

Gujarat University, Ahmedabad 380 009, Gujarat, India.

## M.Sc. MICROBIOLOGY SYLLABUS

From June 2011

- There shall be four theory papers each of four hours (3+1) duration and two practicals each of eight hours duration.
- Each theory paper shall carry hundred marks and each practical shall carry hundred marks.
- The candidate is required to show article to faculty in/before interpreting his/her experimental work.
- Two typed/computerised bound copies of the dissertation shall be submitted to the University during the final M.Sc. at least fifteen days before the commencement of the final examination.
- Each theory paper is divided into four units. Each unit will have equal weightage while setting question paper. Question or its sub question including the options will be set from the same unit.
- There shall be one microbiological study tour / field work during fourth or any semester of P.G. study. It will pertain to different microbiological / environmental industries / research institute / various ecosystems even outside Gujarat State. The microbiological tour is highly essential for studying microbiological process and technology.
- Assignments and group discussions / industrial training accomplished with the bound copy of report are necessary for evaluation.
- Atleast two seminars should be delivered during fourth semester.
- Practical batch will be consisting of maximum 10 students.
- Student can select any one paper from the three elective papers given in semester III.

Paper no.	Title	No. of Hours per Week				Course Credits
		Lecture	Others	Practicals	Total	
<b>Semester 1</b>						
MIC 401	Microbial Diversity and Physiology	3	1	-	4	4
MIC 402	Microbial Biochemistry and Genetics	3	1	-	4	4
MIC 403	Microbial Growth, Enzymology and Bioinstrumentation	3	1	-	4	4
MIC 404 E	Immunology and Biostatistics	3	1	-	4	4
MIC 405 PR	Lab 1	-	-	12	12	4
MIC 406 PR	Lab 2	-	-	12	12	4
<b>Total</b>		<b>12</b>	<b>4</b>	<b>24</b>	<b>40</b>	<b>24</b>
<b>Semester 2</b>						
MIC 407	Biochemical Engineering and Bioinformatics	3	1	-	4	4
MIC 408	Molecular Biology and Genetic Engineering	3	1	-	4	4
MIC 409	Bioprocess Technology	3	1	-	4	4
MIC 410 E	Microbial Technology	3	1	-	4	4
MIC 411 PR	Lab 3	-	-	12	12	4
MIC 412 PR	Lab4	-	-	12	12	4
<b>Total</b>		<b>12</b>	<b>4</b>	<b>24</b>	<b>40</b>	<b>24</b>

## **SEMESTER 1**

### **MIC 401: Microbial Diversity and Physiology**

#### **Unit 1: Principles of microbial diversity**

- Evolution of life
- Principles and concepts of microbial diversity
- Methods of studying diversity
- Conservation of microbial diversity
- Exploitation of microbial diversity

#### **Unit 2: Principles of physiology**

- Membrane structure and nutrient transport
- Signal transduction
- Mechanism of drug resistance
- Quorum sensing
- Bioluminescence
- Bacterial differentiation

#### **Unit 3: Physiological and metabolic diversity of microorganisms and their importance**

- Evolution of energy metabolism
- Evolution and diversity of photosynthetic and autotrophic bacteria
- Diversity of microbial heterotrophic metabolism
- Fungal diversity in soil ecosystem
- Physiological evolution in fungi

#### **Unit 4: Microbial diversity and physiology of extreme environment**

Habitat, diversity, physiology, survival and adaptation and biotechnological potentials of :

- Cold and thermal environment
- Saline and deep sea environment
- Osmophilic and xerophilic environment
- Alkaline and acidic environment

## **MIC 402: Microbial Biochemistry and Genetics**

### **Unit 1: Advances in metabolism and regulation**

- Glycolysis and feeder pathways
- Fate of pyruvate under anaerobic condition
- Polysaccharides and glycoconjugates
- Metabolism of fatty acids
- Concept of bioenergetics

### **Unit 2: Biosynthesis and regulation**

- Biosynthesis of C<sub>1</sub> compounds
- Biosynthesis and regulation of amino acids
- Biosynthesis and regulation of nucleotides

### **Unit 3: Bacterial genetics and plasmid biology**

- Mode of gene exchange in bacteria and their applications
- Use of gene exchange process in gene structure analysis
- Plasmid biology: types, compatibility, replication, control of copy number and segregation

