



SIES

**College of Arts,
Science &
Commerce**

**RISE WITH EDUCATION
Sion(W), Mumbai – 400022**

**Program: B.Sc.
Course: Microbiology
Syllabus for M.Sc. II
To be implemented from 2018-2019**

(Credit Based Semester and Grading System with
effect from the academic year 2018–2019)

PROGRAMME: M.Sc.
COURSE: MICROBIOLOGY (SIPSMIC)
Semester-III and Semester-IV PREAMBLE

With the introduction of Autonomy by the S.I.E.S. College of Arts, Science and Commerce under the University of Mumbai; from the academic year 2018-19; the syllabus for the M.Sc. Microbiology has been drafted to cover the many aspects of the subject.

In order to assist students in developing research skills in general and in specific area of their interest/ specialization in particular, research proposal and research project component has been retained in the revised syllabus. This component will provide students with an opportunity to conduct independent research in the subject of Microbiology at their own P.G. centers and if the research project demands, in conjunction with relevant industries/ research institutes. Topics like Research Methodology, Biostatistics and Biomolecular analysis have been introduced in the revised syllabus.

In order to enable students to develop employable skills concurrently with an understanding of theoretical foundations and practical techniques required in R andD, quality control, regulatory function in pharmaceuticals, food industry, environmental sciences, papers on Pharmaceutical Microbiology, Food Microbiology, Advances in Biotechnology, Applied and Environmental Microbiology and Applied and Environmental monitoring and management have been included in the revised syllabus.

As mentioned in the syllabus, all the 16 courses of theory and practicals are compulsory to M.Sc. Microbiology (By Papers) students. (Semester I, II, III, IV).

1. SIPSMIC-31 and SIPSMIC-41: Tools and Techniques : Research methodology
2. SIPSMI -32 and SIPSMIC-42: Food and Pharmaceutical Microbiology
3. SIPSMIC-33 and SIPSMIC-43: Advances in Biotechnology
4. SIPSMIC-34 and SIPSMIC-44: Applied and Environmental Microbiology, Applied and Environmental Monitoring and Management

M.Sc. Part - II Microbiology Syllabus [Semester - III and IV]

SEMESTER III: THEORY

Course Code	UNIT	TOPIC HEADINGS	Credits	L /Week
SIPSMIC31 Tools and Techniques : Research Methodology	I	Research Fundamentals And Terminology	4	01
	II	Defining Research problem and Data Collection		01
	III	Sampling And Sampling Distributions		01
	IV	Data Analysis and Report Writing		01
SIPSMIC32 Food Microbiology	I	Microbes In Food	4	01
	II	Uses Of Microbes In Food		01
	III	Control Of Microbes In Food		01

	IV	Microbial Detection And Food Safety		01
SIPSMIC33 Advances In Biotechnology	I	Plant And Agricultural Biotechnology	4	01
	II	Animal Biotechnology		01
	III	Nano Biotechnology		01
	IV	Medical Biotechnology		01
SIPSMIC34 Applied and Environmental Microbiology	I	Microbial Diversity	4	01
	II	Techniques In Microbial Ecology		01
	III	Soil, Marine and Agricultural Microbiology		01
	IV	Advanced Food and Water Microbiology		01

PRACTICALS

SIPSMICP31	Literature Survey And Research Project Proposal	2	04
SIPSMICP32	Food Microbiology	2	04
SIPSMICP33	Advances In Biotechnology	2	04
SIPSMICP34	Applied And Environmental Microbiology	2	04

SEMESTER IV: THEORY

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSMIC41 Tools and Techniques: Biomolecular Analysis	I	Spectroscopic Techniques	4	01
	II	Chromatographic Techniques		01
	III	Molecular Biology Techniques		01
	IV	Nanotechnology Techniques		01
SIPSMIC42 Pharmaceutical Microbiology	I	Principles And Applications Of GMP In Pharmaceuticals And Cosmetics	4	01
	II	Quality Management And Regulatory Aspects		01
	III	Analytical Aspects For Pharmaceutical And Cosmetic Products		01
	IV	Drug Discovery		01
SIPSMIC43 Advances in Biotechnology	I	Pharmaceutical Biotechnology	4	01
	II	IPR and ethics in Biotechnology		01
	III	Marine Biotechnology		01

	IV	Advances in Molecular Biotechnology		01
SIPSMIC44 Applied and Environmental Monitoring and Management	I	Bioremediation, Biodegradation and Waste disposal	4	01
	II	Biofilm Management		01
	III	Environmental Monitoring and Pollution		01
	IV	Environmental and Natural Resources Management and safety standards		01

PRACTICALS

SIPSMICP41	Dissertation based on Research Project and Poster Presentation.	2	04
SIPSMICP42	Pharmaceutical Microbiology	2	04
SIPSMICP43	Advances in Biotechnology	2	04
SIPSMICP44	Applied and Environmental Monitoring and Management	2	04

EACH THEORY AND PRACTICAL PERIOD SHALL BE OF ONE HOUR DURATION

SEMESTER -III: DETAILED SYLLABUS

SIPSMIC31: TOOLS AND TECHNIQUES: RESEARCH METHODOLOGY (60L)

