AC/2024/RS 2

SIES

College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

Sion (W), Mumbai – 400022

Program: M.Sc.

Course: Microbiology

Syllabus for M.Sc. Part II

As per National Education policy (2020)

To be implemented from the academic year

2024-25

Semester III Theory Papers

Core Course I			
Course code	**Unit**	**Title**	**Credits**
SIPMICC611	**Food, pharmaceutical and cosmetic Microbiology**		
	I	**Sources and control of microbes in Food**	**4**
	II	**Microbial detection and food safety**	
	III	**Principles and applications of GMP in pharmaceutical and cosmetic industry**	
	IV	**Quality management and analytical aspects of pharmaceutical and cosmetic industry**	
Core Course II			
Course code	**Unit**	**Title**	**Credits**
SIPMICC612	**Advances in Biotechnology I**		
	I	**Plant and Agricultural Biotechnology**	**4**
	II	**Animal Biotechnology**	
	III	**Nanotechnology**	
	IV	**Medical Biotechnology**	
Discipline Specific Elective			
Course code	**Unit**	**Title**	**Credits**
SIPMIEL611	**Applied and Environmental Microbiology I**		
	I	**Microbial diversity and techniques in microbial ecology**	**3**
	II	**Soil, Marine and Agricultural Microbiology**	
	III	**Advanced food and water microbiology**	

Semester III Practical papers

Course code	**Title**	**Credits**
SIPMICCP611	**Food, pharmaceutical and cosmetic Microbiology**	**2**
SIPMICCP612	**Advances in Biotechnology I**	**2**
SIPMIELP611	**Applied and Environmental Microbiology I**	**1**
SIPMIRP611	**Research Proposal**	**6**

Semester IV Theory Papers

Core Course I			
Course code	**Unit**	**Title**	**Credits**
SIPMICC621	**Bimolecular analysis techniques**		
	I	**Spectroscopic techniques**	**4**
	II	**Chromatographic techniques**	
	III	**Molecular Biology techniques**	
	IV	**Characterization techniques in Nanotechnology**	

Core Course II			
Course code	**Unit**	**Title**	**Credits**
SIPMICC622	**Advances in Biotechnology II**		
	I	**Pharmaceutical Biotechnology**	**4**
	II	**Marine Biotechnology**	
	III	**Advances in molecular biotechnology**	
	IV	**IPR and Bioethics in Biotechnology**	
Discipline Specific Elective			
Course code	**Unit**	**Title**	**Credits**
SIPMIEL621	**Applied and Environmental Microbiology II**		
	I	**Bioremediation and Waste disposal**	**3**
	II	**Biofilm management**	
	III	**Pollution control and Safety standards**	

Semester IV Practical papers

Course code	Title	Credits
SIPMICCP621	**Biomolecular analysis techniques**	**2**
SIPMICCP622	**Advances in Biotechnology**	**2**
SIPMIEL621	**Applied and Environmental Microbiology II**	**3**
SIPMIRP621	**Research Project**	**6**

Semester III

Course title: Food, pharmaceutical and cosmetic Microbiology

Course outcomes:

After completion of this course students will be able to:

1. Discuss various sources of microorganism in food.
2. Describe and compare various methods to control the microorganism in food
3. Understand, explain and implement techniques used for quantitative and qualitative microbial detection in food.
4. Understand and discuss HACCP concept in food safety.
5. Understand, differentiate and explain key concepts of quality assurance, quality control and GMP in the pharmaceutical industry.
6. Discuss various control measures used in quality control for the pharmaceutical industry
7. Understand and explain the importance of documentation, validation in the pharmaceutical and cosmetic industry.
8. Discuss and apply the various testing methods in the cosmetic industry.

Detailed Syllabus

Core Course I

Unit	Sub-unit	Title: Food, pharmaceutical and cosmetic Microbiology	Lectures
	Sources and control of microbes in Food		**15**
I	1	Sources of microbes in food and factors influencing microbial growth in food	3
	2	Control of access	1
	3	Control by physical removal, heat, low temperature, reduced aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation	8
	4	Novel emerging techniques of food preservation	2
	5	Control by combination of methods (Hurdle concept)	1
	Microbial detection and food safety		**15**
II	1	Microbial detection: Sampling for microbial analysis, qualitative and quantitative estimation of microbes in food	5
	2	Microbial detection: Bacterial Toxins and use of biosensors for rapid detection	3
	3	Control of Microbiological quality: Sampling schemes and quality criteria.	3
	4	Control of Microbiological quality: Control at source and codes of GMP	2
	5	Control of Microbiological quality: HACCP concept and Laboratory accreditation	2