### **Unit 4: Genetics of microorganisms**

- Fungal genetics: tetrad analysis and mitotic recombination of *Neurospora*
- Bacteriophage genetics: T<sub>4</sub>, T<sub>7</sub>,  $\phi$ 174, MS<sub>2</sub>,
- Viroids and prions

## **MIC 403: Microbial Growth, Enzymology and Bioinstrumentation**

### **Unit 1: Microbial growth**

- Batch and continuous culture, synchronous and diauxic growth
- Factors affecting growth
- Growth measurement
- Growth kinetics
- Control of microbial growth

### **Unit 2: Enzymology I**

- Enzyme kinetics and its analysis
- Enzyme inhibitions
- Enzyme turnover
- Protein folding and denaturation
- Immobilization of enzyme

### **Unit 3: Enzymology II**

- Enzymology of nitrogen metabolism
- Nitrogenase complex
- Factors affecting nitrogenase activity
- Clinical, analytical, industrial enzymology

### **Unit 4: Bioinstrumentation**

Principle, working and application of

- Chromatography: liquid-solid, liquid-liquid, gas-liquid
- Spectrometry: UV-Vis, atomic absorption spectrophotometer
- Electrophoresis: paper and gel
- Polarograph and voltameter

## **MIC 404 E: Immunology and Biostatistics**

### **Unit 1: Major histocompatibility complex**

- Antigen processing and presentation
- MHC: structure and function
- Cytokines
- Compliment system

### **Unit 2: Immune disorders and immunological techniques**

- Hybridoma technology of T and B cell
- Autoimmunity
- Tumour and transplantation immunology
- AIDS and other immune deficiencies
- Immunodiagnostic techniques

### **Unit 3: Principles of biostatistics**

- Principles, data representation and measures of central tendency and dispersion
- Normal, poisson and binomial distribution
- Test of significance,
- Analysis of variance

### **Unit 4: Design of statistical experiments and analysis of co-variance**

- Basic principles of experimental design
- CRD, RBD, LSD, factorial experiments and Plackett-Burman design
- Chi-square
- Analysis of covariance
- Correlation and regression
- Application of biostatistics

### **MIC 405: Practicals**

1. Microbial diversity study: colonial, morphological, metabolic and physiological
2. Isolation of extremophiles
3. Preparation of standard solutions
4. Estimation of carbohydrate, proteins and lipids
5. Estimation of DNA and RNA
6. Conjugation
7. Phage titration and one step growth curve
8. Demonstration of HPLC, IC, AAS, voltameter, fermentor, biolog, ultrasonicator, flame photometer
9. Ultraviolet spectroscopy of protein
10. Absorption spectrum of prodigiosin
11. Chromatography and Electrophoresis: protein, carbohydrate, nucleic acid, amino acid, organic acid

### **MIC 406: Practicals**

1. Effect of water activity on microbes of different environment.
2. Evaluation of bacterial growth in liquid media and factors affecting growth.
3. Enzyme kinetic study of amylase
4. Enzyme assay: protease, lipase
5. Enzyme purification: ammonium sulphate method and dialysis
6. SDS PAGE
7. Single radial immunodiffusion
8. Double diffusion method of Ouchterlony
9. Immunoelectrophoresis
10. Estimation of antigen-antibody response
11. Electrophoretic separation of bovine protein
12. Agglutination reaction
13. Statistical analysis of data, S.D., significance test of the results obtained in each experiments.
14. Hypothesis testing : T- test, F- test, Chi-square test

