner will be able to discuss the principles of the HACCP program.
CLO 11	The learner will be able to identify national and international agencies involved in food safety and quality.

UNIT 1	Microbes in foods (15 Lectures)

1.1	Importance of microbes in food
1.2	Sources of microbes in food
1.3	Normal microbiological quality of food
1.4	Factors influencing microbial growth in food
UNIT 2	Uses of microbes in food (15 Lectures)
2.1	Microbial stress response in food
2.2	Starter cultures
2.3	Microbiology of fermented foods: General method of production a. Cheese – Swiss and Blue cheese b. Fermented meat product - Sausage c. Fermented vegetable products – Pickles, Soy product, Sauerkraut a. Bread and Idli
UNIT 3	Control of Microbes in Food (15 Lectures)
3.1	Control of access
3.2	Control by physical physical removal, heat, low temperature, reduced aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation
3.3	Novel emerging techniques of food preservation
3.4	Control by combination of methods (Hurdle concept)
UNIT 4	Microbial Detection and Food Safety (15 Lectures)
4.1	Conventional Methods a. Methods used, Sampling for microbial analysis b. Quantitative microbial enumeration in food c. Qualitative methods of microbial detection d. Bacterial Toxins e. Rapid methods f. Biosensors
4.2	Controlling the Microbiological quality of food a. Quality and Criteria b. Sampling Schemes c. QC using microbiological control d. Control at source e. Codes of GMP f. HACCP g. Laboratory Accreditation

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NAME OF THE COURSE	ADVANCES IN BIOTECHNOLOGY	
CLASS	MSc-II	
COURSE CODE	SMSMCB303	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To introduce students to the various techniques involved in plant and animal biotechnology
CO 2	To familiarize students with the role of microbial genes in plant and animal biotechnology
CO 3	To inform about the applications and potential risks linked with plant and animal biotechnology

CO 4	To provide students with understanding of the emerging field of nanotechnology, its fundamentals and advances in the area of biotechnology
CO 5	To introduce students to both beneficial and harmful applications of biotechnology in the area of human health, with applications in medicine on one hand and bioterrorism on the other.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate the principles of molecular biology methods with emphasis on the application of recombinant DNA technology to plant and animal biotechnology.
CLO 2	The learner will be able to list the applications of plant and animal biotechnology
CLO 3	The learner will be able to understand the risks associated with plant and animal biotechnology
CLO 4	The learner will be able to understand the basic principles of nanobiotechnology and its applications.
CLO 5	The learner will be able to understand both the beneficial and harmful applications of biotechnology in the area of human health

UNIT 1	Plant and Agricultural Biotechnology (15 Lectures)
1.1	Plant Tissue Culture for crop improvement - Initiation and maintenance of Callus and Suspension culture, Direct and Indirect Organogenesis, Micropropagation, Artificial seeds, Anther culture and dihaploids, Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation, Somatic hybrids, Cybrids.
1.2	Production of secondary metabolites from plant cell cultures, Technology of plant cell culture for production of chemicals, Bioreactor systems and models for mass cultivation of plant cells.
1.3	Plant Transformation Technology - *Agrobacterium* mediated gene transfer, *Agrobacterium* based vectors, viral vectors, Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, Molecular breeding, plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination, Transgene silencing, Strategies to avoid transgene silencing.
1.4	Plant Genetic engineering for productivity and performance - a. Biotic Stress tolerance - Herbicide resistance, Glyphosate, Insect resistance, Bt toxin, Disease resistance, Virus resistance b. Abiotic stress tolerance - Drought, Flooding, Salt and temperature c. By manipulation of - Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency d. For Quality improvement - Proteins, Lipids, Carbohydrates, vitamins and minerals. e. Biosafety concerns of transgenic plants
1.5	Plants as bioreactors

UNIT 2	Animal Biotechnology (15 Lectures)
2.1	Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines
2.2	Scale up, Cryopreservation, Culture Collections
2.3	Risks and Safety, Bioethics
2.4	Stem Cell Technology, Cloning techniques Applications
2.5	Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish
2.6	Applications: Transgenic mice: a. Retroviral method b. DNA microinjection method c. Engineered Embryonic Stem cell method
UNIT 3	Nanobiotechnology (15 Lectures)
3.1	Nanoscale systems, nanoparticles, nanowires, thin films and multilayers, Properties of nanomaterials
3.2	Synthesis of nanostructures - physical, chemical and biological, microbiological methods - a. Biomolecules as nanostructures b. Nanoparticular carrier systems, Micro and Nanofluidics c. Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment
UNIT 4	Medical Biotechnology (15 Lectures)
4.1	Genetic Testing of diseases and disorders, Cancer Genetics, Immunogenetics; prenatal diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation diagnosis, Genetic counseling.
4.2	Gene therapy- concept, vectors, gene targeting and tissue-specific expression, Antisense technology.
4.3	Introduction to pharmacogenomics, Pharmacogenetics, and toxicogenomics.
4.4	Social-genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination
4.5	Tissue Engineering - Methods of synthesis, Biomolecular engineering