	Principles and applications of GMP in pharmaceutical and cosmetic industry		**15**
III	1	Concept of quality and Regulatory factors	5
	2	QA, QC and GMP	2
	3	Quality assurance beyond GMP	2
	4	Premises and contamination control, location, design, structure, layout, services and cleaning.	3
	5	Personnel management, training, Hygiene and health	3
	Quality management and analytical aspects of pharmaceutical and cosmetic industry		**15**
IV	1	Importance of Documentation	2
	2	Quality control and GCLP	2
	3	Sterile and other products	3
	4	Importance of Validation	3
	5	Cosmetics microbiology- testing methods and preservation	5

Core course I Practical:

1. Microbiological load in carrot and apple juice, salad, mayonnaise.

2. Quality Assessment and Analysis of food

i. Milk (Raw, Packed)

ii. Ice-cream

iii. Yoghurt

3. Sterility testing and reporting (as per Pharmacopeia)

4. Microbial load in cosmetic product

5. Efficacy testing of preservatives like parabens

References:

Unit I

1. Bibek Ray and ArunBhunia (2008) – Fundamental Food Microbiology 4th Ed. CRC Press.
2. N ShakuntalaManay and Shadaksharaswamy M (1985) - Foods Facts and Principles. New Age International

Unit II

1. Aylward F (2001) Food Technology Processing and Laboratory Control. Agrobios India
2. Bibek Ray and ArunBhatia (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 ShakuntalaManay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International

Unit III

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

Unit IV

1. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors
2. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell‟s Pharmaceutical Microbiology. Blackwell Publishing.
3. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press
4. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2nd Ed.

Course title: Advances in Biotechnology I

Course outcomes

After completion of this course students will be able to:

1. Understand and discuss various plant tissue cultures and plant transformation technology for crop improvement.
2. Explain biotic, abiotic stress tolerance and discuss various approaches for productivity and performance in plant genetic engineering.
3. Describe collection, types, preservation techniques and application of animal tissue cultures.
4. Explain the process for transgenic animals and its application.
5. Discuss and compare different methods of synthesis of nanostructures.

6. Explain various applications of nanotechnology.
7. Understand and describe nanoparticles and their properties.
8. Understand testing of different genetic diseases which includes prenatal and pre-implantation diagnosis.
9. Explain the concept of gene therapy, different vectors used, gene targeting , tissue specific expression and antisense technology.
10. Discuss pharmacogenomics, pharmacogenetics and toxicogenomics.
11. Understand social genetic discrimination which includes foeticide, cloning, insurance and employment and also they will learn about sex determination.

Detailed Syllabus

Core Course II

Unit	Sub-unit	Title: Advances in Biotechnology I	Lectures
	Plant and Agricultural Biotechnology		**15**
I	1	Plant Tissue Culture for crop improvement: Callus and Suspension culture, direct and indirect organogenesis, Protoplast culture, Haploid cultures, somatic hybridization, Cybrids and artificial seeds, somaclonal variation.	4
	2	Plant Transformation Technology: *Agrobacterium* based vectors, viral vectors, and Direct gene transfer methods.	2
	3	Plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination, Transgene silencing, Strategies to avoid transgene silencing.	2
	4	Plant Genetic Engineering for Productivity and Performance: i. Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance ii. Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature.	4
	5	Plant Genetic Engineering for Productivity and Performance: Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals.	3
	Animal Biotechnology		**15**
II	1	Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines	3
	2	Scale up, Cryopreservation, Culture Collections	2
	3	Stem Cell Technology, Cloning techniques Applications	2
	4	Transgenic and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish	4
	5	Applications: Transgenic mice: a)Retroviral method b) DNA microinjection method c) Engineered Embryonic Stem cell method	4
	Nanotechnology		**15**
III	1	Nanoscale systems, nanoparticles, nanowires, thin films and	4

		multilayers; Properties of nanomaterials	
	2	Synthesis of nanostuctures - physical, chemical and biological, microbiological methods	4
	3	Introduction to micro and nanofluidics	2
	4	Applications: Drug and gene delivery systems, nanomaterials for imaging, Cancer diagnostics and treatment and , lab on chip technologies.	5
	Medical Biotechnology		**15**
IV	1	Genetic counseling and Genetic testing of diseases and disorders: prenatal diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation diagnosis.	5
	2	Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Anti- sense Technology	6
	3	Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics	2
	4	Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination	2

Core course II Practical:

1. Preparation of Nanosilver by Wet reduction Method Chemical), using Neem Extract (plants) and bacteria (Microbiological)

2. Characterisation of Nanosilver by UV spectrometry and microscopic methods

3. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.

4. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria

References:

Unit I

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 .H.Hammond, P.Mcgarvey and V.Yusibov(eds), Plant Biotechnolgy,SpringerVerlag,Heidelberg,2000
4. Plant Biotechnology and Genetics: Principles, Techniques and Applications, Stewart, C.Neal, June 2008,John Wiley andSons
5. Plant Biotechnology: The genetic manipulation of plants, 2005, A.Slater N.ScottandM.Fowler, Oxford Univ Press, Oxford.
6. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2ndEdtn, Academic Press, 2000

Unit II

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

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

Unit IV

1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai,(2008)
2. JuditPongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. PratibhaNallariandV. Venugopal Rao, Medical Biotechnology, Oxford University Press

Course title: Applied and Environmental Microbiology I

Course outcomes

After completion of this course students will be able to:

1. Describe the adaptation mechanisms of various extremophiles.
2. Describe and apply different environmental sample collection and processing methods.
3. Illustrate and compare various physiological and molecular techniques in microbial ecology.
4. Understand and discuss lithosphere, physical and chemical properties of soil along with soil communities.
5. Understand the marine habitats along with the characterisation of oceans
6. Discuss the characteristics and properties of marine microorganisms.
7. Describe the beneficial relationship between plant and microorganism in agricultural microbiology along with uses of microorganism in plant growth
8. Understand, differentiate, classify and discuss the various food additives and ingredients.
9. Understand the concept of neutraceuticals along with its regulation and production of various neutraceutical food products.
10. Discuss the risk assessment, safety, BIS regulation associated with drinking water and bottled water.
11. Explain and differentiate various types of water purifiers.

Detailed Syllabus

DSE

Unit	Sub-unit	Title: Applied and Environmental Microbiology I	Lectures
	Microbial diversity and techniques in microbial ecology		**15**
I	1	Study of habitat and adaptation mechanisms of following extremophiles – Thermophiles, Psychrophiles, halophiles, acidophiles, alkaliphiles, xerophiles, radiation resistant organisms, barophiles	5
	2	Environmental sample collection and processing: i. Soils and Sediment ii. Water iii. Air iv. Detection of Microorganisms on fomites	3
	3	Physiological Methods: i. Measuring microbial activity in pure culture ii. Carbon respiration iii. Stable isotope probing iv. Use of radioisotopes as tracers Adenylate energy charge v. Enzyme assays	3
	4	Functional genomics and proteomics-based approach	1
	5	Molecular Techniques to Assess Microbial Community Structure, Function and Dynamics in the Environment: culturable and unculturable bacterial analysis	3
	Soil, Marine and Agricultural Microbiology		**15**
II	1	Soil Microbiology: i. The lithoecosphere: Soil formation, ii. Properties (physical and chemical) iii. Soil communities- Link to microbial interactions	4
	2	Marine microbiology: i. Marine and estuarine habitats ii. Extreme Environment conditions iii. Characterization and stratification of the oceans iv. Vertical and horizontal zones of marine habitats v. Marine microorganisms characteristics, distribution, composition and activity.	4
	3	Agricultural microbiology: i. Factors affecting microbial load of soils ii. Relationship between plants and microbes rhizosphere phyllosphere iii. Beneficial uses of microorganisms for plant growth and development iv. Interactions with aerial plant structures.	4

	4	Microbial contribution to animal nutrition Special reference to Rumen flora	2
	5	Concept of Carbon credits	1
	Advanced Food and Water Microbiology		**15**
III	1	Sampling and sample processing approaches for analysis of foods in meat/fish products	1
	2	Food additives and ingredients (Definition, Classification and functions): Preservatives, antioxidants, colors, emulsifiers, sequestrants, natural and microbial flavors	4
	3	Nutraceuticals and health foods: introduction, classification, claims and labelling, regulation, safety and efficacy Microbes and production of nutraceuticals: Prebiotics, probiotics, synbiotics, Microbial FOS	4
	4	Drinking water risk assessment & its safety, 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 bottles and the bottling procedure	4
	5	Types of water purifiers, Water Quality attained from point of use water purifier unit	2

DSE Practicals:

1. Enrichment and isolation of thermophiles from hotsprings/compost heaps and extraction of thermopilic enzymes and determination of its specific activity.