Course Code	Title	Credits
SIPSMIC31	Tools and Techniques :Research Methodology (60L)	04
<p>1. Unit I: <u>Research Fundamentals and Terminology</u> (15L)</p> <p>1.1. Meaning and Objective of research, features of a good research study, scientific method (5L)</p> <p>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)</p>		01
<p>2. Unit II: <u>Defining Research problem and data Collection</u> (15L)</p> <p>2.1. Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification, elements, classification, functions of theory; scientific laws and principles(5L)</p> <p>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)</p>		01
<p>3. Unit III: <u>Sampling and sampling distributions</u> (15L)</p> <p>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)</p> <p>3.2. Variables: nominal, ordinal, discontinuous, continuous, derived (5L)</p>		01

<p>4. Unit IV: <u>Data analysis and report writing</u> (15L)</p> <p>4.1. Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing. (6L)</p> <p>4.2. Report writing and presentation: types of research reports, guidelines for writing a report, report format, appendices, Miscellaneous information, poster and oral presentations (9L)</p>	
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PRACTICAL: SIPSMIC3P1

	<u>TOOLS AND TECHNIQUES:RESEARCHMETHODOLOGY</u> (60L)	
SIPSMICP31	Unit I : Literature survey	(15L)
	Unit II : Literature survey	(15L)
	Unit III : Writing Research Project Proposal	(15L)
	Unit IV : Writing Research Project Proposal	(15L)
		02

REFERENCES: SIPSMIC31 (SEMESTER III)

1. Bhattachraya, D.K., 2006, Research Methodology,(2nd.ed.),New Delhi, Excel Books.
2. Das, S.K., 1986, An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Katz J.M., 2009, From Research to Manuscript: A guide to scientific writing, USA, Springer Science
4. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
5. Kothari, C.R., 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
6. Kumar, R., 2005, Research Methodology - Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
7. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company
8. Panneerselvam R., 2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
9. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
10. Saravanel, P. 1990. Research methodology. Allahabad, Kitab Mahal

SIPSMIC32: FOOD MICROBIOLOGY

Course Code	Title	Credits
SIPSMIC32	Food Microbiology (60L)	04
1. Unit I: <u>Microbes in foods</u> (15L)		01
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		
2. Unit II: <u>Uses of microbes in food</u> (15L)		01
2.1. Microbial stress response in food 2.2. Starter cultures 2.3. Microbiology of fermented foods General method of production Swiss Cheese and Blue cheese 2.4. Fermented meat product –Sausage 2.5. Fermented vegetable products – Pickles, soy product, Sauerkraut 2.6. Bread and Idli		
3. Unit : III <u>Control of microbes in food</u> (15L)		01
3.1. Control of access 3.2. Control by physical removal, heat, low temperature, reduced a_w , 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)		

<p>4. Unit: IV <u>Microbial Detection and Food Safety</u> (15L)</p> <p>A. <u>Conventional Methods.</u> (7L)</p> <ul style="list-style-type: none"> i. Sampling for microbial analysis ii. Quantitative microbial enumeration in food iii. Qualitative methods of microbial detection: iv. Bacterial Toxins v. Rapid methods- Biosensors <p>B. <u>Controlling the Microbiological Quality of food.</u> (8L)</p> <ul style="list-style-type: none"> i. Quality and Criteria Sampling Schemes ii. QC using microbiological control. iii. Control at source. iv. Codes of GMP v. HACCP vi. Laboratory Accreditation 	<p>01</p>
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PRACTICALS: SIPSMICP32

SIPSMICP32	Food Microbiology (60L) <ol style="list-style-type: none">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<ol style="list-style-type: none">i. Milk (Raw, Packed)ii. Ice-creamiii. Yoghurt4. Report to be written in journal on Novel detection methods for food borne pathogens/ toxins.	02
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REFERENCES: SIPSMIC32 (SEMESTER III)

REFERENCES: UNIT I

1. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
2. Bibek Ray and Arun Bhunia(2008) Fundamental Food Microbiology 4th Ed. CRC Press.
3. J Maud Kordylas(1991) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.
4. James Jay, M Loessner and D Golden (2005) Modern Food Microbiology 7th Ed.
5. Srilakshami B (2010) Food Science. 5th Ed. New Age International Publishers.

REFERENCES: UNIT II

1. Bibek Ray and Arun Bhunia(2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Gerald Reed (2004) Prescott and Dunn's Industrial Microbiology 4th Ed. CBS Publishers.
3. J Maud Kordylas (1991) Processing and Preservation of tropical and subtropical foods. ELBS

Macmillan.

REFERENCES: UNIT III

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International

REFERENCES: UNIT IV

1. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
2. Aylward F (2001) Food Technology Processing and Laboratory Control. Agrobios India bibek Ray and Arun Bhatia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
3. Harrigan W F and McCance M F (1976) Laboratory methods in food and dairy microbiology. Academic Press.
4. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International.

SIPSMIC33: ADVANCES IN BIOTECHNOLOGY

Course Code	Title	Credits
SIPSMIC33	Advances in Biotechnology (60L)	04
1. Unit I <u>Plant and Agricultural Biotechnology</u> (15L)		01
i. 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. (4L)		
ii. 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.(2L)		
iii. Plant Transformation Technology – <i>Agrobacterium</i> mediated gene transfer , <i>Agrobacterium</i> 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. (4L)		
iv. Plant Genetic Engineering for Productivity and Performance – (3L) <ul style="list-style-type: none"> 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-Protein, Lipids, carbohydrates, vitamins and minerals. e) Biosafety concerns of transgenic plants 		
v. Plants as bioreactors. (2L)		