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NAME OF THE COURSE	APPLIED AND ENVIRONMENTAL MICROBIOLOGY	
CLASS	MSc-II	
COURSE CODE	SMSMCB304	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To discuss microbial diversity, extremophiles, extreme habitats, and their applications.
CO 2	To explain microbial processes such as biofouling, biocorrosion and bioleaching.
CO 3	To explain environmental sample collection and processing, and categorize and compare cultural, physiological, immunological, nucleic acid and molecular methods for studying microorganisms.
CO 4	To describe habitats such as soil and marine, their microbial communities, agricultural microbiology, relationship between plants and microorganisms, and biogeochemical cycles.
CO 5	To develop an understanding of sampling of foods for detection of pathogens, biosensors for analysis of foods, food additives, nutraceuticals and analysis of bottled drinking water as per the standards.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the ecological concepts, differentiate between types of extremophiles and recognize their applications.
CLO 2	The learner will be able to explain the mechanism of biofouling, biocorrosion and bioleaching.
CLO 3	The learner will be able to explain environmental sample collection and also analyze and compare different cultural, physiological, immunological, nucleic acid and molecular methods for studying microorganisms.
CLO 4	The learner will be able to explain and discuss soil, marine and agricultural microbiology, microbial communities, their relationships and biogeochemical cycles.
CLO 5	The learner will be able to explain and apply the methods used for sampling of foods and detection of pathogens
CLO 6	The learner will be able to describe food additives and nutraceuticals
CLO 7	The learner will be able to summarize the analysis of bottled drinking water and justify its significance.

UNIT 1	Microbial Diversity (15 Lectures)
1.1	Microbial ecology: concepts, niche, habitat, ecosystem.
1.2	Introduction to microbial diversity: Types of microorganisms- bacteria, Archaebacteria, Eucarya interactions between microorganisms, ecological succession
1.3	Extremophiles: Habitat, effect of extreme conditions on cellular components- membrane structure, nucleic acids and proteins, adaptation mechanism in microorganisms in diverse environments
1.4	Study of Thermophiles, Psychrophiles, halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms, Methanogens.
1.5	Biotechnological Applications of extreme proteins from the above groups
1.6	Geomicrobiology: Biofouling, biocorrosion, bioleaching.
UNIT 2	Techniques in Microbial Ecology (15 Lectures)
2.1	Environmental sample collection and processing.: Soils and Sediment, Water, Air, Detection of Microorganisms on fomites
2.2	Cultural Methods: Cultural methods for isolation & enumeration of Bacteria
2.3	Physiological Methods: Measuring microbial activity in pure culture; Carbon respiration, Stable isotope probing, use of radioisotopes as tracers, Adenylate energy charge, Enzyme assays.
2.4	Functional genomics & proteomics-based approach
2.5	Immunological methods: Immunoassays
2.6	Nucleic acid based methods of analysis: Obtaining Nucleic acids from Environment, Use of Gene probes, PCR

2.7	Recombinant DNA Techniques, RFLP, Denaturing /Temperature gradient, Plasmid analysis, Reporter genes. Rep PCR fingerprinting and microbial diversity
2.8	Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment: culturable and unculturable bacterial analysis
UNIT 3	Soil, Marine & Agricultural Microbiology (15 Lectures)
3.1	Soil Microbiology: The litho ecosphere: Soil formation, Properties (physical and chemical) Soil communities. Link to microbial interactions. Soil sampling for surface, subsurface soils, Processing and storage of samples.
3.2	Marine microbiology: Marine and estuarine habitats. Characterization and stratification of the oceans Vertical and horizontal zones of marine habitats Marine microbes characteristics, distribution, composition & activity.
3.3	Agricultural microbiology: Factors affecting microbial load of soils. Relationship between plants and microbes: rhizosphere, phyllosphere. Beneficial uses of microorganisms for plant growth and development, Interactions with aerial plant structures.
3.4	Microbial contribution to animal nutrition (Special reference to Rumen flora)
3.5	Biogeochemical cycles for Carbon Nitrogen and Oxygen. Degradation of recalcitrant polymers and xenobiotics eg cellulose, lignin. lignocellulose. Combating Greenhouse effect using microbes. Concept of Carbon credits
UNIT 4	Advanced Food & Water Microbiology(15 Lectures)
4.1	Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi, pathogenic bacteria (*Enteropathogenic E. coli, Vibrio, Salmonellae*) and viruses (Hepatitis A, Norwalk) in meat/fish products as per BIS/ISO/APHA standards
4.2	Use of biosensors, and enzymatic/ thermal techniques for food analysis
4.3	Food additives and ingredients: Food additives - definitions, classification and functions, (Preservatives, antioxidants, colors, emulsifiers, sequestrants, natural and microbial flavors)
4.4	Toxicological evaluation of food additives.
4.5	Applications of fibers from food sources, microbial fructooligosaccharides.
4.6	Nutraceuticals and health foods: Introduction to nutraceuticals: definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals. Microbes and production of nutraceuticals like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals –stability and analytical issues, labeling issues.
4.7	Drinking water risk assessment & its safety: Bottled water–legislation: Types of bottled water. BIS Regulations regarding the production of bottled waters wrt final quality of the product**.** Potential chemical and microbiological hazards in the bottles depending on the type of water, the type of bottle and the bottling procedure. The application of HACCP in the bottling plants: Water Quality obtained from point of use water purifier units, Types of water purifiers.