**Besides these practicals, other practicals of relevance shall be introduced as per the need.**

## REFERENCES

<u>No.</u>	<u>Name</u>	<u>Author</u>
1.	A guide to identifying and classifying yeast	Burnet et.al
2.	Advances in microbial physiology	Volumes
3.	Agricultural statistics-techniques and procedures	Mandal & Nambiar
4.	Analytical biochemistry	D.J. Holme & H.Peck
5.	Annual review of microbiology	Volumes
6.	Bacteria in their natural environment	Fletcher
7.	Bacterial metabolism	Gottschalk, G.
8.	Bacterial respiration and photosynthesis	C.W. Jones
9.	Bergey's manual of systematic bacteriology vol.: I-V	Krieg & Holt
10.	Biochemical methods	Pingoud A. etl.
11.	Biochemistry and molecular biology	W. H. Elliott & D. C. Elliott
12.	Biochemistry Stryer 5 <sup>th</sup> edition	W.H. Freeman
13.	Biodiversity of microbial life	Ed. J. T. Staley & A.L. Reysenbach
14.	Bioinformatics databases, tools and algorithms	O. Bosu & S. K. Thukral
15.	Biology of industrial microorganisms	A.L. Duncun
16.	Biology of the conidial fungi	Cole & Kendrick
17.	Biology of the fungi	I.K. Ross
18.	Bioseparations: principles and techniques	B. Sivasankar, PHI, New Delhi
19.	Biostatistics	Lewis A.E.
20.	Biotechniques theory & practice	S. V. S. Rana
21.	Biotechnology and genomics	P. K. Gupta, Rastogi Publication
22.	Biotechnology of filamentous fungi	Finkelstein & Ball
23.	Biotechnology volumes	H.J. Rehm & Reed
24.	Biotechnology, biosafety and biodiversity	Sivramiah Shantharam & Jane. F. Montgomery
25.	Brock's biology of the microorganisms 8 <sup>th</sup> edition	M.T.Madigan,T.M.
26.	Cell and molecular microbiology	Garald Karp
27.	Comprehensive biotechnology vol.1-4	Conney & Humphrey
28.	Diversity-current perspectives and potential application	Satyanarayan and Johri (eds) IK Int. Publ.
29.	Elements of biostatistics	S. Prasad
30.	Energetics of microbial growth	E.H. Battley
31.	Enzymes and immobilized cells in biotechnology	A. L. Laskin
32.	Enzymes, biochemistry, biotechnology, clinical chemistry	Trevor Palmer
33.	Experimental ecology	R.M. Atlas
34.	Extremophiles	Johri B.N
35.	Fundamentals of enzymology	N.C.Price & L. Sterens, 3rd edn, Oxford press.
36.	Fundamentals of the fungi	E. Moore & Lendecker
37.	Gene function	Robert Glass
38.	Gene V- VII	Benjamin Lewin
39.	General genetics	L. Snyder et. al
40.	General microbiology	Michael, M.M.John Stanier <i>et al.</i>
41.	Genetics 3 <sup>rd</sup> edition	Peter J. Russel
42.	Genetics as a tool in microbiology	Glover & Hopwood
43.	Genetics of bacteria	Scaife et.al
44.	Growth of bacterial cell	Ingraham et. al
45.	Harper's biochemistry	Murray et. al
46.	Introduction to biostatistics	R. N. Forthofer & Lee

47.	Laboratory exercise in microbiology	Harley & Prescott
48.	Microbial cell-cell interaction	Martin
49.	Microbial diversity	Colwd. D
50.	Microbial ecology	Bartha and Atlas, Pearson Edu
51.	Microbial physiology	Dawes & Southerland
52.	Molecular biology and biotechnology	Robert A., Meyers Eds.
53.	Molecular biology of gene	J.D.Watson
54.	Molecular biomethods handbook	Rapley & Walker
55.	Molecular biotechnology	Primrose
56.	Molecular cell biology	Lodish et.al
57.	Molecular genetics of bacteria	Snyder & champnes
58.	Moulds and filamentous fungi in technical microbiology	O. Fassatiova
59.	New approaches in microbial ecology	Tiwari & Saxena
60.	Practical biochemistry	Wilson & Goulding
61.	Practical biochemistry	Plummer
62.	Practical of biochemistry	Lehninger
63.	Principle of biochemistry 3 <sup>rd</sup> edition	Lehninger Nelson & Cox
64.	Principles of microbiology	RM. Atlas
65.	Prokaryotic developments ASM Press, 2000	Brun Y.V. & Shimketes
66.	Quantitative problems in biochemistry	E.A. Dewes
67.	Recent advances in biological N <sub>2</sub> fixation	Subbarao
68.	Smith's introduction to industrial mycology	Onions et. al.
69.	Sources of experiments for the teaching of microbiology	Primrose & Wardlaw
70.	Statistical methods in Biology	N. T. J. Bailey
71.	Statistics and experimental design	G. M. Clarke
72.	Superbugs	Horikoshi & Grants
73.	Text book on principles of bacteriology, virology and immunology, IX edition (5 volumes), Edward, London, 1995	Topley and Wilson's
74.	Textbook of biotechnology	H.K.Das
75.	The genetics of bacteria and their viruses	Hayes W.
76.	The microbial cell cycle	C. Edwards
77.	The prokaryotes vol. I and II	Ed. Starr & others
78.	The yeasts	Rose & Harrison
79.	Topics in enzyme & fermentation biotechnology	Volumes by Wisemen