<p>2. UNIT II <u>Animal Biotechnology</u> (15L)</p> <ul style="list-style-type: none"> i. Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines (4L) ii. Scale up, Cryopreservation, Culture Collections (2L) iii. Risks and Safety, Bioethics.(1L) iv. Stem Cell Technology, Cloning techniques Applications. (2L) v. Transgenic and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish (3L) vi. Applications: Transgenic mice: a)Retroviral method b) DNA microinjection method c) Engineered Embryonic Stem cell method (3L) 	01
<p>3. Unit III <u>Nanobiotechnology</u> (15L)</p> <ul style="list-style-type: none"> i. Nanoscale systems, nanoparticles, nanowires, thin films and multilayers; Properties of nanomaterials. (3L) ii. Synthesis of nanostructures - physical, chemical and biological, microbiological methods(3L) iii. Biomolecules as nanostructures. (1L) iv. Nanoparticle carrier systems, Micro and Nanofluidics. (2L) v. Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment. (6L) 	01
<p>4. Unit IV -<u>Medical Biotechnology</u> (15L)</p> <ul style="list-style-type: none"> i. Genetic testing of diseases and disorders, Cancer genetics. Immunogenetics; prenatal diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation diagnosis. Genetic counselling. (4L) ii. Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Anti-sense Technology (6L) iii. Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics (2L) iv. Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination (1L) v. Tissue Engineering, Methods of Synthesis, Biomolecular Engineering (2L) 	01

PRACTICALS: SIPSMICP33

SIPSMICP33	<p>Advances in Biotechnology (60 L)</p> <ol style="list-style-type: none">1. Terminology, Laboratory design of Animal tissue culture laboratory2. Preparation of complete medium, Sterilization and sterility checking.3. Chick embryo fibroblast culture, viable staining4. Lymphocyte culture, viable staining and haemocytometer count.5. Preparation of Nanosilver By Wet reduction Method Chemical), using Neem Extract (plants)and Bacteria(Microbiological)6. Characterisation of Nanosilver by UV spectrometry and microscopic methods7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria	02
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REFERENCES: SIPSMIC33 (SEMESTER III)

REFERENCES: UNIT II

1. B.B.Buchanan, W.Gruissen and R.L.Jones (eds), Biochemistry and Molecular Biology of Plants, American Society of Plant Biology, Rockville, USA, 2000.
2. H.K.Das(ed),Textbook of Biotechnology,WileyIndia,2004
3. Introduction to Plant Biotechnology(3rdEdtn), H.S.Chawla
4. J.H.Hammond, P.Mcgarvey and V.Yusibov(eds), Plant Biotechnolgy,SpringerVerlag,Heidelberg,2000
5. Plant Biotechnology and Agriculture: Prospects for the 21st Century, Ariealtman ,Paul Michael Hasegawa
6. Plant Biotechnology and Genetics: Principles, Techniques and Applications, Stewart, C.Neal, June 2008,John Wiley andSons
7. Plant Biotechnology: The genetic manipulation of plants, 2005, A.Slater, N.Scott and M.Fowler, Oxford Univ Press, Oxford.
8. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2ndEdtn,Academic Press, 2000

REFERENCES: UNIT II

1. Animal Cell Culture by Ian Freshney
2. Animal Cell Culture Sudha Gangal
3. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
4. Principles of biotechnology and applications-Glick and Pasternack

REFERENCES: UNIT III

1. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
2. Nanobiotechnology by David Goodsell. JohnWiley
3. Nanobiotechnology by Niemeyer CM andMirkin CA 2005 .Wiley Interscience

REFERENCES: UNIT IV

1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai,(2008)
2. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. Pratibha NallariandV. Venugopal Rao, Medical Biotechnology, Oxford University Press, India(2010)

SIPSMIC34: APPLIED AND ENVIRONMENTAL MICROBIOLOGY

Course Code	Title		Credits
SIPSMIC34	APPLIED AND ENVIRONMENTAL MICROBIOLOGY	(60L)	04
1. Unit:I Microbial Diversity		(15L)	01
<ul style="list-style-type: none"> i. Microbial ecology: concepts, niche, habitat, ecosystem. ii. Introduction to microbial diversity: Types of microorganisms- bacteria, Archaeobacteria, Eucarya interactions between microorganisms , ecological succession iii. Extremophiles: Habitat, effect of extreme conditions on cellular components- membrane structure, nucleic acids and proteins, adaptation mechanism in microorganisms in diverse environments iv. Study of Thermophiles, Psychrophiles, halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms, Methanogens. v. Biotechnological Applications of extreme proteins from the above groups vi. Geomicrobiology: Biofouling, biocorrosion,bioleaching 			
UNIT : II <u>Techniques in Microbial Ecology</u>		(15L)	01
<ul style="list-style-type: none"> i. Environmental sample collection and processing.: Soils and Sediment, Water, Air, Detection of Microorganisms on fomites ii. Cultural Methods: Cultural methods for isolation and enumeration of Bacteria iii. Physiological Methods: Measuring microbial activity in pure culture; Carbon respiration, Stable isotope probing, Use of radioisotopes as tracers Adenylate energy charge, Enzyme assays, iv. Functional genomics andproteomics based approach 			