	Microbiological specifications and methods used certify water purifiers. International standards regulating quality of water purifiers.

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Practicals- Semester 3 SMSMCBP3

NAME OF THE COURSE	LITERATURE SURVEY AND RESEARCH PROJECT PROPOSAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES:

CO 1	To select a research topic and design a research plan.
CO 2	To write the origin of the research problem, interdisciplinary relevance and justification.
CO 3	To conduct literature search on the selected research topic.
CO 4	To write Aims and Objectives.
CO 5	To propose appropriate materials and methods in order to conduct the research
CO 6	To comment on the expected results.
CO 7	To write references using APA, Harvard style etc.
CO 8	To write a budget for conducting the research project
CO 9	To present the research proposal.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to select a research topic and design a research plan in consultation with the guide and keeping in mind the facilities provided by the department and common instrument facility available in other science departments.
CLO 2	The learner will be able to justify the need to carry out the proposed research work, highlight the interdisciplinary relevance and propose a hypothesis.
CLO 3	The learner will be able to review primary and secondary sources of data in order to collect literature in an hope to explore areas which have not been researched so far if possible, especially applications.
CLO 4	The learner will be able to write aims and list the objectives of carrying out the research project.
CLO 5	The learner will be able to describe the procurement and use of materials in the order to carry out the research. Also To propose appropriate materials and methods in order to conduct the research
CLO 6	The learner will be able to discuss the expected results after carrying out the key steps of the research project.
CLO 7	The learner will be able to write in text references and also list at least 25 references using APA, Harvard style etc at the end of the proposal.
CLO 8	The learner will be able to list the cost of the chemicals, glassware, instrumental analysis etc carried out during the research project.
CLO 9	The learner will be able to prepare a research proposal of about 25 -30 pages using ICT, check it for plagiarism and also present the same in the form of a Powerpoint presentation during the practical examination.

Sr.no	Name of the experiment
1	Literature survey
2	Writing Research Project proposal

COURSE OBJECTIVES

NAME OF THE COURSE	FOOD MICROBIOLOGY PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP302	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

CO 1	To outline the process for making popular traditional fermented food, monitor microbial succession as the fermentation progresses and study the characteristics of the final product.
CO 2	To impart hands-on experience of the quality control process and regulations for raw and pasteurized milk.
CO 3	To equip learners with practical skills in assessing microbiological quality of raw and processed liquid, solid, semisolid food as per prevailing food safety standards.
CO 4	To isolate probiotic bacteria.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to determine total aerobic count and lactic acid bacteria count of fermented Idli batter & Sauerkraut and monitor its progress at intervals by determining the lactic acid content using titration method.
CLO 2	The learner will be able to prepare food samples for determination of microbial load and determine the APC and coliform count in carrot and apple juice, salad, mayonnaise to comment on hygienic quality and shelf life
CLO 3	The learner will be able to carry out quality Assessment and Analysis of Milk (Raw, Packed) and icecream by performing DMC, RPT and SPC / LPC, Thermophilic/Psychrophilic, yeast-mold counts
CLO 4	The learner will be able to conduct literature survey on latest novel detection methods for food borne pathogens/ toxins.

Sr.No	Name of the experiment
1	Microbiological study of fermented foods (Idli batter and sauerkraut)
2	Microbiological load in carrot and apple juice, salad, mayonnaise.
3	Quality Assessment and Analysis of food: a. Milk (Raw, Packed) b. Icecream c. Yoghurt
4	Report to be written in journal on Novel detection methods for food borne pathogens/ toxins.

NAME OF THE COURSE	ADVANCES IN BIOTECHNOLOGY PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP303	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To understand the principles and practices involved in setting up and running an animal tissue culture laboratory
CO 2	To acquire knowledge of media preparation, sterilization and sterility checking.
CO 3	To learn setting up of chick fibroblast cultures, preparing single cell suspension from adherent cells and viability assessment.
CO 4	To understand the principles of trypan blue exclusion assay for determining cell viability and learn to enumerate lymphocytes using haemocytometer.
CO 5	To acquire knowledge of the wet reduction method for synthesizing nanosilver and using neem extract and bacteria.
CO 6	To learn to characterize nanosilver using UV spectrometry and interpret the characterization data.
CO 7	To compare the antimicrobial properties of nanosilver prepared through different methods.
CO 8	To evaluate the antimicrobial effects of nanosilver-coated gauze/textiles on different bacteria.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to demonstrate proficiency in setting up and requirements of animal cell culture laboratory.
CLO 2	The learner will be able to prepare animal cell culture media, use appropriate sterilization techniques and conduct sterility testing.
CLO 3	The learner will be able to set up chick fibroblast cultures and evaluate the viability of single cells using trypan blue staining.
CLO 4	The learner will be able to enumerate lymphocytes using a haemocytometer.
CLO 5	The learner will be able to prepare nanosilver using wet reduction methods and characterize it using UV spectrometry.
CLO 6	The learner will be able to analyze and evaluate the antimicrobial effects of nanosilver on various bacteria.
CLO 7	The learner will be able to analyze the efficacy of nanosilver-coated gauze / textiles in inhibiting bacterial growth.