2. Microbiological analysis of fish samples for recovery and detection of Enteropathogenic E.coli, Vibrio, and Salmonellae.

3. Assessment of point of use water purifiers (Zero B) for removal of bacteria.

4. Soil analysis- nitrogen, phosphorus, chloride, organic matter, and calcium carbonate content.

5. Enrichment and isolation of cellulose, lignin and xylanase degraders from mangrove soil

References:

Unit I

1. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press)
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.
4. Addison Wesley Longman, Inc. R.M Maier , I.L.Pepper and C.P.Gerba 2010,Environmental Microbiology Academic Press

5. Rastogiand Sani, Microbes and Microbial Technology, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment

Unit II

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed.
2. Gaithersburg, MD, USA, Association of Analytical Communities.
3. Kirk RS and Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific andTechnical.
4. Leo ML. 2004. Handbook of Food Analysis. 2nd Ed. Vols.I-III.
5. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH. 23
6. Macleod AJ. 1973. Instrumental Methods of Food Analysis. ElekSci.Marcel Dekker
7. Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones and Bartlett

Unit III

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

Semester IV

Course title: Biomolecular analysis techniques

Course outcomes

After completion of this course students will be able to:

1. Discuss and illustrate instrumentation, principle, operation and application of various spectroscopic techniques such as UV-visible, IR and Atomic absorption spectroscopy.
2. Describe and illustrate instrumentation, principle, operation, advantages and application of various chromatographic techniques.
3. Differentiate between various chromatographic techniques such as gas chromatography, high performance and superficial liquid chromatography.
4. Explain and differentiate various modifications of PCR.
5. Describe various hybridization array technologies and its application.
6. Discuss the FISH technology and its types.

7. Understand and explain instrumentation, principle and application of various scanning probe microscopes.
8. Describe principle, instrumentation, types and application of X-ray Diffraction method.
9. Discuss principle, instrumentation and application of various photoluminescence spectroscopies.

Detailed Syllabus

Core Course I:

Unit	Sub-unit	Title: Biomolecular analysis techniques	Lectures
	Spectroscopic Techniques		**15**
I	1	UV-visible spectroscopy: Beer- Lambert‟s Law, Instrumentation, operation, calibration, accuracy and applications	5
	2	IR: Principles, Instrumentation, operation, calibration, accuracy and applications	5
	3	Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, calibration, accuracy and applications	5
	Chromatographic Techniques		**15**
II	1	Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications	5
	2	High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications	5
	3	Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications	5
	Molecular Biology Techniques		**15**
III	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	5
	2	Hybridization array technology: applications of microarrays in microbiology, oligonucleotide microarrays and cDNA microarrays	5
	3	FISH technology, CARD-FISH, FISH with extended techniques: confocal laser scanning microscopy, micro autoradiography, flow cytometry, and immunofluorescence	5
	Characterization techniques in Nanotechnology		**15**
IV	1	Scanning probe microscopes: scanning tunneling microscope(STM), atomic force microscope(AFM), magnetic force microscope(MFM), scanning near field microscope (SNOM)	5
	2	Diffraction Techniques: X-ray diffraction(XRD)	5
	3	Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies(XPS)/Auger electron spectroscopy	5

Core course I Practicals:

1. Separation of plant pigments by column Chromatography
2. Estimation of plant pigments using UV-Visible spectrometry
3. Chromatographic separation of pigment fractions from Serratia marcesence strain
4. Characterisation of serratia pigments by UV-Visible Spectroscopy and FTIR analysis
5. Kit based DNA extraction, PCR analysis and Agarose gel Electrophoresis

References:

Unit I

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.