<ul style="list-style-type: none"> v. Immunological methods: Immunoassays. Nucleic acid based methods of analysis: Obtaining Nucleic acids from Environment, Use of Gene probes, PCR vi. Recombinant DNA Techniques, RFLP, Denaturing /Temperature gradient, Plasmid analysis, Reporter genes. Rep PCR fingerprinting and microbial diversity vii. Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment: culturable and unculturable bacterial analysis. 		
<p>Unit III : Soil, Marine and Agricultural Microbiology</p> <ul style="list-style-type: none"> i. Soil Microbiology: The lithoecosphere: Soil formation, Properties (physical and chemical) Soil communities. Link to microbial interactions. Soil sampling for surface, subsurface soils .Processing and storage of samples. ii. Marine microbiology: Marine and estuarine habitats. Characterization and stratification of the oceans Vertical and horizontal zones of marine habitats Marine microbes characteristics, distribution, composition and activity. iii. 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. iv. Microbial contribution to animal nutrition Special reference to Rumen flora v. Biogeochemical cycles for Carbon Nitrogen and Oxygen. Degradation of recalcitrant polymers and xenobiotics e.g. cellulose, lignin .lignocellulose. Combating Greenhouse effect using microbes. vi. Concept of Carbon credits 	(15L)	01

UNIT IV: Advanced Food and Water Microbiology	(15L)	01
<p>i. Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi, pathogenic bacteria (Enteropathogenic <i>Ecoli</i>, <i>Vibrio</i> ,<i>Salmonellae</i>) and viruses (<i>HepatitisA</i>, Norwalk) in meat/fish products as per BIS/ISO/APHA standards.</p> <p>ii. Use of biosensors, and enzymatic/ thermal techniques for food analysis.</p> <p>iii. Food additives and ingredients: Food additives-definitions, classification and functions, (Preservatives, antioxidants, colors, emulsifiers, sequesterants, natural and microbial flavors). Toxicological evaluation of food additives.</p> <p>iv. Nutraceuticals and health foods: Introduction, definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals. Microbes and production of Nutraceuticals 12like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Applications of fibres from food sources, microbial fructooligosaccharides. Formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues.</p> <p>v. Drinking water risk assessment and its safety: Bottled water–legislation: Types of bottled water. BIS Regulations regarding the production of bottled waters w.r.t 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 attained 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.</p>		

PRACTICALS: SIPSMICP34

Practicals	SIPSMICP34	60L	02
<ol style="list-style-type: none"> 1. Enrichment and isolation of thermophiles from hotspots/compost heaps and extraction of thermophilic enzymes and determination of its specific activity. 2. Estimation of anti-oxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method. 3. Microbiological analysis of fish samples w.r.t sample processing for recovery and detection of Enteropathogenic <i>Ecoli</i>, <i>Vibrio</i>, <i>Salmonellae</i> 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, and calcium carbonate content. 6. Enrichment and isolation of cellulose, lignin and xylanase degraders from mangrove soil 			

REFERENCES: SIPSMIC 34 (SEMESTER III)

REFERENCES: UNIT – I

1. Brock Biology of microorganisms 12thed Madigan, Martinko, Dunlap, Clara, Pearson Intl Ed
2. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press)
3. Microbial Diversity- Current Perspective and Potential Application--Johri and Satyanarayana
4. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications. Addison Wesley Longman, Inc.

REFERENCES: UNIT – II

1. A K Bej and M H Mahbubani, Applications of the polymerase chain reaction in environmental .Microbiology. Genome Res. 1992 1: 151-159
2. Metagenomics: DNA sequencing of environmental samples, Susannah Green Tringe and Edward M.Rubin,806/November2005/Volume6.
3. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. Addison Wesley Longman, Inc. R.M Maier ,I.L.Pepper and C.P.Gerba 2010,Environmental Microbiology Academic Press
4. Rastogi andSani ,Microbes and Microbial Technology, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment,
5. The Metagenomics of soil by Rolf Daniel, 470/ June2005/ vol3, ww.nature.com/reviews.
6. www.nature.com/reviews/genetics

REFERENCES: UNIT – III

1. Environmental Microbiology. Alan H. Varnam. Manson Publishing.2000. Agricultural Microbiology. G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj. PHI Learning Pvt. Ltd.,2004
2. Marine Microbiology: Ecology and Applications. Colin Munn. Garland publishing. ISBN: 0815365179
3. Microbes and Microbial Technology: Agricultural and Environmental Applications. Iqbal Ahmad, Farah Ahmad, John Pichtel. Springer, 2011.

REFERENCES: UNIT – IV

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.
2. Kirk RS and Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific andTechnical.
3. Leo ML. 2004. Handbook of Food Analysis. 2nd Ed. Vols.I-III.
4. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.

5. Macleod AJ. 1973. Instrumental Methods of Food Analysis. ElekSci.Marcel Dekker
6. Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones and Bartlett.

Suggested Readings for Food additives

1. Branen AL, Davidson PM and Salminen S. 2001. Food Additives. 2nd Ed. Marcel Dekker.
2. Gerorge AB. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
3. Madhavi DL, Deshpande SS and Salunkhe DK. 1996. Food Antioxidants: Technological, Toxicological and Health Perspective. Marcel Dekker.
4. Stephen AM. (Ed.). 2006. Food Polysaccharides and Their Applications. Marcel Dekker.