Sr. No	Name of the experiment
1	Laboratory design of Animal tissue culture laboratory

2	Preparation of complete medium, Sterilization and sterility checking.
3	Chick embryo fibroblast culture and viable staining
4	Lymphocyte culture, viable staining and hemocytometer count.
5	Preparation of Nanosilver By Wet reduction Method (Chemical) and using Neem Extract (plants) & Bacteria (Microbiological)
6	Characterisation of Nanosilver by UV spectrometry and microscopic methods
7	Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods
8	Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria

NAME OF THE COURSE	APPLIED AND ENVIRONMENTAL MICROBIOLOGY PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP304	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES:

CO 1	To enrich and isolate thermophiles from hot springs/compost heaps, extract the enzymes and determine the specific activity.
CO 2	To estimate antioxidants and anti-nutritional factors by spectrometric methods
CO 3	To analyze fish samples for the recovery and detection of Enteropathogenic *E. coli, Vibrio, Salmonellae* as per BIS/APHA standards.
CO 4	To assess Zero B water purifiers used for the removal of bacteria.
CO 5	To analyze soil samples by determining the nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content
CO 6	To enrich and isolate cellulose, lignin and xylan degraders from mangrove soil

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to enrich and isolate thermophilic bacteria from compost heaps/hot springs, extract cell free enzymes and determine specific activity.
CLO 2	The learner will be able to estimate the concentration of antioxidants and anti-nutritional factors by spectrometric methods
CLO 3	The learner will be able to analyze fish samples and detect Enteropathogenic *E. coli, Vibrio, Salmonellae* as per BIS/APHA standards
CLO 4	The learner will be able to judge the quality of Zero B water purifiers
CLO 5	The learner will be able to analyze soil samples, determine the nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content and interpret the data
CLO 6	The learner will be able to perform experiments to enrich and isolate cellulose, lignin and xylan degraders from mangrove soil and study their cultural and morphological characteristics

Sr. No	Name of the experiment
1	Enrichment & isolation of thermophiles from hot springs/compost heaps & extraction of thermophilic enzymes & determination of its specific activity.
2	Estimation of antioxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method

3	Microbiological analysis of fish samples wrt sample processing for recovery and detection of Enteropathogenic *E. coli, Vibrio, Salmonellae* as per BIS/ISO/APHA standards and computation of measure of uncertainty
4	Assessment of point of use water purifiers (Zero B) for removal of bacteria..
5	Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content.
6	Enrichment and isolation of cellulose, lignin & xylan degraders from mangrove soil

ASSESSMENT DETAILS:

Internal assessment (40 marks

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (15 marks)

- An activity for 15 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report, Preparation of study material, any other activity)

Part 3: Active Participation (05 marks)

Semester end examination (60 marks)

The duration of the paper will be two and a half hours.

- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3). Q1-4 shall carry a maximum of 12 marks.
- Q5 shall be from Units 1 to 4 and consist of objective type questions. Q5 shall carry a maximum of 12 marks (attempt any 4 of 6 for Part A and B and any 2 of 3 for Part C)

Practical Assessment

- The duration of the practical exam will be three days.

- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.

SEMESTER 4

NAME OF THE COURSE	TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS	
CLASS	MSc-II	
COURSE CODE	SMSMCB401	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To understand the basic and advanced spectroscopic techniques in judging purity and properties of an analyte.
CO 2	To explore the various chromatography techniques for separation and analysis of compounds.
CO 3	To familiarize about molecular biology techniques like PCR, FISH etc
CO 4	To explore the advanced microscopic techniques and their applications in various fields including Nanobiotechnology.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the principle, instrumentation and applications of various spectroscopic techniques in order to explain the properties like lambda max, dispersion, purity etc.
CLO 2	The learner will be able to analyze the principle, instrumentation and applications of various chromatographic techniques for separation of molecules of interest and study their characteristics like molecular weight.
CLO 3	The learner will be able to discuss appropriate methods for amplification of DNA/ detection of RNA to help in genetic analysis of a sample.
CLO 4	The learner will be able to explain the principle, instrumentation and applications of various microscopic techniques in order to find out the size, shape and structure of an organelle/ microorganism/ surface/nanomaterial.

UNIT 1	Spectroscopic techniques (15 Lectures)
1.1	UV-visible spectroscopy: Beer-Lambert's Law, Instrumentation, operation, calibration, accuracy and applications (05L)
1.2	IR: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)
1.3	Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, calibration, accuracy and applications (05 L)
UNIT 2	Chromatographic techniques (15 Lectures)
2.1	Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)
2.2	High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)
2.3	Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications (05L)
UNIT 3	Molecular Biology techniques (15 Lectures)
3.1	Variations/ Modifications of PCR: Hot- Start PCR, Multiplex PCR, Nested PCR, RT-PCR, Broad Range PCR, arbitrarily primed PCR, Quantitative PCR, Real time PCR (05L)
3.2	Hybridization array technology: applications of microarrays in microbiology, Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays) (05L)
3.3	FISH with other techniques: (confocal laser scanning microscopy, micro autoradiography, flow cytometry, immunofluorescence, microsensors, peptide, nucleic acids (05 L)
UNIT 4	Nanotechnology techniques (15 Lectures)
4.1	Microscopy: i. Scanning Probe Microscopes - scanning tunneling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM), ii. Electron Microscopy: SEM, TEM (10L)
4.2	Diffraction Techniques: X-ray diffraction (XRD) (02L)
4.3	Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies (XPS)/Auger electron spectroscopy (03L)

