St. Xavier's College (Autonomous), Ahmedabad

Syllabus of Semester – III of the following departments under Faculty of Science based on Post Graduate Curriculum Framework - 2024 to be implemented from the Academic Year 2024-25.

FACULTY OF SCIENCE

DEPARTMENT OF MICROBIOLOGY

MSc. Microbiology

CORE PAPER: Recombinant DNA Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Recombinant DNA Technology (PMB 3801)	4	0	2	Life Science Graduate from a UGC recognized University	Basic knowledge of DNA recombination and molecular biology

LEARNING OBJECTIVES (LO)	
LO-1	Understanding of various techniques used for screening and selection of recombinants.
LO-2	Understanding the applications of R-DNA techniques and advances in various discipline of life science.
LO-3	To understand gene expression concept and hybridization technique
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Analyse recombinants and characterize nucleic acids.
CO-2	Explain and utilize various enzymes and vectors for recombination.

CO-3	Apply rDNA technology in various research work

Unit-1: Characterization of Nucleic Acids and analysis of recombinants (15 L)

1. Quantification, radiolabelling of nucleic acids, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, pyrosequencing
2. Principle of hybridization. Northern blotting, Southern blotting, Western blotting, selection and screening of recombinants, restriction fragments length polymorphism (RFLP), RAPD, AFLP, MAP.

Unit-2: Enzymes used in rDNA technology (15 L)

1. Ligases, reverse transcriptase (RTase)
2. Restriction endonucleases: types of restriction endonucleases, nomenclature, recognition sequences, cleavage patterns, frequency of recognition sites, modification of cut ends (linkers and adaptors), exonucleases, polymerases
3. DNA modifying enzymes: alkaline phosphatase, poly nucleotide kinase, terminal deoxynucleotidyl transferase

Unit-3: Vectors used in rDNA technology (15 L)

1. Cloning vectors: properties of a good vector, nomenclature of plasmid cloning vectors.
2. Plasmids- size and copy number, classification of plasmids: stringent plasmids, relaxed plasmids, resistance or R plasmids, Col plasmids, degradative plasmids, virulence plasmids, Ti plasmids
3. PBR322- nomenclature of pBR322, structure and useful properties of pBR322, pedigree of pBR322, recombinant selection of pBR322 using replica plating technique,
4. PUC18- nomenclature and structure of pUC18, a Lac selection plasmid, expression vectors, phages- λ genetic map, insertional and replacement vectors, cloning experiment with λ based vectors
5. Phagemids and their applications
6. Yeast vectors (shuttle vectors): 2μm plasmid, YEps, YRps, YCps, YAC

Unit-4: Applications of rDNA technology (15 L)

1. Gene Therapy: introduction, somatic gene therapy, delivery techniques – ex vivo & in vivo, delivery vectors – viral & Non-viral, germinal gene therapy, limitations and ethical considerations.

2. Molecular diagnosis: introduction to molecular diagnostics, hybridization techniques – micro-arrays, fluorescence in situ hybridization (FISH), introduction to genetic testing, Types; pre-implantation genetic diagnosis, newborn screening, prenatal diagnosis, medical procedures – Amniocentesis, Chorionic villus sampling
3. Forensic testing: DNA Fingerprinting
4. Therapeutics: Production of monoclonal antibody, engineered antibodies-humanized antibodies-monoclonal antibodies for cancer diagnostics and therapy-Immunotoxins

Suggestive Readings:

- Primrose and Twyman, Principles of gene manipulation and Genomics. 7th Edition, Blackwell, 2006.
- Glick et al., Molecular biotechnology Principles and Applications of Recombinant DNA. 4th Edition, ASM, 2010.
- Rastogi and Pathak, Genetic engineering. 1st Edition, Oxford, 2009.

CORE PAPER: Environmental Microbiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Environmental Microbiology (PMB 3802)	4	0	2	Life Science Graduate from a UGC recognized University	Basic knowledge of Microbiology

LEARNING OBJECTIVES (LO)	
LO-1	To understand the solid and liquid wastewater management.
LO-2	To get insite of microbial functions in agricultural environment.
LO-3	To understand air and water microbial presence and their significance.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Understand solid and hazardous waste as well as waste water management.
CO-2	Manage and utilize agriculturally important microbes
CO-3	Recognize the presence of microbes in air and aquatic environment and its significance.

Unit-1: Waste water treatment technology (15 L)

1. Types of waste water effluents, sources and characteristics.
2. Composition of the waste water: chemical, physical & biological
3. Preliminary treatments, primary treatment, secondary treatment and tertiary treatments - Coagulation and flocculation - sedimentation - filtration - disinfection and chlorination
4. Treating waste waters by - trickling filters - rotating biological contactors - activated sludge - stabilization ponds

5. Wastewater characteristics and effluent quality parameters - odor, color, turbidity, pH and EC - Hydrogen sulphide - Nitrogen (nitrification/denitrification) - Biological Phosphorus amendment - Potassium amendment.
6. GPCB norms for wastewaters disposal

Unit-2: Solid and hazardous waste management (15 L)

1. General introduction including definitions of solid waste including municipal, hospital and industrial solid waste; legal issues and requirements for solid waste management and health and environmental issues related to solid waste management.
2. Sampling and characterization of solid waste.
3. Treatment and disposal techniques for solid wastes–composting, vermin-composting, autoclaving, microwaving, incineration, non-incineration thermal techniques, use of refuse derived fuels, land filling.
4. Integrated waste management practices.