Suggested Readings for Nutraceuticals

1. Losso JN. 2007. Anti-angiogenic Functional and Medicinal Foods. CRC Press.
2. Manson P. 2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press.
3. Shi J. (Ed.). 2006. Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC

SIPSMIC41 : TOOLS AND TECHNIQUES : BIOMOLECULAR ANALYSIS(60L)	04
<p>Unit I <u>Spectroscopic Techniques</u> (15L)</p> <p>i. UV-visible spectroscopy: Beer- Lambert’s Law, Instrumentation, operation, calibration, accuracy and applications (05L)</p> <p>ii. IR: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)</p> <p>iii. Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)</p>	01
<p>Unit II <u>Chromatographic Techniques</u> (15L)</p> <p>i. Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)</p> <p>ii. High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)</p> <p>iii. Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications (05L)</p>	01
<p>Unit III <u>Molecular Biology Techniques</u> (15L)</p> <p>i. Variations/ Modifications of PCR: Hot- Start PCR, Multiplex PCR, Nested PCR, RT-PCR, Broad Range PCR, arbitrarily primed PCR, Quantitative PCR, Realtime PCR (05L)</p> <p>ii. Hybridization array technology: applications of microarrays in microbiology, Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays) (05L)</p> <p>iii. FISH with other techniques: (confocal laser scanning microscopy, micro autoradiography, flow cytometry, immunofluorescence, microsensors, peptide, nucleic acids) (05L)</p>	01

Unit IV <u>Nanotechnology Techniques</u>	(15L)	01
i. Microscopy: Scanning Probe Microscopes - scanning tunneling microscope(STM), atomic force microscope(AFM), magnetic force microscope(MFM), scanning near field microscope (SNOM),Electron Microscopy: SEM, TEM (10L)		
ii. Diffraction Techniques: X-ray diffraction(XRD) (2L)		
iii. Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies(XPS)/Auger electron spectroscopy (3L)		

Practical: SIPSMIC41

SIPSMICP41: Tools and Techniques: Biomolecular Analysis

SIPSMICP41	TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS(60L)		02
	Unit I : Research project experimental work	(15L)	
	Unit II : Research project experimental work	(15L)	
	Unit III : Research project experimental work	(15L)	
	Unit IV : Research project experimental work	(15L)	

REFERENCES: SIPSMICP41 (SEMESTER IV)

1. Analytical Chemistry by Open Learning Series, 2008, New York, John Wiley and Sons.
2. Banwell, C.N. and McCash, E.M., 2012, *Fundamentals of Molecular Spectroscopy*, 4th Ed., New Delhi, Tata McGraw Hill Education Pvt.Ltd.
3. Braithwaite A. and Smith F.J., 2001, *Chromatographic Methods*, 5th Ed. , London, Kluwer Academic Publishers
4. Braun R., Introduction to Instrumental Analysis, New York, McGraw Hill Book Company
5. Chandler D.E. and Roberson R.W. 2009, *Bioimaging: current concepts in light and electron microscopy*, Singapore, Jones and Bartlett Publishers
6. Chattopadhyay K.K. and Banerjee A.N., 2012, *Introduction to Nanoscience and Nanotechnology*, New Delhi, PHI Learning Pvt.Ltd.
7. Kulkarni Sulabha, 2011, *Nanotechnology: Principles and Practices*, New Delhi, Capital Publishing Company.
8. McNair H. M. and Miller J. M., 2009, *Basic Gas Chromatography* , Wiley International
9. Miller J. M. , 2009, *Chromatography: Concepts and Contrasts*, USA, John Wiley and Sons,Inc.
10. Muralidharan V.S. and Subramania A. 2010, *Nanoscience and Technology*, New Delhi Ane Books PvtLtd.
11. Narayana P. 2008, *Essentials of Biophysics*, New Age International Pvt Ltd Publishers
12. Pattabhi V. and Gantham N. 2002, *Biophysics* (2nd Ed.)Springer.
13. Persing, H.D. et al. 2004, *Molecular Microbiology: Diagnostic principles and practice*, Washington D.C., ASMpress.
14. Scott R. P.W. 2012,*Principles and Practice of Chromatography (Chrom-Ed Book Series)* , Reese-ScottPartnership
15. Sharon, Madhuri and Maheshwar, 2012, *Bio-Nanotechnology: concepts and applications*. New Delhi, Ane books Pvt. Ltd.
16. Skoog, Holler and Nieman, *Principles of Instrumental Analysis*, 5th Ed. Australia, Thomson Brock/Col
17. Upadhyay, Upadhyay and Nath, 2012, *Biophysical Chemistry: Principles and Techniques*, Mumbai, Himalaya Publishing House
18. Viswanathan B. 2010, *NanoMaterials*, New Delhi, Narosa Publishing House.

SIPSMIC42: PHARMACEUTICAL MICROBIOLOGY

Course Code	Title	Credits
SIPSMIC42	Pharmaceutical Microbiology (60L)	04
<p style="text-align: center;">Unit I: Principles and applications of GMP in pharmaceuticals And cosmetics (15L)</p> <p>i. Principles – Applications and Definitions (2L)</p> <p>ii. The concept of Quality (2L)</p> <p>iii. The regulatory factors (2L)</p> <p>iv. QC, QA and GMP (2L)</p> <p>v. Quality assurance beyond GMP (2L)</p> <p style="padding-left: 20px;">a) ISO (2L)</p> <p style="padding-left: 20px;">b) Sanitary practices in cosmetic manufacturing (3L)</p>		01
<p style="text-align: center;">Unit II Quality management and regulatory aspects (15L)</p> <p>i. Premises and contamination control, location, design, structure, layout, services and cleaning. (3L)</p> <p>ii. Personnel management, training, Hygiene and health. (2L)</p> <p>iii. Documentation (2L)</p> <p>iv. Quality control and GCLP (2L)</p> <p>v. Sterile and other products. (3L)</p> <p>vi. Global regulatory and toxicological aspects of cosmetic preservation (3L)</p>		01
<p style="text-align: center;">Unit III Analytical aspects for pharmaceutical and cosmetic Products (15L)</p> <p>i. Quality control and GCLP (3L)</p> <p>ii. Sterile and other products. (4L)</p> <p>iii. Validation (3L)</p> <p>iv. Cosmetics microbiology- testing methods and preservation (5L)</p> <p style="padding-left: 20px;">a) Antimicrobial preservation efficacy and microbial content testing</p> <p style="padding-left: 20px;">b) Validation method for cosmetics</p> <p style="padding-left: 20px;">c) Preservation strategy</p> <p style="padding-left: 20px;">d) Evaluation of antimicrobial mechanism</p>		01