## **SEMESTER 2**

### **MIC 407: Biochemical Engineering and Bioinformatics**

#### **Unit 1: Fermentor design and mass transfer**

- Fermentor designs: batch and continuous
- Measurement and control systems
- Mass transfer: oxygen transfer, determination of  $K_La$  and factors affecting  $K_La$ ,
- Heat transfer

#### **Unit 2: Fermentation kinetics and control**

- Kinetic models, utilization of fermentation input and growth
- Biosensors for monitoring and control
- Micro process based control systems and data analysis

#### **Unit 3: Bioinformatics**

- Sequence comparison
- Multiple sequence alignment
- Profiles, motifs and feature identification
- Phylogeny

#### **Unit 4: Applications of bioinformatics**

- Bioinformatics in genomics
- Human genome project
- Rational drug design
- Network bioinformatics

## **MIC 408: Molecular Biology and Genetic Engineering**

### **Unit 1: Concepts of molecular biology**

- Genome organization
- DNA replication, transcription and translation
- Mutation
- DNA damage and repair

### **Unit 2: Gene expression and regulation**

- Transcriptional and translational control
- Lac, arabinose and tryptophan operon circuits
- Regulation of lytic and lysogenic cycle

### **Unit 3: Fundamentals of genetic engineering**

- Enzymes involved in genetic engineering
- Extraction, purification, analysis and size fractionation of nucleic acid
- Blotting, PCR, electroporation, DNA sequencing and microarray techniques
- Synthesis of oligonucleotides and cDNA

### **Unit 4: Cloning and expression**

- Cloning and expression vectors
- Characterization of cloned gene
- Expression of cloned genes
- Metagenomics
- Gene library
- Application and safety of rDNA technology

## **MIC 409: Bioprocess Technology**

### **Unit 1: Elements of bioprocess**

- Screening for novel products
- Isolation, screening, strain improvement and maintenance of industrial cultures
- Media formulation and modification
- Mixed culture and mixed substrate

### **Unit 2: Upstream processing**

- Solids and liquid handling, sterilization of media, air and reactors
- Inoculum development
- Aeration and agitation and maintenance of optimum fermentation condition

### **Unit 3: Downstream processing**

- Characterization of products and by-products, flocculation and conditioning of broth
- Methods of cell separation, disruption, product recovery and purification
- Case studies: antibiotics, biopolymers

### **Unit 4: Scale-up of bioprocess**

- Fundamentals of fermentation scale-up
- Scale-up steps, problems and monitoring mechanisms
- Scale-up of sterilization
- Scale-up of aeration and agitation
- Scale-up of inoculum

## **MIC 410 E: Microbial Technology**

### **Unit 1: Microbial production of organic acids, solvents and beverages**

- Organic acids: citric acid, acetic acid
- Solvents: ethanol, acetone-butanol
- Beverages: beer, wine

### **Unit 2: Microbial production of therapeutic agents**

- Streptomycin, cephalosporin
- Anticancer agents
- Vaccines and siderophores
- rDNA and nanobiotechnology

### **Unit 3: Microbial production of enzymes, vitamins and amino acids**

- Enzymes: protease, amylase, lipase
- Vitamins: B<sub>2</sub>, B<sub>12</sub>
- Amino acids: lysine, glutamic acid, tryptophan

### **Unit 4: Other microbial products**

- Biopolymers and EPS
- Bioplastics
- Biosurfactants
- Steroid transformation
- Ergot alkaloids

### **MIC 411: Practicals**

1. Bioinformatics: data base exploration, BLAST, multiple sequence alignment, primer design, phylogenetic tree construction
2. Isolation, quantification and amplification of DNA, RNA and plasmids from bacteria
3. RE digestion of plasmid and mapping
4. Transformation and cloning
5. DNA fingerprinting
6. Blotting experiment
7. Gene expression
8. Isolation of antibiotic resistance mutants and pigment variant mutants
9. Characterisation of mutants with altered pigmentation
10. Induction of mutant by radiation and chemicals
11. Selection for enrichment of auxotrophs by antibiotics
12. Oxygen transfer rate (OTR)
13. Determination of del factor

