Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA
(Autonomous)

Lead College
of
Karmaveer Bhaurao Patil University,Satara.

Syllabus For

Master of

Science Part - II

INDUSTRIAL MICROBIOLOGY

Syllabus to be Implemented w.e.f June,2024

As per NEP 2020

Preamble:

This syllabus is framed to give advanced knowledge of Industrial Microbiology to postgraduate students at second year of two years of M.Sc. degree course.

The goal of the syllabus is to make the study of Industrial Microbiology popular, interesting and encouraging to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students

M.Sc. Part II

Credit Framework for M.Sc. II

Structure of Course: M.Sc. – II Semester – III

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	III	MIMiT 531	Molecular Biotechnology	4	4
		MIMiT 532	Fermentation Technology I	4	4
		MIMiT 533	Pharmaceutical Microbiology	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MIMiT 534 E-I MIMiT 534 E-II	E-I)Scientific Writing E-II) Medical Microbiology	2	2
		MIMiT 535	Research Project	12	6
		MIMiT 536	LAB- III (based on MIMiT-531, 532 and 533)	4	2
Total					**22**

Structure of Course: M.Sc. – II Semester –IV

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	IV	MIMiT 541	Microbial Technology	4	4
		MIMiT 542	Food And Dairy Microbiology	4	4
		MIMiT 543	Microbiological Quality Control And Assurance	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MIMiT 544 E-I MIMiT 544 E-II	E-I) Fermentation Technology-Ii E-Ii) Waste Management System	4	4
		MIMiT 545	On Job Training (OJT)	8	4
		MIMiT 546	LAB- IV (based on MIMiT-541, 542 and 543)	4	2
Total					**22**

SEMESTER III

MIMiT 531: MOLECULAR BIOTECHNOLOGY

Course Objectives:

The student should be able to :-

1.learn the mechanisms of action of nucleic acids as therapeutic agents.

2.Understand the principles of genetic engineering and recombinant DNA technology in producing commercial products.

3.Develop strategies for implementing bioremediation techniques in polluted environments and biomass utilization for energy production.

4.aware of the various modes of action employed by microbial insecticides against insect pests.

CREDIT=4	**MOLECULAR BIOTECHNOLOGY**	**No. of hours=60**
Unit I	**Nucleic Acids as Therapeutic Agents**	15
	1.1 Antisense RNA -Antisense Oligonucleotides **1.2 Ribozymes** -Deoxyribozymes 1.3 Chimeric RNA–DNA Molecules 1.4 Aptamers **1.5 Interfering RNAs** -Principles, Applications **1.6 Antibody Genes** **1.7 Nucleic Acid Delivery** -Human Gene Therapy,Targeting Systems	
Unit II	**Synthesis of Commercial Products by Recombinant Microorganisms**	15
	2.1 Restriction Endonucleases **2.2 Small Biological Molecules** -Synthesis of l-Ascorbic Acid, Microbial Synthesis of Indigo, Synthesis of Amino Acids, Microbial Synthesis of Lycopene **2.3 Antibiotics-**Cloning Antibiotic Biosynthesis Genes, Modulating Gene Expression in Streptomycetes, Synthesis of Novel Antibiotics, Engineering Polyketide Antibiotics **2.4 Biopolymers -**Xanthan Gum,Melanin ,Adhesive Protein, Rubber, Polyhydroxyalkanoates, Hyaluronic Acid	

Unit III	**Bioremediation and Biomass Utilization**	15
	3.1 Microbial Degradation of Xenobiotics 3.2 Genetic Engineering of Biodegradative Pathways - Manipulation by Transfer of Plasmids, Manipulation by Gene Alteration**.** 3.3 Utilization of Starch and Sugars 3.4 Commercial Production of Fructose and Alcohol,Altering Alcohol Production, Improving Fructose Production, Silage Fermentation, Isopropanol Production, Engineering Yeast Transcription. 3.5 Utilization of Cellulose 3.6 Lignocellulosics,Components of Lignocellulose, Isolation of Prokaryotic Cellulase Genes,Isolation of Eukaryotic Cellulase Genes, Manipulation of Cellulase Genes	
Unit IV	**Microbial Insecticides**	15
	4.1 Insecticidal Toxin of B. thuringiensis - Mode of Action and Use, Toxin Gene Isolation. 4.2 Engineering of B. thuringiensis Toxin Genes - Synthesis during Vegetative Growth, Broadening the Spectrum of Target Insects, Improving Delivery of a Mosquitocidal Toxin, Protecting Plant Roots, Protoxin Processing, Preventing the Development of Resistance, Improved Biocontrol . 4.3 Baculoviruses as Biocontrol Agents- Mode of Action, Genetic Engineering for Improved Biocontrol.	