Unit II

1. Braithwaite A. and Smith F.J., 2001, Chromatographic Methods, 5th Ed. , London, Kluwer Academic Publishers
2. McNair H. M. and Miller J. M., 2009, Basic Gas Chromatography , Wiley International
3. Miller J. M. , 2009, Chromatography: Concepts and Contrasts, USA, John Wiley and Sons,Inc.
4. Scott R. P.W. 2012,Principles and Practice of Chromatography (Chrom-Ed Book Series) , Reese-ScottPartnership

Unit III

1. Braun R., Introduction to Instrumental Analysis, New York, McGarw Hill Book CompanyPersing, H.D. et al. 2004, Molecular Microbiology: Diagnostic principles and practice, Washington
2. D.C., ASMpress. Skoog, Holler and Nieman, Principles of Instrumental Analysis, 5th Ed. Australia, Thomson Brock/Col

Unit IV

1. Chattopadhyay K.K. and Banerjee A.N., 2012, Introduction to Nanoscience and Nanotechnology,
2. New Delhi, PHI Learning Pvt.LtdKulkarni Sulabha, 2011, Nantotechnology: Principles and Practices, New Delhi, Capital
3. Publishing CompanyMuralidharan V.S. and Subramania A. 2010, Nanoscience and Technology, New Delhi Ane Books
4. PvtLtd.Sharon, Madhuri and Maheshwar, 2012, Bio-Nanotechnology: concepts and applications. New Delhi, Ane books Pvt. Ltd

Course title: Advances in Biotechnology II

Course outcomes

After completion of this course students will be able to:

1. Outline and discuss drug discovery process in detail.
2. Describe various new approaches in vaccine designing.
3. Discuss different aspects of marine biotechnology along with marine bioprospecting.
4. Discuss various marine derived compounds and bioactive compounds from marine environment.
5. Describe chemical method for synthesis of DNA and various DNA sequencing methods.
6. Discuss the different strategies use for manipulation of gene expression in prokaryotes and various eukaryotic expression systems.
7. Describe different types of directed mutagenesis and various strategies for protein engineering.
8. Understand and discuss the concept of IPR and its types.
9. Understand the specification and license agreements in IP system along with explain the various categories of biotechnological patents.
10. Understand and explain the various aspects of bioethics.

Detailed Syllabus

Core Course II:

Unit	Sub-unit	Title: Advances in Biotechnology II	Lectures
		Pharmaceutical Biotechnology	**15**
I		Drug discovery: modern methods, proteomics, High throughput screening, Natural products and lead identification and The role of protein 3D structures	6
		Biologics, Biopharmaceuticals	4
		Vaccines: Newer Vaccines, Vaccine Designing Approaches	5
		Marine Biotechnology	**15**
II	1	Different aspects of Marine Microbiology i. Detection of microorganisms and microbial activity, Metabolic diversity ii. Biomimetic materials, new class of pharmaceuticals, industrial products and processes, vaccines, diagnostics and analytical reagents iii. Environmental research in marine environment: Biofouling and biodeterioration, Degradation of pollutants, Bioremediation	5
	2	Marine bioprospecting – Isolation of Marine Natural Products	3

	3	Diversity of marine derived compounds: Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymesprotease, lipase, chitinase, glucanase; Marine biominerals; Biominerelizedstructures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagens.	5
	4	Bioactive Compounds and Biomaterials from Marine Environment	2
	Advances in Molecular Biotechnology		**15**
III	1	Chemical synthesis and sequencing of DNA: Phosphoramidite method, Uses of synthesized oligonucleotides, Sanger‟s Chain sequencing and Automated DNA sequencing	2
	2	Manipulation of Gene Expression in Prokaryotes: Gene expression from strong and regulatory promoters, Fusion proteins, Increasing protein stability, protein folding and DNA integration into host chromosome	3
	3	Heterologous protein production in eukaryotic cells: Expression systems like *Saccharomyces cerevisiae,* Baculovirus-Insect cell, mammalian cell	4
	4	Directed Mutagenesis: Oligonucleotide directed mutagenesis using M13 DNA, Oligonucleotide directed mutagenesis with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primer, Error- prone PCR, DNA shuffling, Mutant proteins with unusual amino acids.	3
	5	Protein Engineering: Adding disulfide bonds, changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, Modifying metal cofactor requirement, Modifying protein specificity, Increasing enzyme stability and specificity	3
	IPR and Bioethics in Biotechnology		**15**
IV	1	IPR and Types of IP-protection, Biotechnological Patents, Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement	3
	2	Patent Specifications and Basic Component of License Agreement, In IP System	1
	3	Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Indian Scenario, Non-Patentable IP and Patentable IP in Indian Patent Act, Concerns Over Biotechnology Patents.	2
	4	Bioethics: i. Principles of ethics, ii. Cross-cultural Bioethics iii. Perceptions of ethical biotechnology iv. Past and Present „bioethical‟ conflicts in biotechnology v. Future „Bioethical‟ conflicts in Biotechnology	6
	5	vi. Bioethics versus Business: A Conflict?	3

		vii. Resolution of Conflicts viii. Ethical limits of Biotechnology ix. Criteria to assess whether biotechnology research is ethical	