### **MIC 412: Practicals**

1. Strain improvement study
2. Study of rheological changes of broth due to fungal growth
3. Recovery and purification of fermentation products-enzymes, antibiotics, organic acids, alcohol, exopolysaccharide
4. Influence of medium composition
5. Immobilisation of cells and enzymes
6. Scale up from flask to lab fermentor
7. Solid state fermentation
8. Submerged fermentation

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## REFERENCES

<b>No.</b>	<b>Name</b>	<b>Author</b>
1.	Genetic engineering	Rastogi & Pathak, Oxford
2.	Biotechnology and genomics	P. K. Gupta, Rastogi Publication
3.	The elements of immunology	F. H. Khan, Pearson Edu.
4.	Elements of molecular biology	J.K. Pal & S.S. Ghaskadbi, Oxford Pr.
5.	Biotechnology	U. Satyanarayana
6.	Molecular biology and genetic engineering	P. K. Gupta
7.	Immunology and immunotechnology	A. K. Chakravarty
8.	Immunology	I. R. Tizard
9.	Kuby Immunology	R.A. Goldsby, T.J. Kindt, B.A. Osborne
10.	Preservation and Sterilisation Methods in Microbiology	Norris & Ribbons
11.	Annual review of Microbiology	Volumes
12.	Principles of Microbiology	RM. Atlas
13.	Molecular biology of gene	J.D.Watson
14.	Genetics as a tool in Microbiology	Glover & Hopwood
15.	Genetics of Bacteria	Scaife et.al
16.	Molecular Genetics of Bacteria	Snyder & champnes
17.	Laboratory exercise in Microbiology	Harley & Prescott
18.	Molecular Biotechnology	Primrose
19.	Gene cloning and manipulation	Christopher Howe
20.	Essentials of Immunology, ELBS, 1998	Roitt, I. M.
21.	Immunology II, 1994	Kuby, J
22.	Immunology – understanding of immune system	Wiley-Liss Klaus 1996 D. Elgert
23.	Text book on principles of bacteriology, virology and immunology, IX edition (5 volumes),	Topley and Wilson's, Edward, London, 1995
24.	Molecular Biology and Biotechnology	Robert A., Meyers Eds.
25.	Textbook of Biotechnology	H.K.Das
26.	Principle of Gene Manipulation, An Introduction to Genetic Engineering	R. W. Old & S.B. Primrose
27.	Essential of Molecular Biology	George M. Malacinski
28.	Recombinant DNA Principles and Methodology	James J Greene & Venigalla B. Rao
29.	Molecular Bio methods Handbook	Rapley & Walker
30.	Cell and Molecular Microbiology	Garald Karp
31.	Biotechnology An Introduction	Susan R. Barnum
32.	Topics in Enzyme & Fermentation Biotechnology	Volumes by Wisemen
33.	Biology of Industrial Microorganisms	A.L. Duncun
34.	Bioprocess Engineering	P.K. Ghosh
35.	Biotechnology	U. Satayanarayan
36.	Biotechnology secondary metabolites	K. G. Ramawat and J. M. Merillon
37.	Biotechnology Volumes	H.J. Rehm & Reed
38.	Comprehensive Biotechnology Volumes	Conney & Humphrey
39.	Fermentation Microbiology and Biotechnology	EL-Mansi & C.F.A.Bryce eds
40.	Genetic Engineering	S. Mitra
41.	Manual of Industrial Microbiology and Biotechnology	Demain & Davies, 2 <sup>nd</sup> ed.
42.	Microbial Biotechnology	A. N. Glazer and H. Nikaido
43.	Molecular Industrial Mycology	Leong & Berka
44.	Principles of Fermentation Technology	Stanbury, Whittaker & Hall
45.	Process Biotechnology Fundamentals	S. N. Mukhopadhyay
46.	Recombinant DNA Methodology II	Ray Wu
47.	Sources of experiments for the teaching of microbiology	Primrose & Wardlaw