Unit-3: Microbiology of agro environment (15 L)

1. Agro and forest-feedstocks to fermentable sugars, sugars to ethanol (yeasts, substrate range, substrate utilization).
2. Alternative ethanol producing organism - *Zymomonas mobilis*; Clostridial fermentations.
3. Single cell protein, mycoprotein, GMO's, GEM's, rDNA technology and its application in Agriculture.
4. Degradation of lignocellulosic waste, bio-composting-different methods, different types of compost, conditions for production of compost.

Unit-4: Aero and aquatic environment microbiology (15 L)

1. Microbes in air: composition of air; Number and kinds of organisms in air; distribution and sources of air borne organisms, droplet nuclei – aerosol.
2. Assessment of air quality - some important air borne diseases caused by bacteria, fungi, viruses their symptoms and preventive measures.
3. Aquatic microbiology: distribution of microorganisms in the aquatic environment-fresh water (ponds, lake, River), sources and types of water pollution, biological indicators of water pollution.
4. Determination of the quality of water - MPN index, membrane filtration, biological oxygen demand, potability of water - microbial assessment of water quality, water borne diseases and preventive measures.

Suggestive Readings:

- Handbook of Water and Wastewater Treatment Plant Operations by Frank R. Spellman, Lewis publishers, CRC Press Company, Boca Raton London New York Washington, D.C. 2003.
- Central Public Health and Environmental Engineering Organization (CPHEEO) (2000) Manual on Municipal Solid Waste Management, New Delhi, Controller of Publications.
- Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.

CORE PAPER: Industrial Microbiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Industrial Microbiology (PMB 3803)	4	0	2	Life Science Graduate from a UGC recognized University	Basic knowledge of fermentation technology

LEARNING OBJECTIVES (LO)	
LO-1	To understand the role of fermentative human consumption products.
LO-2	To get an insight regarding industrial waste management.
LO-3	To understand the production of various fermentative products.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Recognize the significance of fermentative production of antibiotics and vaccines.
CO-2	Understand the fermentative production of organic acids and polysaccharides.
CO-3	Treat industrial waste efficiently knowing the pros and cons.

Unit-1: Microbial fermented products for human consumption (15 L)

1. Antibiotic fermentation: production of β lactams (penicillins), semi-synthetic penicillins and cephalosporins.
2. Recombinant and synthetic vaccines: problems with traditional vaccines, impact of biotechnology on vaccine development, subunit vaccine for Hepatitis B, potential problem of subunit vaccines.
3. Vitamin production: Vitamin A and B12.

Unit-2: Fermentative production of enzymes, organic acids and industrial alcohols (15 L)

1. Production and applications of: amylase, protease and lipase.
2. Production and applications of: citric acid, lactic acid, and acetic acid.
3. Production of industrial alcohol: acetone-butanol fermentation, glycerol from yeasts.
4. Alcoholic beverages: beer, whisky and wine.

Unit-3: Fermentative production of hormones, polysaccharides and polyesters (15 L)

1. Industrial production of hormones: insulin and steroids.
2. Industrial production of polysaccharides: xanthan, dextran and alginate.
3. Microbial polyesters - bioplastics (polyhydroxyalkanoates).

Unit-4: Industrial waste management (15 L) (Industrial regulation awareness)

1. Types of industrial waste-solid, liquid and gaseous (PAH, radioactive waste, heavy metals, xenobiotic compounds, etc.), detailed discussion on the type of industry and the waste from the industry.
2. Biomedical waste and its management.
3. Solid waste and hazardous waste management-xenobiotic compounds (pesticides, insecticides, organo-metallic compounds), radioactive material waste management, hydrocarbonaceous waste management.
4. Air pollutants and their management, sampling and monitoring of gaseous and particulate pollutants, emission monitoring.
5. US FDA and BIS norms, pharmacopeia.

Suggestive Readings:

- Industrial Microbiology: An Introduction by M.J. Waites et al. Blackwell Science. 2001.
- Biotechnology: A test Book of Industrial Microbiology. Second edition, 2000. Ed. W. Crueger & A. Crueger. Panima Publishing corporation.
- Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press.

CORE PAPER: Applied Microbial Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Applied Microbial Technology (PMB 3804)	4	0	2	Life Science Graduate from a UGC recognized University	Basic knowledge of microbiology

LEARNING OBJECTIVES (LO)	
LO-1	To explain basic concept and important of microorganisms available in environment.
LO-2	To learn basic principles, explaining and solving environmental problems with different aspects.
LO-3	To analyze problems and enhance careers of Research in the field of bioremediation.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Understand and acknowledge bioremediation technique.
CO-2	Understand the significance of microbial deterioration and degradation of economically important products.
CO-3	Have an insite about biohydrometallurgy technique.

