



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 4th Semester Courses in **Microbiology** (June 2015 onwards)

Contents:

Theory Syllabus for Courses:

**MS.MIC.4.01 - APPLIED AND ENVIRONMENTAL MICROBIOLOGY, MONITORING
AND MANAGEMENT**

MS.MIC.4.02 –FOOD MICROBIOLOGY

MS.MIC.4.03 - PHARMACEUTICAL MICROBIOLOGY

MS.MIC.4.04 - ADVANCES IN BIOTECHNOLOGY – 2

Practical Syllabus for Courses:

MS.MIC.4.PR

M.Sc. II

Course: MS.MIC.4.01

Title: APPLIED AN ENVIRONMENTAL MICROBIOLOGY, MONITORING AND MANAGEMENT

LEARNING OBJECTIVES

1. Understand microbial communities in various habitats and their adaptations
2. Understand the techniques needed to study microbial ecology
3. Know biofilm formation in various environments.
4. Understand the bioremediation process, its feasibility and various methods.
5. Understand sewage & sludge treatment and disposal methods with plant loading criteria.
6. Know the types of pollution, its monitoring and control
7. Understand waste management, biohazard and biosafety standards.

Number of lectures: 60

UNIT 1: MICROBIAL DIVERSITY & ADAPPTIONS TO DIVERSE HABITATS

15 LECTURES

LEARNING OBJECTIVES

1. Understand microbial biodiversity in different habitats
2. Know the adaptations of microorganisms to extreme environmental conditions and application of the adaptations
3. Understand the role of microorganisms in biofilm formation and biogeochemical cycling

1. Principles of microbial ecology

2L

- Ecological concepts –Concepts, Niche, Habitat, Ecosystem
- Interactions between microorganisms with emphasis on any two examples of each
- Ecological succession

2. Microbial ecosystems and biogeochemical cycling

13L

- Environments and microenvironments
- Biofilms
 - i. Structure, properties and models of biofilms
 - ii. Formation of biofilm , Regulation of Initial Attachment, Biofilm Formation Processes 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 in biofilm formation
 - iv. Biofouling associated microbial biofilms
 - v. Prosthetics associated biofilms
 - vi. Gut associated Biofilms

- vii. Control of biofilms
- Freshwater habitat
- Marine habitat
- Soil habitat
 - i. Soil composition
 - ii. Soil formation
 - iii. Soil as a microbial habitat
 - iv. Deep subsurface microbiology
- Plant microbial ecosystems
 - i. Rhizosphere
 - ii. Phyllosphere
 - iii. Plant pathogens
- Animal associated microbes: Rumen associated microbes
- Extreme environments: Study of Thermophiles, Psychrophiles, Halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms
- Biogeochemical cycling:
 - i. Biogeochemical cycles for Carbon Nitrogen, Sulphur and Oxygen
 - ii. Concept of Carbon credits

UNIT 2: TECHNIQUES IN MICROBIAL ECOLOGY

15LECTURES

LEARNING OBJECTIVES

1. Understand the techniques used for studying ecological habitats
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1. Environmental sample collection and processing

1L

- Soils and Sediment
- Water
- Air

2. Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment Cultural Methods

14L

- Cultural methods for isolation & enumeration of bacteria
- Physiological Methods
 - i. Measuring microbial activity in pure culture
 - ii. Carbon respiration
 - iii. Stable isotope probing
 - iv. Use of radioisotopes as tracers
 - v. Adenylate energy charge
 - vi. Enzyme assays
- Immunological methods: Immunoassays
- Nucleic acid based methods of analysis

- i. Obtaining Nucleic acids from Environment
- ii. Use of Gene probes
- iii. FISH, ISRT FISH, CARD FISH
- iv. Microarrays
- v. PCR- RTPCR, qPCR, ICC PCR, PCR-fingerprinting
- vi. RFLP
- vii. ARISA, ARDRA
- viii. Denaturing /Temperature gradient Gel electrophoresis
- ix. Sequencing
- x. Metagenomics
- xi. Reporter genes.