6.	Elements of molecular biology	J.K. Pal & S.S. Ghaskadbi, Oxford Press
11.	Molecular biology and genetic engineering	P. K. Gupta
55.	How computer works	Rem White
56.	How the internet works	Priston Grall & Techmich
60.	Bioinformatics 2000	Higgins & Taylor
62.	Bioinformatics, 1998	Baxevanis
83.	N <sub>2</sub> Fixation	Muller & Newton

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## M.Sc. MICROBIOLOGY SYLLABUS

From June 2011

Paper no.	Title	No. of Hours per Week				Course Credits
		Lecture	Others	Practicals	Total	
<b>Semester 3</b>						
MIC 501	Microbiology of Food, Agriculture and Fuel	3	1	-	4	4
MIC 502	Environmental Microbiology	3	1	-	4	4
MIC 503	Biogeotechnology and Waste Management	3	1	-	4	4
MIC 504 E1	Fermentation Economics and Regulatory Affairs	3	1	-	4	4
MIC 504 E2	Recombinant DNA Technology					
MIC 504 E3	Biopharmaceuticals and Drug Development					
MIC 505 PR	Lab 5	-	-	12	12	4
MIC 506 PR	Lab 6	-	-	12	12	4
<b>Total</b>		<b>12</b>	<b>4</b>	<b>24</b>	<b>40</b>	<b>24</b>
<b>Semester 4</b>						
MIC 507 PT	Project			-	16	16
MIC 508 S	Seminar / Field Work / Study Tour			6	6	4
MIC 509 M	Assignments, Group Discussion / Industrial Training			6	6	4
<b>Total</b>		<b>0</b>	<b>0</b>	<b>12</b>	<b>28</b>	<b>24</b>



## **SEMESTER 3**

### **MIC 501: Microbiology of Food, Agriculture and Fuel**

#### **Unit 1: Food and dairy microbiology**

- Microbial production of SCP and mushroom
- Microbial production of SCO
- Microbial production of flavours and fragrances
- Probiotics and nutraceuticals
- Fermented dairy products and Fermented foods

#### **Unit 2: Microbes in agriculture**

- Biofertilizer, mycorrhizae
- Vermicomposting
- Biopesticides and bioinsecticides
- Integrated pest management

#### **Unit 3: Agriculture technology**

- Organic matter decomposition
- Microbial plant hormones
- Tissue culture technology and commercial application
- Transgenic crops and plants

#### **Unit 4: Scientific aspects of bioprocess for biofuel production**

- Bioethanol
- Biogas
- Biodiesel
- Biohydrogen
- Algae as biofuel

## **MIC 502: Environmental Microbiology**

### **Unit 1: Environmental problems and monitoring**

- Global environmental problems: global warming, acid rain, ozone depletion
- Environmental monitoring: environmental impacts and their assessments using bio-indicators, biomarkers, biosensors and toxicity testing, rDNA technology
- Conservation strategies

### **Unit 2: Bioremediation**

- Bioremediation principles
- Strategies and techniques of bioremediation: *in situ* and *ex situ*
- Bioremediation of metals
- Phytoremediation
- GMOs and their impact on bioremediations

### **Unit 3: Biodegradation**

- Principles of biodegradation and mechanism of detoxification
- Biodegradation of detergent, pesticide, oil, surfactant, lignin, hydrocarbon and dyes

### **Unit 4: Biodeterioration**

- Principles and mechanisms of biodeterioration
- Methodology to assess biodeterioration
- Prevention and control of biodeterioration
- Biodeterioration of selected materials

## **MIC 503: Biogeotechnology and Waste Management**

### **Unit 1: Geomicrobiological processes**

- Types of microbial activities influencing geological processes
- Molecular and non-molecular methods for studying geomicrobial process
- Microbial indicators of marine pollution
- Biogeotechnology of ocean nodules and MEOR

### **Unit 2: Microbiology of minerals**

- Mechanisms of biogeohydrotechnology of sulphidic minerals
- Methods of biogeohydrotechnology
- Biobeneficiation
- Acid mine drainage formation and control

### **Unit 3: Waste treatment - I**

- Classification and characterization of waste
- Principles and mechanisms of waste treatment
- Stoichiometry for waste treatment processes
- Kinetics for waste treatment processes

### **Unit 4: Waste treatment - II**

- Biological methods of liquid waste treatment
- Biological methods for solid waste management
- Economics and special aspects of waste treatment
- Environmental laws and policies in India