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NAME OF THE COURSE	PHARMACEUTICAL MICROBIOLOGY
CLASS	MSc-II
COURSE CODE	SMSMCB402
NUMBER OF CREDITS	4
NUMBER OF LECTURES PER	4

WEEK		
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1.	To summarize the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical and cosmetic industry.
CO 2.	To explain the design, structure, layout of pharmaceutical premises and personnel management .
CO 3.	To discuss the principles of personnel hygiene and health in the pharmaceutical industry
CO 4	To justify the significance of Documentation in the pharmaceutical industry
CO 5	To explain the concept of GCLP.
CO 6	To recognize the importance of sterility in the pharmaceutical industry and methods of sterilization used.
CO 7	To summarize validation in the pharmaceutical industry
CO 8	To discuss cosmetic microbiology, global, regulatory and toxicological aspects of cosmetic preservation, antimicrobial preservation efficacy, microbial content testing and validation.
CO9	To familiarize with the fundamental processes involved in development of new or more effective and safe drugs
CO10	To highlight the importance of modern analytical techniques and bioinformatics in the process of drug discovery.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the relationship between Quality assurance, Quality Control and GMP.
CLO 2.	The learner will be able to explain the design, layout and structure of pharmaceutical premises along with control of contamination.
CLO 3	The learner will be able to recall the responsibilities of the key personnel involved in the industry, the training given and the principles of personnel hygiene and health in the pharmaceutical industry and justify its significance.
CLO 4	The learner will be able to justify the importance of documentation in the pharmaceutical industry..
CLO 5	The learner will be able to recall GCLP
CLO 6	The learner will be able to describe, categorize and differentiate between the methods of sterilization used in the pharmaceutical industry.
CLO 7	The learner will be able to summarize the validation methods in the pharmaceutical industry

CLO 8	The learner will be able to explain and discuss global, regulatory and toxicological aspects of cosmetic preservation, antimicrobial preservation efficacy, microbial content testing and validation and apply the same in the practicals.
CLO 9	The learner will be able to explain the terms and describe the steps involved in the new drug development
CLO 10	The learner will be able to list various natural resources useful for drug discovery.
CLO 11	The learner will be able to compare traditional methods of drug discovery with that of the modern tools used in high throughput screening.

UNIT 1	Principles and applications of GMP in Pharmaceuticals and Cosmetics (15 Lectures)
1.1	Principles – Applications and Definitions
1.2	The concept of Quality
1.3	The regulatory factors
1.4	QC, QA and GMP
1.5	Quality assurance beyond GMP
1.6	ISO
1.7	Sanitary practices in cosmetic manufacturing
UNIT 2	Quality Management and Regulatory Aspects (15 Lectures)
2.1	Premises and contamination control, location, design, structure, layout, services and cleaning.
2.2	Personnel management, training, Hygiene and health.
2.3	Documentation
2.4	Global regulatory and toxicological aspects of cosmetic preservation
UNIT 3	Analytical aspects for pharmaceutical and cosmetic products (15 Lectures)
3.1	Quality control and GCLP
3.2	Sterile and other products.
3.3	Validation
3.4	Cosmetics microbiology- testing methods and preservation a. Antimicrobial preservation efficacy and microbial content testing b. Validation method for cosmetics c. Preservation strategy d. Evaluation of antimicrobial mechanism
UNIT 4	Drug Discovery (15 Lectures)
4.1	Modern Methods of Drug Discovery

4.2	Proteomics
4.3	Bioinformatics
4.4	High throughput screening technology
4.5	Natural products for lead identification
4.6	The role of protein 3D structures in the drug discovery process.

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NAME OF THE COURSE	ADVANCES IN BIOTECHNOLOGY	
CLASS	MSc-II	
COURSE CODE	SMSMCB403	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1.	To familiarize students with the various categories of biotechnological products used in the area of human health care.
CO 2.	To introduce students to the basic concepts of IPR related to inventions in the field of biotechnology and the requirements for patent filing.
CO 3.	To raise students' awareness of the bioethical concerns linked to applications of biotechnology in areas of plant, animal and human health
CO 4	To make students aware of the adaptations of marine microorganisms in extreme environments.
CO 5	To introduce students to the industrial applications of marine-derived bioproducts and biomaterials.
CO 6	To familiarize students with the steps involved in chemical synthesis of DNA and the strategies to regulate and control transgene expression
CO 7	To introduce students to the fundamental concepts associated with manipulating biomolecules and their applications.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to describe the applications of biotherapeutics in human health care.
CLO 2.	The learner will be able to outline the types of Intellectual Property Rights for safeguarding various intellectual works in the field of biotechnology.
CLO 3	The learner will be able to analyze ethical issues associated with biotechnology and recognize the associated risks.
CLO 4	The learner will be able to explain the adaptations of marine microorganisms in extreme environments.
CLO 5	The learner will be able to describe the potential industrial applications of products obtained from marine microorganisms.
CLO 6	The learner will be able to explain the steps involved in chemical synthesis of oligonucleotides and their application in biotechnology through effective and controlled expression in heterologous systems.
CLO 7	The learner will be able to outline the processes involved in manipulating biomolecules suited for industrial applications.