Unit : IV Drug Discovery	(15L)	01
i. Modern Methods of Drug Discovery (1L)		
ii. Proteomics (2L)		
iii. Bioinformatics (3L)		
iv. High throughput screening technology (3L)		
v. Natural products for lead identification (3L)		
vi. The role of protein 3D structures in the drug discovery process. (3L)		

PRACTICALS: SIPSMICP42

SIPSMICP42	Pharmaceutical Microbiology (60L) 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	02
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REFERENCES: SIPSMIC42: PHARMACEUTICAL MICROBIOLOGY

REFERENCES: UNIT I

1. Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.
2. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach. 2nd Ed.
3. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.

REFERENCES: UNIT II

1. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors.
2. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4th Ed. CRC Press.
3. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.
4. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.

REFERENCES: UNIT III

1. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach. 2nd Ed.
2. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.

REFERENCES: UNIT IV

1. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition.
2. Kadam S, S. Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry. Vol II Nirali Prakashan Pune.
3. Lemke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry. 6th Ed. Wolter Luwer, Lippincott Williams and Wilkins. N Delhi.

SIPSMIC43: ADVANCES IN BIOTECHNOLOGY

Course Code	Title	Credits
SIPSMIC43	Advances in Biotechnology (60L)	04
	<u>Unit I -Pharmaceutical Biotechnology</u> (15L)	01
	<ul style="list-style-type: none"> i. Biologics, Biopharmaceuticals, ii. Protein structure stability, folding, structure prediction, Post translation modifications, Protein Therapeutics – Upstream and Downstream processing, Cytokines, Interferon production, Interleukins production, Therapeutic hormones – Insulin, Human Growth Hormone, Recombinant blood products, Therapeutic Enzymes iii. Newer Vaccines, Vaccine Designing Approaches iv. Drug Discovery Tools, Combinatorial Chemistry, High Throughput Screening, Cheminformatics, <i>In silico</i> Modelling, Molecular Modeling, Structure Prediction, Rational Drug Designing, Drug Development, Concept of Pharmacognosy, Pharmacokinetics and Pharmacodynamics 	
	<u>Unit II Biotechnology and Bioethics</u> (6L)	
	<ul style="list-style-type: none"> i. Biotechnology and Bioethics ii. Bioethics and cross-cultural bioethics.- Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making iii. Perceptions of Ethical Biotechnology.-‘Moral’ is not the same as Ethical, Mixed Perception of Benefit and Risk, and Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about consuming products of GMOs. iv. Past and Present ‘Bioethical Conflicts’ in Biotechnology-Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse v. Future ‘Bioethical Conflicts’ in Biotechnology. - Changing perception of Nature, Human Genetic Engineering vi. Bioethics vs Business: A Conflict?- IPP, Global Issues of Technology Transfer, 	

<p>Safety vs Costs, Is New Technology Better</p> <p>vii. Resolution of Conflicts- Who can be trusted?, Public Education, Sufficient Regulations</p> <p>viii. Ethical limits of Biotechnology.-Absolute or Relative, Timeless or Transient</p> <p>ix. Criteria to assess whether Biotech Research is Ethical.</p>	
<p>Unit III -Marine Biotechnology (15L)</p> <p>i. 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 biodetroration, Degradation of pollutants, Bioremediation, Role of microorganisms in ocean processes, Marine Genomics and Proteomics.</p> <p>ii. Marine bioprospecting – Isolation of Marine Natural Products</p> <p>iii. Diversity of marine derived compounds - Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymes- protease, lipase, chitinase, glucanase; Marine biominerals; Biominerelized structures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagens.</p> <p>iv. Bioactive Compounds and Biomaterials from Marine Environment.</p>	01
<p>Unit IV: Advances in Molecular Biotechnology (15L)</p> <p>i. 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</p> <p>ii. Manipulation of Gene Expression in Procaryotes: Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays, Increasing protein stability, protein folding, DNA integration into host chromosome, Heterologous protein production production in eukaryotic cells: Expression systems like <i>Saccharomyces cerevisiae</i>, <i>Pichia pastoris</i>, Baculovirus- Insect cell, mammalian cell</p>	01

<p>iii. 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 aminoacids</p> <p>iv. 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</p> <p>v. Synthetic Biology: Introduction, types, mechanisms, applications in industry</p>	
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PRACTICAL: SIPMICP43 ADVANCES IN BIOTECHNOLOGY

PRACTICAL: SIPSMICP43 ADVANCES IN BIOTECHNOLOGY (60L)		
SIPSMIC4P3	<ol style="list-style-type: none"> 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 	02

REFERENCES SIPSMIC43

REFERENCES: UNIT I:

1. Daan J. A. Crommelin, Robert D. Sindelar and Bernd Meibohm Pharmaceutical Biotechnology: Fundamentals and Applications, informa healthcare, (Oct 30, 2007)