UNIT 3: BIOREMEDIATION, BIODEGRADATION &WASTE DISPOSAL

15 LECTURES

LEARNING OBJECTIVES

1. Understand the bioremediation process and its feasibility.
 2. Learn the various methods of bioremediation.
 3. Learn the various methods of sewage sludge treatment.
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1. Introduction to Bioremediation

3L

- Factors affecting bioremediation: Nutrient sources, environmental conditions, Bioavailability, adsorption/desorption kinetics
- Needs and Limitations
- Strategies for bioremediation
 - i. Intrinsic and Enhanced : Indigenous and bioaugmentation, Use of surfactants
 - ii. *In situ* bioremediation: Bioremediation on land, land farming, Bioventing, Biosparging, Bioaugmentation
 - iii. *Ex situ* bioremediation: Composting, Biopile process, Bioreactors, Novel technologies
 - iv. Molecular methods for bioremediation

2. Bioremediation in Soil of BTEX hydrocarbons

2L

- Significance of BTEX contamination
- Concept of aerobic and anaerobic processes of breakdown

3. Petroleum contamination

2L

- Metabolism of alkanes and aromatic compounds
- Genetics of petroleum degradation

4. Polycyclic Aromatic hydrocarbons

3L

- Sources, Toxicity and Persistence
- Microbial metabolism of PAH (by bacteria, algae, ligninolytic- and non ligninolytic-

fungi)

- Methods of bioremediation: Solid phase, Bioreactor and *in situ* methods, advantages and disadvantages of these methods.

5. Bioremediation and biodegradation of Xenobiotics **1L**

- Nitro aromatic compounds
- PCB
- Chlorinated Phenols
- Chlorinated aliphatic compounds.

6. Sewage & Sludge treatment and disposal methods **4L**

- Aerobic processes
- Anaerobic processes
- Various plant loading criteria eg. MLSS, TSS, HRT, MCRT and F:M
- Disposal methods

UNIT 4: ENVIRONMENTAL & NATURAL RESOURCES MANAGEMENT, SAFETY STANDARDS, POLLUTION CONTROL AND MONITORING **15 LECTURES**

LEARNING OBJECTIVES

1. Understand pollution of various resources and their effects.
2. Understand pollution monitoring, assessment and control.
3. Understand solid, hazardous and biomedical waste management.
4. Know the biohazards and biosafety levels.

1. Introduction to Pollution and types of pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in pollution control **3L**

2. Solid waste management **3L**

- 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, plastic and metal recycling

3. Harardous waste management **2L**

- Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce this waste through Common Effluent Treatment Plants

4. Biomedical waste management **2L**

5. Biohazards **2L**

- Introduction, levels of biohazards, risk assessment, proper cleaning procedures

6. Biosafety

3L

- 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)

CIA: Quiz, Test

References:-

Unit 1:

1. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 12th ed, 2009 Pearson Intl Ed
2. Microbial Ecology - Fundamentals and Applications, R. M. Atlas and R. Bartha - 1998, Addison Wesley Longman, Inc.
3. Prescott's Microbiology, Willey J. M., Sherwood, L. M., Woolverton, C. J., 2014, 9th edition, McGraw Hill Education
4. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press)
5. Biofilm formation as microbial development, O'Toole, G., Kaplan, H. B. and Kolter, R., 2000, Annu. Rev. Microbiol. 2000. 54:49–79
6. The involvement of cell-to-cell signals in the development of a bacterial biofilm, Davies DG, Parsek M. R., Pearson J. P., Iglewski B. H., Costerton J. W., Greenberg E. P., 1998, Science 280 (5361):295–98
7. A review of current and emergent biofilm control strategies, Simoes M. et al., 2010, LWT-Food science technology, 43(4):573-583
8. Biofilms and device associated infections, Donlan R. M., 2001, Emergent infectious diseases, 7(2): 277-281
9. Modulation of gut mucosal biofilms, Kleesen, B., and Blaut M., 2005, British journal of Nutrition, 93(suppl.1): S35-S-40
10. Bacterial biofilms in the human gastrointestinal tract, Probert H. M. and Gibson G. R., 2002, Current issues in intestinal microbiology, 3: 23-27

Unit 2:

1. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 12th ed, 2009, Pearson Intl Ed.
2. Environmental Microbiology, Maier R.M., Pepper. L. and Gerba C. P., 2010, Academic Press
3. Microbes and Microbial Technology, Rastogi & Sani, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment *in* Microbes and Microbial Technology: Agricultural and