UNIT 1	Pharmaceutical Biotechnology (15 Lectures)
1.1	Biologics, Biopharmaceuticals,
1.2	Protein structure stability, folding, structure prediction, Post translational modifications, Protein Therapeutics – Upstream and Downstream processing, Cytokines, Interferon production, Interleukins production, Therapeutic hormones – Insulin, Human Growth Hormone, Recombinant blood products, Therapeutic Enzymes
1.3	Newer Vaccines, Vaccine Designing Approaches
1.4	Drug Discovery Tools, Combinatorial Chemistry, High Throughput Screening, Cheminformatics, In silico Modelling, Molecular Modeling, Structure Prediction,

	Rational Drug Designing, Drug Development, Concept of Pharmacognosy, Pharmacokinetics and Pharmacodynamics
UNIT 2	IPR and Ethics in Biotechnology (15 Lectures)
2.1	Biotechnology and Intellectual Property Rights (9 L) a. Intellectual Property Rights (IPR) and Protection (IPP) b. Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations, Biotechnological Patents c. Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement. d. Patent Specifications and Basic Component of License Agreement, In IP System e. Categories of Biotechnological Patents-Patenting in the New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents. f. Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non-Patentable IP and Patentable IP in Indian Patent Act
2.2	Biotechnology and Bioethics (6 L) a. Biotechnology and Bioethics b. Bioethics and cross-cultural bioethics. - Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making c. Perceptions of Ethical Biotechnology. - 'Moral' is not the same as Ethical, Mixed Perception of Benefit & Risk, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs. d. Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature, Fear of Unknown, Regulatory Concerns, Human Misuse e. Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering f. Bioethics vs Business: A Conflict? - IPP, Global Issues of Technology Transfer, Safety vs Costs, Is New Technology Better g. Resolution of Conflicts- Who can be trusted? Public Education, Sufficient Regulations h. Ethical limits of Biotechnology. -Absolute or Relative, Timeless or Transient i. Criteria to Assess whether Biotech Research is Ethical.
UNIT 3	Marine Biotechnology (15 Lectures)
3.1	Extreme environmental conditions, Marine life forms, Biomimetic materials, new class of pharmaceuticals, industrial products and processes, vaccines, diagnostics and analytical reagents, Environmental research in marine environment, Methods in Marine Microbiology – Detection of microorganisms and microbial activity, Metabolic diversity, Extreme Environment conditions, Marine bacteria, marine archaea, Biofouling and biodeterioration, Degradation of pollutants, Bioremediation, Role of microorganisms in ocean processes, Marine Genomics and Proteomics.

3.2	Marine bioprospecting – Isolation of Marine Natural Products
3.3	Diversity of marine derived compounds - Alkaloid, Terpenoids and steroids, nucleoside, amino acids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymes- protease, lipase, chitinase, glucanase; Marine biominerals; Biomineralized structures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagens.
3.4	Bioactive Compounds and Biomaterials from Marine Environment.
UNIT 4	Advances in Molecular Biotechnology (15 Lectures)
4.1	Chemical synthesis and sequencing of DNA: Phosphoramidite method, uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Using Phage M13 as a sequencing vector
4.2	Manipulation of Gene Expression in Prokaryotes: Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays**,** Increasing protein stability, protein folding, DNA integration into host chromosome
4.3	Heterologous protein production in eukaryotic cells: Expression systems like *Saccharomyces cerevisiae, Pichia pastoris,* Baculovirus-Insect cell, mammalian cell
4.4	Directed Mutagenesis: Oligonucleotide directed mutagenesis with M13, Oligonucleotide directed mutagenesis with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primer, Random mutagenesis with nucleotide analogues, Error-prone PCR, DNA shuffling, Mutant proteins with unusual amino acids
4.5	Protein Engineering: Adding disulfide bonds, changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, increasing enzymatic activity, modifying metal cofactor requirement, decreasing protease sensitivity, modifying protein specificity, increasing enzyme stability and specificity, altering multiple properties
4.6	Synthetic Biology: Introduction, types, mechanisms, applications in industry

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NAME OF THE COURSE	APPLIED AND ENVIRONMENTAL MONITORING & MANAGEMENT	
CLASS	MSc-II	
COURSE CODE	SMSMCB404	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To discuss bioremediation and waste disposal methods.
CO 2	To explain the significance and mechanism of biofilm formation in nature, along with methods to manage the same.
CO 3	To discuss and classify pollution into different types and describe measures to manage and control the same.
CO 4	To discuss methods of solid and hazardous waste management, management of other types of waste, biohazards and biosafety.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the bioremediation strategies and waste disposal methods and recall and relate it during the field visit to the effluent treatment plant.
CLO 2	The learner will be able to recall the mechanism of biofilm formation, beneficial and harmful biofilms and discuss methods for controlling biofilm growth.
CLO 3	The learner will be able to classify pollution into different types and describe the methods to manage and control the pollution
CLO 4	The learner will be able to explain the methods of solid and hazardous waste management, other types of waste management such as electronic waste and justify the importance of biosafety