Course Outcomes:

Student will be able to :-

1. Apply their knowledge to design therapeutic strategies using nucleic acids for various medical conditions.
2. Design a protocol for synthesizing a specific commercial product using recombinant microorganisms.
3. Implement their knowledge to propose practical approaches for remediation of polluted sites and efficient utilization of biomass resources.
4. Apply their knowledge to produce and apply microbial insecticides effectively in agricultural systems.

References:-

1. Glick B.R., Pasternack J.J.,Molecular Biotechnology-Principles and Applications of Recombinant DNA , ASM press, 2010.
2. J. F Borgio., K. Sahayaraj, and I. A. Susurluk. 'Microbial Insecticides: Principles and Applications' 2011.
3. B.R. Glick, C.L.Patten, 'Molecular Biotechnology: Principles and Applications of Recombinant DNA', 6th Edition ,Nova Science Publishers.

MIMiT 532: FERMENTATION TECHNOLOGY I

Course Objectives:

Student should be able to :-

1. Understand the principles and processes involved in the industrial production of Single Cell Protein (SCP) and microbial insecticides
2. Identify key parameters and variables that influence the outcome of fermentation processes
3. Learn the industrial processes involved in the production of polysaccharides, bacterial vaccines, and antisera
4. Study the principles and techniques involved in the industrial production of distilled beverages, nucleotides, and steroids

CREDIT =4	**FERMENTATION TECHNOLOGY I**	**No. of hours per =60**
Unit I	**Industrial production of SCP and Microbial insecticides**	**15**
	1.1 Production of single cell protein (SCP) - Microorganisms and substrates used, techniques of production, nutritional value of SCP, economics of production, merits and demerits 1.2 Microbial insecticides- Candidates for development into microbial insecticides, production of insecticides, evaluating potential hazards to man and environment, effectiveness, safety, economics, advantages and disadvantages	
Unit II	**Typical Fermentation processes**	**15**
	2.1Typical Fermentation processes – industrial production of: 2.2 Lactic starter culture for food fermentations 2.3 Bacitracin 2.4 Streptomycin 2.5 β-carotene pigments 2.6 Typical Fermentation processes – industrial production of: 2.7 Riboflavin 2.8 Gluconic acid 2.9 Gibberellin 2.10 Itaconic acid	
Unit III	**Industrial production of polysaccharides, bacterial vaccines and antisera**	15
	3.1. Production and applications of microbial polysaccharides- Xanthan gum and Dextran.	

	3.2 Production of mushrooms – Production steps, harvesting and preservation and nutritive value 3.3 Production of bacterial vaccines and antisera	
Unit IV	**Industrial production of distilled beverages, nucleotides and steroids**	**15**
	4.1 Industrial production of distilled alcoholic beverages – Whisky and Brandy 4.2 Microbial production of nucleosides and nucleotides 4.3 Introduction 4.4 Classification of methods for production of 5' IMP and 5'GMP 4.5 Production of 5'IMP and 5'GMP by fermentation. 4.6 Microbial transformations of antibiotics and steroids	

Course Outcomes:

Students will be able to:

1. Apply bioprocessing techniques effectively to enhance the yield and quality of SCP and microbial insecticides in an industrial setting
2. Describe the fermentation processes to design and optimize production strategies for specific bioproducts
3. Evaluate bioprocess engineering principles to design and optimize production protocols for polysaccharides, bacterial vaccines, and antisera
4. Explain industrial production methods effectively to achieve desired yields, purity, and quality of distilled beverages, nucleotides, and steroids

References :

1. Schwartz, W. "LE Casida jr., Industrial Microbiology. XI und 460 S., 193 Abb., 7 Tab. Boffins Lane-Chichester-Sussex 1968: John Wiley and Sons Inc. 130 s." 1969

2. Peppler, Henry J., and David Perlman, eds. *Microbial technology: Fermentation technology*. Academic press, 2014.

3. G.Reed, Prescott and Dunn's Industrial Microbiology, 4th edition 1982.

4. Arora, J. K., S. S. Marwaha, and A. Bakshi. "Biotechnological advancement in food processing." *Food Processing: Biotechnological Applications* (2000): 1-24.