Unit-1: Principles of bioremediation (15 L)

1. Bioremediation: in situ and ex situ bioremediation technologies; bioremediation of oil spills, hazardous wastes and heavy metals; use of GMO in bioremediation.
2. Biosorption, biostimulation, bioaugmentation and phytoremediation.
3. Biological treatment of waste gas (polluted air): biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.

Unit-2: Biodeterioration and biodegradation (15 L)

1. Principles and mechanisms of biodeterioration, assessment of biodeterioration, biodeterioration of selected materials, prevention and control.
2. Biodegradation: Principles of biodegradation and mechanism, biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.

Unit-3: Bioleaching and biofuels (15 L)

1. Mechanisms and techniques of biomining, biofilm development during biomining, useful microorganisms for biomining, metal recovery in biomining.
2. Acid mine drainage (AMD) and microbially enhanced oil recovery (MEOR).
3. Biofuels: Liquid fuel (Alcohol), gaseous fuel (biogas and hydrogen).

Unit-4: Pharmaceutical and clinical microbiology (15 L)

1. Medical pathology: blood chemistry and urine chemistry – physical and microbial study (albumin test, reducing sugar test, bile test, bile pigment test, ketone body and blood pigment test, microbial tests).
2. Chemotherapeutic agents: Chemotherapy and their principles, limitations to effective chemotherapy, local tissues factors, systemic host factors and super infections and drug resistance, aspects of antimicrobial therapy, tropical therapy, combined therapy, chemoprophylaxis.
3. Antibiotics: Study of different class of drugs, their classification, mode of action, medicinal use, steroids, applications of monoclonal antibodies, detection of human pathogens using monoclonal and polyclonal antibodies.

Suggestive Readings:

- Tille, Patricia. Bailey & Scott's diagnostic microbiology-E-Book. Elsevier Health Sciences, 2015.
- Pepper et al., Environmental Microbiology, Academic Press, Elsevier, 2014.
- Mooray Moo Young, Comprehensive Biotechnology, Elsevier, 2011.

PRACTICAL: RDNA TECHNOLOGY & ENVIRONMENTAL MICROBIOLOGY PRACTICAL

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
rDNA Technology & Env. Microbiology Practicals (PMB 3805 L)	0	0	4	Life Science Graduate from a UGC recognized University	Basic knowledge of rDNA and env microbiology

LEARNING OBJECTIVES (LO)	
LO-1	To learn water and waste water analysis.
LO-2	To learn basic rDNA technology practical work.
LO-3	To learn the analysis of air and water quality.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Understand the functioning of basic rDNA technology procedures.
CO-2	Analyse the waste water.
CO-3	Get the insight about the various parameters influencing the quality of waste water.

1. Water and wastewater analysis: BOD, COD, DO, TS, TDS, SS, Alkalinity, Acidity, Chloride, Sulphate, Hardness measurement.
2. Microbial treatment of wastewater
3. PCR amplification
4. Restriction enzyme digestion of pUC18 DNA.
5. Ligation of DNA fragment with cloning vectors.
6. Preparation of competent cells.

7. Transformation of *E. coli* with recombinant vectors.
8. Microbial assessment of air quality. (Microbial load of air)
9. Microbial assessment of water quality. (Microbial load in water)

PRACTICAL: INDUSTRIAL & APPLIED MICROBIOLOGY PRACTICAL

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	**Credit Distribution of The Course**			**Eligibility Criteria**	**Pre-requisite(s) of the Course (if any)**
	Lecture	**Tutorial**	**Practical / Practice**		
Industrial and Applied Microbiology Practicals (PMB 3806 L)	0	0	4	Life Science Graduate from a UGC recognized University	Basic knowledge of Fermentation technology and clinical microbiology

LEARNING OBJECTIVES (LO)	
LO-1	To learn how remediation and leaching process works.
LO-2	To learn the pharmaceutical efficiency needed as a microbiologist.
LO-3	To learn the basic understanding of biodeterioration and biodegradation.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	To understand the role of microbiologist in pharmaceutical and clinical industry.
CO-2	To have an insite about the bioremediation and bioleaching process.
CO-3	Understand the significance and prevention of biodeterioration of economically important products.

1. Test for sterility.
2. Effectiveness of antimicrobial preservatives.
3. MIC and MBC estimation.

4. Fermentative production of EPS.
5. Fermentative production of amylase / protease / lipase.
6. Fermentative production of citric acid / lactic acid.
7. Fermentative production of alcoholic beverages: beer / wine, alcohol production measurement
8. Bioremoval of chromium from polluted water.
9. Decolorization of Azo dyes by microorganisms.
10. Phytoremediation of metals.
11. Bioleaching of Cu from sulphidic ores.
12. Bio-oxidation and determination of oxidation rate: Fe and S.

Suggestive Readings:

- Arceivala, Waste water treatment for pollution control, 2007.
- APHA for examination of water and waste waters, 1992.
- Ram Lakhan Singh, Applied Environmental Science and Engineering for a Sustainable Future.