- Environmental Applications, Iqbal Ahmad, Farah Ahmad, John Pichtel, 2011, Springer
4. Applications of the polymerase chain reaction in environmental, A K Bej and M H Mahbubani, Microbiology. Genome Res. 1992 1: 151-159
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 6. Metagenomics: DNA sequencing of environmental samples, Susannah Green Tringe and Edward M. Rubin, 806/November2005/Volume6
 7. www.nature.com/reviews/genetics

Unit 3:

1. A Textbook of Biotechnology, Dubey R.C., Illustrated Revised edition, 2010, S Chand and company
2. Environmental Biotechnology. Fulekar, M.H., 2010, CRC Press and Science Publishers
3. Environmental Microbiology, Maier R. M., Pepper I. L. and Gerba C. P., 2nd edition, 2009, Academic Press
4. Bioremediation: Principles and Applications, Ronald L, Crawford and Don L Crawford, 1st edition (September 8, 2005), Cambridge University Press
5. Bioremediation of PAH: Current knowledge and future directions, Bamforth, S.M. and Singleton, I.; J Chemical Technology and Biotechnology, 80: 723-736, 2005
6. Environmental Biotechnology, Allan Scragg, 2nd Edn, 2005, Springer
7. Bioremediation of BTEX hydrocarbons, Prenafeta-Boldu, F.X. *et. al* Biodegradation, 15:59-65. 2004
8. Wastewater engineering: Treatment and reuse, Metcalf and Eddy, 4th Ed. 2004 Tata McGraw Hill Publishing Co. Ltd.
9. Biotechnology, B.D.Singh, 2002, Kalyani Publishers
10. Exploitation of Micro-organisms, edited by Jones, D.G., 1993, Chapman and Hall, London.

Unit 4:

1. Fundamentals of ecology, Agarwal S. K., 2008, APH Publishers
2. Industrial hygiene and chemical safety, Fulekar M. H., 2006, IK International Publishers
3. Environmental management, Jadhav H. V., 2002, Vipul Prakashan.
4. Environmental assessment, Jain R.K., 2002, Mc Graw-Hill.
5. Modern trends in ecology and environment, Ambasht R. S., 1998, Backhuy Publishers
6. Technical EIA guidance manual for Common Hazardous Waste Treatment, Storage and Disposal Facilities, Prepared by Ministry of environment and forests, Government of India, 2010: http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/TGM_Comman%20Hazardous%20Waste%20Treatment_010910_N K.pdf

7. Guidelines for environmentally sound management of e-waste, ministry of environment & forests central pollution control board, Delhi, 2008:
<http://www.cpcb.nic.in/latest/27.06.08%20guidelines%20for%20E-Waste.pdf>
8. Evidence-Based Biosafety: a Review of the Principles and Effectiveness of Microbiological Containment Measures, 2008:
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2493080/>
9. Gearing Up for Patents: The Indian Scenario, Prabuddha Ganguli, 1998 Universities Press

M.Sc.II

Course: MS.MIC.4.02

Title: FOOD MICROBIOLOGY

LEARNING OBJECTIVES

1. Understand significance of microbes in food and their control
2. Understand concepts of Food Safety, quality management and regulation in the food industry
3. Know the varied applications of microbes in food
4. Apply concepts of sampling, QA, QC, GMP and HACCP in food industry

Number of lectures: 60

UNIT 1: MICROBES IN FOODS

15 LECTURES

LEARNING OBJECTIVES

Understand the incidence of microbes in food and their role in food spoilage.

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| 1. Current status of Food microbiology | 1L |
| 2. Sources of microbes in food & characteristics of predominant microorganism | 3L |
| 3. Normal microbiological quality of food and significance | 2L |
| 4. Factors influencing microbial growth in food | 3L |
| • Intrinsic | |
| • Extrinsic | |
| 5. Microbial food spoilage | 4L |
| • Important factors in Microbial food spoilage | |
| • Spoilage of specific foods, | |
| • New spoilage bacteria in refrigerated food | |
| • Indicators of Microbial Food spoilage | |
| 6. Predictive Modeling of Microbial Growth in food | 2L |

UNIT 2: CONTROL OF MICROBES IN FOOD

15 LECTURES

LEARNING OBJECTIVES

Know the principles of techniques used in food preservation to control the access and

growth of microorganisms in food

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| 1. Control of access of microbes in foods | 1L |
| 2. Control by physical removal, heat, low temperature, reduced Aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation | 8L |
| 3. Novel processing technologies of food preservation | 3L |
| 4. Control by combination of methods (Hurdle concept) | 3L |

UNIT 3: BENEFICIAL USES OF MICROBES AND OTHER FORMULATIONS IN FOOD	15 LECTURES
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LEARNING OBJECTIVES:

1. Understand general production methods of fermented foods from milk, meat, vegetable and cereals.
2. Know the other applications of microbes and microbial products in the food industry
3. Understand functional foods especially nutraceuticals.