## **MIC 504 E1: Fermentation Economics and Regulatory Affairs**

### **Unit 1: Fermentation economics**

- Expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration, agitation etc
- Cost of plant and equipments, batch process cyclic time, continuous culture, recovery and effluent treatments
- Cost recovery due to waste usages and recycling

### **Unit 2: IPR**

- History and introduction
- Protection of IPR
- Patent process
- Benefits, problems and management of IPR
- International harmonization of patent law
- Patents of fermentation industry and their protection
- Indian scenario

### **Unit 3: Regulatory affairs**

- Introduction to pharmacopoeia, good microbiological techniques and good laboratory practice (GLP)
- Basic principles of quality control (QA) and quality assurance (QC)
- Guidelines for QA and QC: raw materials, sterilization, media, stock cultures and products
- Validation study
- LAL test, sterility testing and bioassay
- Role of culture collection centre, public health laboratories and regulatory agencies

### **Unit 4: Biosafety and bioethics**

- Biosafety guidelines
- Risk and risk assessment
- Biosafety levels, laboratory biosecurity concepts
- Pre-clinical and clinical trials
- Basics of bioethics principles, international codes and guidelines in India
- Ethics in post-genomic era

## **MIC 504 E2: Recombinant DNA Technology**

### **Unit 1**

- Core techniques and essential enzymes used in rDNA. Restriction digestion, ligation and transformation.

### **Unit II**

- Cloning vectors-plasmids, phages and cosmids. Cloning strategies. Cloning and selection individual genes, gene libraries: cDNA and genomic libraries.

### **Unit III**

- Specialised cloning stratifies. Expression vectors, Promoter probe vector's, vectors for library construction-artificial chromosomes.

### **Unit IV**

- PCR methods and application.
- DNA sequencing methods; dideoxy and chemical method.
- Sequence assembly. Automated sequencing. Genome sequencing and physical mapping of genes

## **MIC 504 E3: Biopharmaceuticals and Drug Development**

### **Unit 1**

- Introduction to pharmaceuticals of animal, plant and microbial origin
- Hemotopoietic growth factors and coagulation factors
- Interferons and cytokines for anti-infective and cancer therapy
- Insulin and growth hormones
- Vaccine: genetically improved vaccines, synthetic peptide based vaccines, nucleic acid vaccines

### **Unit II**

- Recombinant thrombolytic agents: tissue type plasminogen activator, first and second generation of thrombolytic agents
- Concept and approaches for gene therapy, ex vivo and in vivo gene therapy
- Potential target diseases for gene therapy (inherited disorders and cancer)
- Antigene and antisense therapy

### **Unit III**

- Xenotransplantation in pharmaceutical biotechnology
- The role of biotechnology in forensic sciences
- Estimation of toxicity: LD50 and ED50
- Pre-clinical and clinical trails

### **Unit IV**

- Introduction to pharmacopoeia, guide to good manufacturing practice
- Manufacturing facility
- Final product fills and analysis
- Validation study
- Introduction to drug designing
- Search of database

## **MIC 505: Practicals**

1. Microbial precipitation of metals
2. Biotransformation of metals
3. Phytoaccumulation of metals
4. Bioremediation of organic and inorganic pollutants
5. Physical characterisation of waste
6. Chemical characterisation of waste
7. Biological characterization: BOD
8. Biotreatment of domestic water
9. Analysis of drinking water by MTT and MFT
10. Biodegradation of hydrocarbon
11. Development of SCP
12. SCO production by yeast
13. Estimation of phosphatase and dehydrogenase activity of soil
14. Isolation and evaluation of probiotic culture
15. Production of Indian fermented foods
16. Production of bread and yoghurt

## **MIC 506: Practicals**

1. Biooxidation of ferrous
2. Biooxidation of sulphur in soil
3. Bioleaching study
4. Desulphurisation of fuel
5. Validation of instruments and lab material
6. Quality assurance
7. Development of economic media
8. Biocatalyst from marine microbes
9. Bioassay
10. Sterility testing
11. Microbial load determination
12. Biodeterioration of material
13. Microbial production of biogas
14. Development of biofertilizer and biopesticides