2. Gary Walsh, Pharmaceutical Biotechnology – Concepts and Applications (E- Book), John Wiley and Sons Ltd. (2007)
3. Jogdand S. N., Biopharmaceuticals, Himalaya Publishing House, Mumbai (2006)
4. K. Sambamurthi, Pharmaceutical Biotechnology, New Age International (2006)

REFERENCES: UNIT II

1. A textbook of Biotechnology, R.C. Dubey, S. Chand.
2. Biodiversity, Biotechnology and Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, Narosa
3. Biotechnology, Second Completely Revised Edition-Volume 12
4. Ethics in Biotechnology-An Executive Guide, Chris MacDonald and Rahul.K. Dhanda
5. Legal, Economic and Ethical Dimensions. Volume Editor-D. Brauer (A multi- Volume Comprehensive Treatise), H. J. Rehm and G. Reed, A. Puhler ,P Stadler
6. www.biotechethics.ca

REFERENCES: UNIT III

1. David H. Attkway and Oskar R. Zabusky: Marine Biotechnology: Volume 1,2,3, Plenum Press
2. David H. Attkway and Oskar R. Zabusky: Marine Biotechnology, Volume 123, plenum press (1993).
3. O. Kinne: Marine Ecology, Vol V. Ocean Management 3 and 4, John Wiley and Sons, (1984).
4. P.J. Scheuer: Marine Natural Products, Volume 1 and 2 (1978) Volume (1980, 81), Academic Press
5. P.J. Scheuer: Marine. Natural Products, Volume 1 and 2 (1978). Volume (1980-81) Academic Press
6. R.R. Colwell et. al (eds) Biotechnology of Marine polysaccharides, (1985).
7. R.R.Colwell (ed), Biotechnology of Marine Science, (1982).
8. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, (1981).
9. RSK Barners and R.N Huges : Introduction to Marine Ecology, Blackwell

REFERENCES: UNIT IV

1. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology edited by Michael Wink, (2006) Wiley VCH
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
3. Molecular biotechnology: principles and practices Channarayappa, (2006), Universities Press.

SIPSMIC44: APPLIED AND ENVIRONMENTAL MONITORING and MANAGEMENT

CourseCode	Title		Credits
SIPSMIC44	Applied and Environmental Monitoring and Management	(60L)	04
UNITI: Bioremediation, biodegradation and Waste disposal		(15L)	01
<ul style="list-style-type: none"> i. Engineering and bioremediation process its needs and limitations. ii. Bioremediation in Soil of BTEX hydrocarbons. iii. Petroleum contamination, Polycyclic aromatic compounds, iv. Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds. Molecular technique Bioremediation. v. Sewage and Sludge treatment and disposal methods. 			
UNITII: Biofilm management		(15L)	01
<ul style="list-style-type: none"> i. Structure and properties of biofilms: ii. 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 iii. Study of Quorum Sensing: Cell- Cell Communication amongst bacteria, and its similarity with <i>M. xanthus</i> Fruiting Body Development. iv. Multispecies biofilms: Clinical Relevance v. 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,) vi. Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quarternary ammonium compounds. vii. Use of other biofilm management methods such as probiotic organisms and prebiotics to restore disrupted beneficial biofilms to a 			

<p>“normal state”. Correction of environmental conditions for enhanced bioremediation of biofilms (e.g. dental plaque)</p> <p>viii. Disadvantages of biofilm management strategies-development of resistant strains-cross resistance induction</p> <p>ix. 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</p>		
<p>UNIT : III Pollution control and monitoring</p> <p>i. Introduction to Pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in pollution control</p> <p>ii. 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 and monitoring. (Indoor air pollution, vehicular pollution and control, odour control)</p> <p>iii. 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.</p> <p>iv. Wastewater treatment – aerobic and anaerobic. CETP, Water quality criteria and standards for discharge. Assessment and monitoring of water pollution.</p> <p>v. Marine pollution: Sources, effects and coastal management</p> <p>vi. Thermal pollution: Sources, effects and control</p> <p>vii. 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.</p>	<p>(15L)</p>	<p>01</p>

<p>viii. Noise pollution: Sources, impact, measurement and indices, control and abatement</p> <p>ix. Radioactive pollution: Sources, effects, prevention and control measures</p>		
<p style="text-align: center;">UNIT : IV</p> <p style="text-align: center;">Environmental and natural resources management and safety standards</p> <p>i. Natural resources: Renewable/ non renewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development</p> <p>ii. 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.</p> <p>iii. Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these waste through Common Effluent Treatment Plants.</p> <p>iv. Biomedical and electronic waste management, recovery of precious metals from electronic wastere sources.</p> <p>v. Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures</p> <p>vi. 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)</p>	<p>(15L)</p>	<p>01</p>

PRACTICALS:SIPSMICP44 (60L)	
<ol style="list-style-type: none"> 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 SO_x, NO_x , 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 centres <p style="text-align: center;">OR</p> <p style="text-align: center;">Study tour/ academic visit to Sewage treatment plant/ ETP of any industry / water purification unit/ Pollution Control Board Lab, CETP, landfill, etc.</p> <ol style="list-style-type: none"> 6. Preparation/ drafting of an EIA report. 7. Case studies: sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, oilspills. 	02