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| 1. Microbiology of fermented foods | 4L |
| <ul style="list-style-type: none">• Cheese – Swiss and Blue cheese• Fermented meat product – Sausage• Fermented vegetable products – Pickles, soy product, Sauerkraut• Bread and Idli | |
| 2. Food additives of microbial origin | 3L |
| <ul style="list-style-type: none">• Enzymes• Biopreservatives• Sweeteners , flavours and colors• Probiotics and Prebiotics | |
| 3. Nutraceuticals | 4L |
| <ul style="list-style-type: none">• 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• Applications of fibers from food sources• Microbial fructooligosaccharides | |
| 4. Packaged Drinking water | 4L |
| <ul style="list-style-type: none">• Types of bottled water | |

- BIS /regulations regarding the production of packaged waters with respect to final quality of 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

UNIT 4: METHODS FOR FOOD SAFETY

15 LECTURES

LEARNING OBJECTIVES

1. Understand conventional, modern and rapid methods of detection of microbes and their products in food.
2. Be able to apply concepts of sampling, QA, QC, GMP, ISO 22000 and HACCP in Food industry
3. Understand Laboratory Accreditation criteria.

1. Microbial Foodborne diseases

2L

- Important facts in food borne diseases
- Food Borne infections
- Food Borne intoxicants
- Foodborne Toxico-Infections
- Opportunistic pathogens
- New and emerging food pathogens
- Indicators of Bacterial Pathogens

2. Methods for detection of microbes and their products

9L

- Conventional Microbiological Methods
 - i. Sampling for microbial analysis
 - ii. Microbial enumeration in food
 - iii. Qualitative Methods for detection of microbes and their toxins in food
 - iv. Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi, pathogenic bacteria (EPEC, *Vibrio*, *Salmonellae*) and viruses (Hepatitis A , Norwalk) in meat/fish products as per BIS/ISO/APHA standards
- Chemical Methods
 - i. DNase test
 - ii. LAL test
 - iii. Tests with Fluorogenic and Chromogenic Substrates
- Immunological Methods
 - i. FAT
 - ii. ELISA
 - iii. RIA
 - iv. Hemagglutination

- Molecular Methods
 - i. PCR
 - ii. Lux Gene Luminescence
 - iii. Fingerprinting methods
- Physical Methods
 - Biosensors: Use of biosensors and enzymatic/ thermal techniques for food analysis

3. Controlling the Microbiological Quality of food/food safety

4L

- Quality and Criteria
- Sampling Schemes
- QC using microbiological control
- Control at source
- Codes of GMP , Codex Alimentarius and FSSAI
- HACCP/ISO 22000
- Laboratory Accreditation
- Biofilm control

CIA: Presentation, Test

References:

Unit 1:

1. Fundamental Food Microbiology, 5th Ed., Bibek R. and Bhunia A., 2014, CRC Press
2. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
3. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing
4. Fundamentals of food microbiology, Fields M., 1979, AVI Publishing

Unit 2:

1. Fundamental Food Microbiology, 5th Ed., Bibek Ray and Arun Bhunia, 2014, CRC Press
2. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
3. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing
4. Foods Facts and Principles, N Shakuntala Manay and Shadaksharaswamy M., 1985, New Age International

Unit 3:

1. Fundamental Food Microbiology, 5th Ed., Bibek Ray and Arun Bhunia, 2014, CRC Press
2. Prescott and Dunn's Industrial Microbiology, Reed G., 4th Ed. CBS Publishers, 2004
3. Functional Foods – Concept to Product, Gibson GR & William CM., 2000, Woodhead Publishing
4. Nutraceuticals - Global status and applications: A Review, Sapkale A. P., Thorat M. S., Vir Prasad R. and Singh M. C. International Journal of Pharmaceutical And Chemical Sciences, Vol. 1 (3) Jul-Sep 2012
5. Nutraceuticals as therapeutic agents: A Review , Rajasekaran A., Sivagnanam G. and Xavier R., Research J. Pharm. and Tech. 1(4): Oct.-Dec. 2008,328-340
6. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer

7. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing
8. Biotechnology-Food fermentations: Food Fermentation : Microbiology, Biochemistry, and Technology, Volume 2, Joshi V. K., Pandey A., 1999, Educational publishers and distributors
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1. Fundamental Food Microbiology, 5th Ed., Bibek Ray and Arun Bhunia, 2014, CRC Press
2. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed RSC Publishing, 2008
3. Laboratory methods in food and dairy microbiology, Harrigan W. F. and McCance M. F., Academic Press, 1976
4. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
5. Lab Manual 14, FSSAI, Manual of methods of analysis of foods Microbiological testing, 2012, Food safety and standards authority of India, Ministry of health and family welfare, Government of India
6. Microbiological safety of processed foods: Proceedings of symposium sponsored by Hindustan Lever research foundation, ed. Crowther J.S., Marthi B., 1998, Oxford and IBH publishing company Pvt. Ltd.
7. www.fssai.gov.in
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M.Sc.II

Course: MS.MIC.4.03

Title: PHARMACEUTICAL MICROBIOLOGY

LEARNING OBJECTIVES

1. Understand concepts of QA and validation in pharmaceutical and cosmetic products.
2. Understand modern methods of drug discovery.

Number of lectures: 60

UNIT 1: PRINCIPLES AND APPLICATIONS OF GMP IN PHARMACEUTICALS AND COSMETICS **15 LECTURES**

LEARNING OBJECTIVES

Understand GMP and its significance

1. Principles – Applications and Definitions	2L
2. The concept of Quality	2L
3. The regulatory factors	2L
4. QC, QA and GMP	2L
5. Quality assurance beyond GMP	2L
6. ISO	2L
7. Sanitary practices in cosmetic manufacturing	3L

UNIT 2: QUALITY MANAGEMENT AND REGULATORY ASPECTS **15 LECTURES**

LEARNING OBJECTIVES

Know the different aspects of quality management

1. Premises and contamination control, location, design, structure, layout, services and cleaning	3L
2. Personnel management, training, Hygiene and health	2L

3. Documentation for quality management	2L
4. Quality control and GCLP	2L
5. Sterile and non-sterile products	3L
6. Global regulatory and toxicological aspects of cosmetic preservation	3L

UNIT 3: ANALYTICAL ASPECTS FOR PHARMACEUTICAL AND COSMETIC PRODUCTS

15 LECTURES

LEARNING OBJECTIVES

Understand the analytical aspects of QA and validation in pharmaceutical and cosmetic products.

1. Analytical Aspects of QC and GCLP for Pharmaceuticals.	10L
<ul style="list-style-type: none">• Assurance of quality in the manufacture of sterile products.• Validation: concepts, principles, analytical methods and applications.	
2. Cosmetic microbiology- testing methods and preservation	5L
<ul style="list-style-type: none">• Antimicrobial preservation efficacy and microbial content testing• Validation method for cosmetics• Preservation strategy• Evaluation of antimicrobial mechanism	

UNIT 4: DRUG DISCOVERY

15 LECTURES

LEARNING OBJECTIVES

1. Understand modern methods of drug discovery.
 2. Understand concepts of Pharmacokinetics and Pharmacodynamics.
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1. Drug Discovery Tools	9L
<ul style="list-style-type: none">• Pharmacokinetics and Pharmacodynamics, Natural products for lead identification, High Throughput Screening, Combinatorial Chemistry• Concept of Pharmacognosy	
2. Modern Methods of Drug Discovery	6L
<ul style="list-style-type: none">• Cheminformatics, in silico-modelling, Molecular Modeling, Structure Prediction, Rational Drug Designing, Drug Development, Proteomics, protein 3D structures in the drug discovery process, microbial genome mining	

CIA: Presentation, Test

References:-

Unit 1:

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

Unit 2:

1. Hugo and Russell's Pharmaceutical Microbiology, Denyer S. P., Hodges N. A., Gorman S. P. And Gilmore B., 8th Edition, 2011, Blackwell Publishing.
2. Quality in the manufacture of medicines and other healthcare products, Sharp J., 2000, Pharmaceutical Press.
3. Quality Assurance in Microbiology, Bhatia R. and Ichhapujani R. L. 1995, CBS publishers and distributors.