UNIT 1	Bioremediation, biodegradation & Waste Disposal (15 Lectures)
1.1	Engineering and bioremediation process its needs and limitations.
1.2	Bioremediation in Soil of BTEX hydrocarbons.
1.3	Petroleum contamination, Polycyclic aromatic compounds
1.4	Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds. Molecular technique in Bioremediation.
1.5	Sewage & Sludge treatment and disposal methods.
UNIT 2	Biofilm management (15 Lectures)
2.1	Structure and properties of biofilms:
2.2	Formation of biofilm, Regulation of Initial Attachment, Biofilm formation proceeds via Multiple Convergent Genetic Pathways, Early Attachment Events, Maturation of the Biofilm, Detachment and Return to the Planktonic Growth Mode
2.3	Study of Quorum Sensing: Cell- Cell Communication amongst bacteria, and its similarity with *M. xanthus* Fruiting Body Development.
2.4	Multispecies biofilms: Clinical Relevance
2.5	Biofilms in plant-associated habitats: In the Phyllosphere (impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms,), In the Rhizosphere (ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology,)
2.6	Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quaternary ammonium compounds.
2.7	Use of other biofilm management methods such as probiotic organisms and prebiotics to restore disrupted beneficial biofilms to a “normal state”. Correction of environmental conditions for enhanced bioremediation of biofilms (e.g., dental plaque)
2.8	Disadvantages of biofilm management strategies-development of resistant strains-cross resistance induction

2.9	Biofilms from different environments, Impact of environment on biofilm development and its composition and implications of each on biofilms in water bodies, biofouling associated microbial biofilms, prosthetics associated biofilms, human associated biofilms e.g. Gut
UNIT 3	Pollution control and monitoring (15 Lectures)
3.1	Introduction to Pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in pollution control
3.2	Air pollution: Sources - Organic and inorganic pollutants, particulate matter, photochemical smog, acid rain, ozone depletion, greenhouse effect, global warming, and role of microorganisms in cause and mitigation of global warming, climate change. Control measures of air pollution - dust control equipment, control measures for specific gaseous pollutants, Effects of air pollution, assessment & monitoring. (Indoor air pollution, vehicular pollution and control, odor control)
3.3	Water pollution: Sources of water and their contamination, types of pollutants, Effects of water pollution on plants, animals and human beings. Indicator microorganisms. Eutrophication – causes, effects and control measures.
3.4	Wastewater treatment – aerobic and anaerobic. CETP, Water quality criteria and standards for discharge. Assessment & monitoring of water pollution.
3.5	Marine pollution: Sources, effects and coastal management
3.6	Thermal pollution: Sources, effects and control
3.7	Soil Pollution: Chemical composition and classification (hazardous and non hazardous) of soil, sources of soil pollution, effects on plants, animals and human beings, biomagnification, control measures, assessment and monitoring.
3.8	Noise pollution: Sources, impact, measurement and indices, control and abatement
3.9	Radioactive pollution: Sources, effects, prevention and control measures
UNIT 4	Environmental & natural resources management and safety standards (15 Lectures)
4.1	Natural resources: Renewable/ nonrenewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development
4.2	Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non-biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling.
4.3	Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these wastes through Common Effluent Treatment Plants.
4.4	Biomedical and electronic waste management, recovery of precious metals from electronic waste resources.

4.5	Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures
4.6	Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)

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SMSMCB404

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Practicals- Semester 4 SMSMCBP4

NAME OF THE COURSE	DISSERTATION BASED ON RESEARCH PROJECT AND POSTER PRESENTATION	
CLASS	MSc-II	
COURSE CODE	SMSMCBP401	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To conduct research according to the proposed research plan.
CO 2	To maintain a journal for entry of results obtained.
CO 3	To outsource samples for advanced instrumental analysis.
CO 4	To outsource identification of microorganisms isolated during the research work.
CO 5	To explain and discuss the results obtained.

CO 6	To prepare a manuscript on the research conducted using ICT.
CO 7	To present the research work.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to purchase chemicals of appropriate grade, standardize and carry out experiments according to the plan of work. Understand the modalities of preparing media, reagents etc, their sterilization and discard.
CLO 2	The learner will be able to maintain a journal for entry of raw data, discuss the data with the guide regularly and then proceed further with the research work.
CLO 3	The learner will be able to submit samples for GC-MS, SEM, TEM, FTIR to institutes that can carry them out for various types of information that can help in gaining more knowledge about the research work.
CLO 4	The learner will be able to give a promising microorganism isolated during the research work for identification using 16S or 18S analysis if possible
CLO 5	The learner will be able to describe in detail citing cross references the results obtained with appropriate discussion.
CLO 6	The learner will be able to prepare a thesis in a specified format suggested by the department with appropriate in text references, figures, tables, etc using ICT.
CLO 7	The learner will be able to present the research in the form of a poster for assessment by an external examiner. Also write a research paper and try to publish it in a scientific journal.