Core course II Practicals:

1. Qualitative estimation of various enzymes from marine isolates
2. Extraction, Purification, characterization of pigment from marine isolate
3. Antimicrobial and antioxidant activity of pigment from marine isolate
4. Debate on IPR and Bioethics case studies

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)

Unit II

1. David H.Attwayand Oskar R.Zabosky: Marine Biotechnology, Volume 123, plenum press (1993).
2. O. Kinne: Marine Ecology, VolV.Ocean Management 3and4, John Wiley and Sons, (1984).
3. P.J.Scheuer: Marine. Natural Products, Volume 1 and 2 (1978). Volume (1980-81) Academic Press
4. R.R.Colwellet. et, al (eds) Biotechnology of Marine polysaccharides, (1985).
5. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, (1981).
6. RSK Barnersand R.N Huges : Introduction to Marine Ecology, Blackwell

Unit III

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.

Unit IV

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

Course title: Applied and Environmental Microbiology II

Course outcomes

After completion of this course students will be able to:

1. Explain the needs and limitation of bioremediation process.
2. Discuss the process involved in bioremediation of various compounds.
3. Discuss the waste disposal and management associated with electronic and biomedical waste.
4. Understand and describe structure, properties and process involve in formation of biofilms.
5. Understand the quorum sensing in biofilm and study interaction, impact of biofilms in plant associated habitat.
6. Describe various methods of biofilm eradication.
7. Discuss the control measures, assessments and monitoring of air, soil, radioactive, thermal pollution and eutrophication.
8. Understand and describe the different levels of biohazards and their risk assessment.
9. Understand the prevention and management of laboratory accidents which includes dealing with sharp injuries, infectious agents and gaseous in the laboratory.
10. Describe the solid waste management such as its types, components, disposal, management and treatment.

Detailed Syllabus

DSE :

Unit	Sub-unit	Title: Applied and Environmental Microbiology II	Lectures
	Bioremediation and Waste disposal		**15**
I	1	Engineering and bioremediation process its needs and limitations	6
	2	Bioremediation in Soil of BTEX hydrocarbons	1
	3	Petroleum contamination, Polycyclic aromatic compounds	3
	4	Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds, Molecular technique Bioremediation	3
	5	Biomedical and electronic waste management	2
	Biofilm Management		**15**
II	1	Structure and properties of biofilms 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	5
	2	Study of Quorum Sensing: Cell- Cell Communication amongst bacteria, and its similarity with M. xanthus Fruiting Body Development.	3
	3	Multispecies biofilms: Clinical Relevance 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	3
	4	Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quarternary ammonium compounds. Use of other biofilm management methods such as probiotic organisms and prebiotics to restore disrupted beneficial biofilms to a “normal state”.	3
	5	Biofilms from different environments: human associated biofilms e.g. Gut	1
	Pollution Control and Safety Standards		**15**
III	1	Air pollution – control measure (dust control equipment, control measures for specific gaseous pollutants) , assessment & monitoring Soil pollution – control measures, assessment and monitoring. Eutrophication – causes, effects and control measures. Radioactive pollution – prevention and control measure Thermal pollution – control measure	5
	2	Biohazards: Introduction, levels of biohazards, Risk assessment	2
	3	Biosafety – Introduction and Biosafety levels	2
	4	Prevention and Management of Laboratory accidents: Sharp	3

		injuries, Spill response procedure for infectious agent, gases in the laboratory	
	5	Solid waste management – types, components of solid waste management, on-site disposal and off-site disposal Hazardous waste management – management, treatment and disposal.	2

DSE Practicals :

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. Demonstration of Analysis of SOx, NOx , heavy metal (As/Cr) pollutants using volumetric/ spectrophotometric methods.
4. Study tour/ academic visit to any large scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centers

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Unit I

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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

Unit II

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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

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1. A textbook of environmental pollution and control. S S. Dar
2. Biotechnology of Odour and Air pollution Control. Springer
3. Environmental pollution control engineering. C.S.Rao .New Age International Publishers.
4. Environmental management. H. V. Jadhav, VipulPrakashan , 2002
5. Environmental management. R.K. Jain and others
6. Biosafety manual for public health laboratories – Government of India