Unit 3:

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

Unit 4:

1. Modern Methods of drug discovery, Hillisch A. and Hilgenfeld R., 2009, Springer International Edition
2. Principles of Medicinal Chemistry, Kadam S. S., Mahadik K. R. and Bothara K. G., 2009, Vol II, Nirali Prakashan Pune
3. Foye's Principles of Medicinal Chemistry, Lemke T. L. and Williams D. A., 6th Ed, 2008, Wolter Luwer, Lippincott Williams and Wilkins. N Delhi.
4. Principles of pharmacology: the pathophysiologic basis of drug therapy by Golan D. E., 2nd Edition, 2007, Lippincott Wiliams and Wilkins

M.Sc. II

Course: MS.MIC.4.04

Title: ADVANCES IN BIOTECHNOLOGY – 2

LEARNING OBJECTIVES

1. Know the applications and advances in the field of Animal, plant, molecular and nano biotechnology.
2. Understand the concepts of IPR in the field of biotechnology
3. Understand the concepts of bioethics and entrepreneurship

Number of lectures: 60

UNIT 1: ANIMAL BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know the concept and techniques in animal tissue culture.
2. Understand generation and applications of transgenic animals.

1. Animal Tissue Culture	2L
• Primary culture, Organ culture, Embryo Culture, Established Cell lines	
2. Scale up, Cryopreservation, Culture Collections	2L
3. Risks and Safety, Bioethics	2L
4. Stem Cell Technology, Cloning techniques, Applications	1L
5. Methods of generation of transgenic mice	4L
• Retroviral method	
• DNA microinjection method	
• Engineered Embryonic Stem cell method.	
6. Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish	4L

UNIT 2: PLANT TISSUE CULTURE & NANOBIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know the concept and techniques in plant tissue culture.
 2. Understand synthesis and properties of nanostructures and their applications.
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- 1. Plant Tissue Culture for crop improvement** **5L**
 - 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
- 2. Production of secondary metabolites from plant cell cultures** **2L**
 - Technology of plant cell culture for production of chemicals
 - Bioreactor systems and models for mass cultivation of plant cells
- 3. Nanoscale systems and Synthesis of nanostructures** **3L**
 - Nanoparticles, nanowires, thin films and multilayers
 - Physical, chemical and biological methods
- 5. Nano-biosensors** **1L**
 - Cantilevers: types and applications
 - Electrochemical nanosensors
- 6. Manipulation of biomolecules using nanotechnology** **2L**
 - Optical tweezers
 - Dielectrophoresis
 - Micro and Nanofluidics
 - Chip technologies
- 7. Medical nanotechnology** **2L**
 - Drug and gene delivery systems
 - Nanoimaging
 - Nanomedicine and Cancer diagnostics and treatment.

UNIT 3: IPR, ETHICS AND ENTERPRENEURSHIP IN BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES:

1. Understand IPR and its role in biotechnology
2. Understand the concept of bioethics and its relevance in biotechnology
3. Understand the concept of entrepreneurship in biotechnology and obtain a preliminary knowledge of its components

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- 1. Biotechnology and Intellectual Property Rights** **8L**
 - Intellectual Property Rights (IPR) and Protection (IPP)
 - Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations
 - Biotechnological Patents

- Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement.
- Patent Specifications and Basic Component of License Agreement, In IP System
- Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents.
- Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act

2. Biotechnology and Bioethics

4L

- Bioethics and cross-cultural bioethics.- Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making
- Perceptions of Ethical Biotechnology, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about consuming products of GMOs.
- Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering

3. Entrepreneurship in biotechnology

3L

- Introduction
- Case Studies in Entrepreneurship
- Entrepreneurial Skills
- Initiating a Venture
- Planning a Venture
- Financing a Venture

UNIT IV: ADVANCES IN MOLECULAR BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES:

Learn the different methodologies involved in molecular biotechnology

1. Chemical synthesis and sequencing of DNA

2L

- Phosphoramidite method, Uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Using Phage M13 as a sequencing vector

2. Manipulation of Gene Expression in Prokaryotes

3L

- Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays, Increasing protein stability, protein folding, DNA integration into host chromosome