**Besides these practical, other practical of relevance shall be introduced as per the need.**

## REFERENCES

<b>No.</b>	<b>Name</b>	<b>Author</b>
1.	Geomicrobiology	Ehrlich & Newman, CRC Press
2.	Environmental engineering and management	S. K. Dhameja, Publ: Kataria & Sons
3.	Microbial ecology	Bartha and Atlas, Pearson Edu
4.	A text book of environmental chemistry and pollution control	S. S. Dara
5.	Biotechnology	U. Satyanarayana
6.	General Microbiology	Michael, M.M.John Stanier <i>et al.</i>
7.	Experimental ecology	R.M. Atlas
8.	Principles and Practice of Disinfection	Russel et.al
9.	Preservation and Sterilisation Methods in Microbiology	Norris & Ribbons
10.	Annual review of Microbiology	Volumes
11.	Scientific American	Volumes
12.	Principles of Microbiology	RM. Atlas
13.	Laboratory exercise in Microbiology	Harley & Prescott
14.	Agricultural Statistics-Techniques and Procedures	Mandal & Nambiar
15.	Basic Biotechnology	Colin Ratledge and Bjor
16.	Biochemical Methods	Pingoud A. etl.
17.	Textbook of Biotechnology	H.K.Das
18.	Methods in Biotechnology	Hans-peter-schmauder
19.	Biotechnology An Introduction	Susan R. Barnum
20.	Practical biochemistry	Plummer
21.	Topics in Enzyme & Fermentation Biotechnology	Volumes by Wisemen
22.	Assessing Ecological Risks of Biotechnology	Lev R. Ginzburg
23.	Basic biotechnology	C. Ratledge & B. Kristiansen (eds)
24.	Biology of Industrial Microorganisms	A.L. Duncun
25.	Bioprocess Engineering	P.K. Ghosh
26.	Biotechnology, Biosafety and Biodiversity	Sivramiah Shantharam & J.F. Montgomery
27.	Biotechnology secondary metabolites	K. G. Ramawat and J. M. Merillon
28.	Biotechnology Volumes	H.J. Rehm & Reed
29.	Comprehensive Biotechnology Volumes	Conney & Humphrey
30.	Environmental Biotechnology	B.C. Bhattacharyya and R. Banerjee
31.	Environmental biotechnology	G. M. Evans and J. C. Furlong
32.	Environmental biotechnology	A. Scragg, Oxford
33.	Environmental Microbiology – A Laboratory Manual	Pepper et. al
34.	Environmental Science	S. C. Santra, Central, India
35.	Fermentation Microbiology and Biotechnology	EL-Mansi & C.F.A.Bryce eds
36.	Genetic control of environmental pollutants	Gilbert & Alexander
37.	Handbook of water and waste water treatment technology	Paul
38.	How computer works	Rem white
39.	Introduction to environmental Microbiology	Michael R.
40.	Manual of Environmental Microbiology, 2 <sup>nd</sup> ed.	C. J. Hurst <i>et al</i> (eds)
41.	Manual of Industrial Microbiology and Biotechnology,	Demain & Davies, 2 <sup>nd</sup> ed.
42.	Microbial Biotechnology	A. N. Glazer and H. Nikaido
43.	Microbial Mineral Recovery	Ehrlich & Bierley
44.	Microbiological Quality Assurance	Brown & Gilbert
45.	Principles of Fermentation Technology	Stanbury, Whittaker & Hall
46.	Process Biotechnology Fundamentals	S. N. Mukhopadhyay



47.	Sources of experiments for the teaching of microbiology	Primrose & Wardlaw
48.	Waste Water Treatment	Arceivala

## **SEMESTER 4**

### **MIC 507 PT : Project / Dissertation Work Theory**

- The candidate is required to show article to faculty in/before interpreting his/her experimental work.
- Two typed/computerised bound copies of the dissertation shall be submitted to the University during the final M.Sc. at least fifteen days before the commencement of the final examination.

### **MIC 508 S : Seminar / Field Work / Study Tour**

- Atleast two seminars should be delivered during fourth semester.
- There shall be one microbiological study tour / field work during fourth or any semester of P.G. study. It will pertain to different microbiological / environmental industries / research institute / various ecosystems even outside Gujarat State. The microbiological tour is highly essential for studying microbiological process and technology.

### **MIC 509 M : Assignments, Group Discussion / Industrial Training**

- Assignments and group discussions / industrial training accomplished with the bound copy of report are necessary for evaluation.