Sr. No	Name of the experiment
1	Research project experimental work

COURSE OBJECTIVES

CO 1	To equip learners with practical skills in assessing sterility of pharmaceuticals as per prevailing standards

NAME OF THE COURSE	PHARMACEUTICAL MICROBIOLOGY PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP402	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

CO 2	To impart hands-on experience of the quality control process and regulations for cosmetic products
CO 3	To prepare a cosmetic product and evaluate the effectiveness of preservatives
CO 4	To write a detailed report on LAL test for pyrogen testing

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to carry out quality assessment by testing the sterility of injectables as per Pharmacopoeia.
CLO 2	The learner will be able to judge the quality of a cosmetic product by determining its Microbial load.
CLO 3	The learner will be able to test and comment about the antimicrobial effect of preservatives added to the cosmetic / pharmaceutical preparations.
CLO 4	The learner will be able to develop a cosmetic product and evaluate the effectiveness of the added preservative
CLO 5	The learner will be able to write a report on LAL test for pyrogen testing and justify its significance in the Quality Control

Sr. No	Name of the experiment
1	Sterility testing and reporting (as per Pharmacopeia)
2	Microbial load in cosmetic product
3	Efficacy testing of preservatives like parabens

4	Efficacy of preservation and shelf-life study.
5	Preparation of cosmetic product and its preservation study
6	Report on LAL and other tests for QC

NAME OF THE COURSE	ADVANCES IN BIOTECHNOLOGY PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP403	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES:

CO 1	To understand the criteria for patentability and the process of obtaining patents.
CO 2	To understand the fundamental principles of ethics and identify the key ethical concerns related to biotechnology.
CO 3	To present research outcomes in an effective and engaging manner.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to understand the process of obtaining patents.
CLO 2	The learner will be able to understand the importance of intellectual property rights in protecting innovations and managing IP in biotechnology.
CLO 3	The learner will be able to conduct a research project involving experimental work, analyze results, and communicate research findings effectively.

Sr. No	Name of the experiment
1	Assignments on IPR-Case studies on different patents granted
2	Report on International Bioethics survey on specific concerned issues.
3	Research Project experimental work

NAME OF THE COURSE	APPLIED AND ENVIRONMENTAL MONITORING & MANAGEMENT PRACTICAL	
CLASS	MSc-II	
COURSE CODE	SMSMCBP404	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To develop and examine microbial biofilms with emphasis to their structure and composition.
CO 2	To determine and compare MIC of a disinfectant for planktonic and sessile bacteria
CO 3	To analyze domestic and industrial sewage for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), and F/M ratio.
CO 4	To analyze samples for the presence of SOx, NOx , and heavy metal pollutants such as Chromium using spectrophotometric methods
CO 5	To visit any large-scale industry to gain knowledge of environmental, health and safety aspects OR Common Effluent Treatment Plant Kopar Khairane Navi Mumbai to learn the treatment of domestic and industrial waste OR Pollution Control Board to learn the methods of pollution management
CO 6	To write a detailed report on EIA and understand its significance

CO 7	To review and discuss various environmental-related case studies

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to develop biofilms from different natural environments and analyze their structure and composition
CLO 2	The learner will be able to determine and compare MIC of a disinfectant such as Lizol for planktonic and sessile bacteria
CLO 3	The learner will be able to analyze domestic and industrial sewage for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), and F/M ratio.
CLO 4	The learner will be able to analyze samples for the presence of heavy metal pollutants such as Chromium using spectrophotometric methods and judge the level of pollution
CLO 5	The learner will be able to connect the practical aspects learnt during the field visit to industry/CETP/ Pollution board with the theory
CLO 6	The learner will be able to write a detailed report on EIA and justify its significance
CLO 7	The learner will be able to discuss case studies on any of the following environmental related issues such as sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, and oil spills.

Sr. No	Name of the experiment
1	Biofilm visualization by staining of a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environments).
2	Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to planktonic cells) quantified using crystal violet assay.
3	Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.
4	Demonstration of Analysis of SOx, NOx , heavy metal (As/Cr) pollutants using volumetric/ spectrophotometric methods.
5	Study tour/ academic visit to any large-scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centers OR Study tour/ academic visit to Sewage treatment plant/ ETP of any industry / water purification unit/ Pollution Control Board Lab, CETP, landfill, etc.

6	Preparation/ drafting of an EIA report.
7	Case studies: sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, oil spills.

ASSESSMENT DETAILS:

Internal assessment (40 marks

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (15 marks)

- An activity for 15 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report, Preparation of study material, any other activity)

Part 3: Active Participation (05 marks)

Semester end examination (60 marks)

The duration of the paper will be two and a half hours.

- There shall be five compulsory questions

- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3). Q1-4 shall carry a maximum of 12 marks.
- Q5 shall be from Units 1 to 4 and consist of objective type questions. Q5 shall carry a maximum of 12 marks (attempt any 4 of 6 for Part A and B and any 2 of 3 for Part C)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.