3. Heterologous protein production in eukaryotic cells

2L

- Expression systems like *Saccharomyces cerevisiae*, *Pichia pastoris*, Baculovirus-Insect cell, mammalian cell

4. Rational Mutagenesis

4L

- 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

5. Protein Engineering

3L

- 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

6. Synthetic Biology

1L

- Introduction, types, mechanisms, applications in industry

CIA: Assignment, test

References:-

Unit 1:

1. Culture of Animal Cells, Freshney I., 2011, John Wiley and Sons.
2. Basic Cell Culture, Davis J. M., 2nd.Ed 2007, Oxford press
3. Animal Cell Culture, Gangal S., 2010, Universities press.
4. Molecular Biotechnology, Glick and Pasternak, 4th edition, (2010) ASM press.

Unit 2:

1. Introduction to plant tissue culture, Razdan M. K., 2003, Science Publishers.
2. Biotechnology, B. D. Singh, 2010, Kalyani Publishers
3. An introduction to Plant Tissue Culture, Kalyan Kumar De, 1992, New Central Book Agency
4. Fundamentals of Nanotechnology, Hornyak D., Moore J., Tibbals H., Dutta J., 2008, CRC press.
5. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology, Nalwa H. S., 2005, American Scientific Publishers
6. Nanobiotechnology, Niemeyer C. M. and Mirkin C. A., 2005, Wiley Interscience

Unit 3:

1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, 2010, Narosa Publishers.

2. A textbook of Biotechnology, Dubey R. C., 2001, S. Chand Publishers.
3. Biotechnology, 2nd Edition-Volume 12- Legal, Economic and Ethical Dimensions, Volume Editor-D. Brauer (A multi-Volume Comprehensive Treatise), Rehm H. J. and Reed G., Puhler A., Stadler P. (1995) VCH Publishers.
4. Patent It Yourself, 9th Edition, Pressman D., 2002, Nolo
5. Ethics in Biotechnology - an executive guide:
www.BiotechEthics.ca/tools/biotech_guide_1_0.pdf

Unit 4:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
2. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology, edited by Wink M., 2006, Wiley VCH
3. Molecular biotechnology: Principles and practices, Channarayappa, 2006, Universities Press
4. Synthetic Biology, Benner S., Sismour A. M., 2005, Nature Reviews Genetics, v6, p533 - 543.

M.Sc. II
Practicals semester IV

Course: MS.MIC.4.PR

INTERNAL PROJECT

MS.MIC.4.01.PR

Group based Research Projects to study industrially important microbes/ microbial processes using microbial diversity rich environmental sample (e.g. mangrove soil).

APPLIED AN ENVIRONMENTAL MICROBIOLOGY, MONITORING AND MANAGEMENT

MS.MIC.4.02.PR

1. Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content.
2. 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 environment).
3. 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
4. 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.

FOOD AND PHARMACEUTICAL MICROBIOLOGY

MS.MIC.4.03.PR

Food Microbiology

1. Microbiological study of fermented food: Idli batter
2. Quality Assessment and Analysis of packaged foods: Milk, Salad, Juice, Yogurt (ISI standards)
3. Farm to fork: identifying the sources of cross contamination, mitigation strategies.

Pharmaceutical and cosmetic Microbiology

1. Sterility testing and reporting (as per Pharmacopia)
2. Microbial load of cosmetic product
3. Efficacy testing of preservatives like parabens
4. Efficacy of preservation and shelf life study.
5. Preparation of cosmetic product and study of its preservation

ADVANCES IN BIOTECHNOLOGY

MS.MIC.4.04.PR

1. Terminology, Laboratory design of Animal tissue culture laboratory
2. Preparation of complete medium, Sterilization and sterility checking.
3. Chick embryo fibroblast culture, viable staining
4. Lymphocyte, viable staining and haemocytometer count.
5. Preparation of Nanosilver By Wet reduction Method(Chemical),using Neem Extract(plants) & Bacteria(Microbiological)
6. Characterisation of Nanosilver by UV spectrometry 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
9. Alcohol fermentation and assessment of efficacy

CIA:

MS.MIC.3.01: Project Conduct

MS.MIC.3.02: Rough draft of internal Project Report

MS.MIC.3.03: Lab experiment

MS.MIC.3.04: Lab experiment