REFERENCES: SIPSMIC44

References: UNIT- I

1. A Textbook of Biotechnology, R C Dubey, S. Chand Publishing, 1993
2. Bioremediation: Principles and Applications Volume 6 of Biotechnology Research, ISSN 1368-8499
Ronald L. Crawford, Don L. Crawford, Cambridge University Press, 2005
3. Biotechnology: B.D.Singh, Kalyani publishers, 2016
4. Environmental Biotechnology, Alan Scragg, 2nd Ed, illustrated, OUP, 2005, ISBN0199268673,
9780199268672

References: UNIT- II:

1. Bacterial biofilms: from the Natural environment to infectious diseases. Nature Reviews
Microbiology 2, 95-108 (February 2004)
2. Davies DG, Parsek MR, Pearson JP, Iglewski BH, Costerton JW, Greenberg EP. 1998. The
involvement of cell-to cell signals in the development of a bacterial biofilm. Science 280 (5361):295–
98
3. Morris, C. E. and Monier, J. M. 2003. The ecological significance of biofilm formation by plant-
associated bacteria. Annu. Rev. Phytopathol. 41:429–53
4. O'Toole GA, Kolter R. 1998. The initiation of biofilm formation in *Pseudomonas aeruginosa*
WCS365 proceeds via multiple, convergent signaling pathways: a genetic analysis. Mol. Microbiol.
28:449–61
5. O'Toole, G., Kaplan, H. B. and Kolter, R., 2000. Biofilm formation as microbial development. Annu.
Rev. Microbiol. 2000. 54:49–79

References: UNIT - III

1. A textbook of environmental pollution and control. S S. Dara
2. APHA 1998. Standard Methods for the examination of water and wastewater , 20th Ed.
3. Biotechnology of Odour and Air pollution Control. Springer
4. Environmental chemistry A. K. De
5. Environmental chemistry B. K. Sharma
6. Environmental microbiology. P. D. Sharma. Alpha Science International 2005 ed.
7. Environmental pollution control engineering. C.S.Rao .NewAgeInternational Publishers.
8. K. Maiti. ABD Publishers 2004

9. Soil analysis Volume 2. Handbook of methods in environmental studies. S.
10. Wastewater engineering: Treatment and reuse. Metcalf and Eddy, Tata McGraw Hill Publishing Co. Ltd. 4th Ed.
11. Water and Wastewater analysis Volume 1. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004

References: UNIT IV

1. Environmental management. H. V. Jadhav, VipulPrakashan , 2002
2. Environmental management. R.K. Jain and others
3. Industrial hygiene and safety. M. H. Fulekar
4. Modern trends in ecology and environment. R. S. Ambasht
5. Resource ecology. S. K. Agarwal

MODALITY OF ASSESSMENT

A. Theory Examination Pattern:

AJ INTERNAL EXAMINATION FOR THEORY (40%):-	40 marks
1. Active participation in routine 2. Class instructional deliveries 3. Overall conduct as a responsible learner, 4. Communication and leadership qualities in organizing related academic activities. 5. One seminar based on curriculum to be assessed by the teacher of the institution teaching P.G.learners/ publication of a research paper /presentation of a research paper in seminar or conference (i) Selection of the topic, Introduction, write up, references (ii) Presentation with the use of ICT	05 05 30 15 15
BJ EXTERNAL EXAMINATION - 60 %	60 marks
Semester End Theory Assessment - <ol style="list-style-type: none"> i. Duration - These examinations shall be of two and half hours duration. ii. Theory question paper pattern:- iii. There shall be five questions each of 12 marks. On each unit there will be one question and fifth one will be based on all the four units. iv. All questions shall be compulsory with internal choice within the questions. Each question will be of 24 marks with options. v. Questions may be sub divided into sub questions a, b, c and d only, each carrying six marks OR a, b, c, d, e and f only each carrying four marks and the allocation of marks depends on the weightage of the topic. 	

Practical Examination Pattern

SEMESTER III:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Research proposal: Candidates are required to present duly certified research proposal (as per the BCUD format) with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner. (The research proposal must be included with literature survey of the selected research topic.)

A. Internal Examination:-

- There will not be any internal examination/ evaluation for practicals.

B. External (Semester end practical examination) Per course:-

<u>PAPER I</u>		<u>PAPER II</u>		<u>PAPER III</u>		<u>PAPER IV</u>		<u>TOTAL</u>
<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Marks</u>
Proposal	30	Major	20	Major	30	Major	20	200
		Minor	10	Report (ATC)	10	Minor	10	
Presentation	20	Journal	10	Viva	10	Quiz	20	
		Report (foodborne pathogen detection)	10					
<u>Total</u>	50	<u>Total</u>	50	<u>Total</u>	50	<u>Total</u>	50	

SEMESTER IV:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Research project work: Candidates are required to present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.

<u>PAPER I</u>		<u>PAPER II</u>		<u>PAPER III</u>		<u>PAPER IV</u>		<u>TOTAL</u>
<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Practical</u>	<u>Marks</u>	<u>Marks</u>
DISSERTATION	50	Major	20	Poster	20	Major	20	200
		Minor	10	Bioethics assignment	10	Minor	10	
		Quiz	10	IPR assignment	10	Viva	10	
		Report	10	Journal	10	CETP Report	10	
<u>Total</u>	50	<u>Total</u>	50	<u>Total</u>	50	<u>Total</u>	50	

Overall Examination and Marks Distribution Pattern

Semester III

Course	SIPSMIC31			SIPSMIC32			SIPSMIC33			SIPSMIC34			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Semester IV

Course	SIPSMIC41			SIPSMIC42			SIPSMIC43			SIPSMIC44			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200