5. Stanbury, Peter F. "Fermentation technology." *Extraction* 2 (2000): 1-1.

6.Umbreit, Wayne W. *Advances in applied microbiology*. Vol. 2. Academic Press, 1960.

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MIMiT 533 : PHARMACEUTICAL MICROBIOLOGY

Course Objectives:

The student should be able to :-

1. Understand the recent research on drug discovery and development.
2. know the tools and techniques used in antimicrobial testing.
3. Learn about peptide and protein drug design
4. Study microbial spoilage of pharmaceutical products

CREDIT= 4	**PHARMACEUTICAL MICROBIOLOGY**	**No. of hours=60**
Unit I	**Drug Discovery and Development**	15
	1.1 Introduction 1.2 Contributions and postulates of Paul Ehrlich 1.3 Significance of terms - lead optimization, candidate selection 1.4 Drug Discovery and Design 1.5 Conventional Process of bioprospecting (medicinal chemistry) 1.6 Extraction and purification principles, 1.7 Purification and characterization of bioactive molecules from natural sources 1.8 Rational Drug Design – Principle (Structure Activity Relationship- SAR) and Tools (applications of High Throughput Screening, Combinatorial Synthesis, Pharmacogenomics) 1.9 Drug Development 2.0Preclinical Development – Toxicity Testing: Acute, Sub-acute and Chronic. 2.1 Clinical Development 2.2 Clinical Trials: Aims, Objectives, Conduct, Phases of Clinical Trials – I,II,III, IV.	
Unit II	**Peptide and protein drug design**	15
	2.1 Introduction and Historical Perspective 2.2 Aspects of Peptide and Protein Drug Design 2.3 Peptide and Protein Protraction 2.4 Polymer Extension PEGylation Polypeptide Modification Carbohydrate-Based Polymer Modification 2.5 Albumin as Protractor Reversible Binding by Fatty Acid Acylation Reversible Binding by Other Moieties Fusion Proteins and Conjugates	

Unit III	**Antimicrobial Testing Systems**	15
	3.1 Introduction: Antimicrobial agents, broad types, therapeutic ratio, MIC and MBC. 3.2 Antimicrobial Susceptibility Testing Use of liquid and solid media. Factors affecting susceptibility testing, guidelines issued by CLSI. Diffusion methods – Agar Dilution Technique Gradient Plate Technique E-test Kirby Bauer Method Stokes Method 3.3 Susceptibility Testing for – Anti-mycobacterial agents. Anti-fungal agents. Anti-protozoan agents. Anti-viral agents.	
Unit IV	**Microbial spoilage of pharmaceutical product, infection risk, contamination control**	15
	4.1 Spoilage- chemical and physicochemical deterioration of pharmaceuticals observable effects of microbial attack on pharmaceutical products 4.2 Pharmaceutical ingredients susceptible to microbial attack Therapeutic agents Surface active agents Non - ionic surfactants Organic polymers Humectants Fats and oils Sweetening, flavoring and colouring agents. Preservatives and disinfectants. 4.3 Factors affecting microbial spoilage of pharmaceutical products Types and size of contaminant inoculum Nutritional factors Moisture content: water activity (Aw) Redox potential storage temperature	

Course Outcomes:

Student will be able to: -

1. Imbibe the basic concepts of drug development.
2. Perform antimicrobial testing.
3. Evlaute peptide and protein drug design
4. Apply pharmaceutical ingredients susceptible to microbial attack.

References:-

1. K. Park , Park's Textbook of Preventive and Social Medicines by K. PARK - 27 edition, Generic publisher, 2023

2. K, Konrad J., R. Daneshjou, and R. B. Altman. "Chapter 7: pharmacogenomics." *PLoS computational biology* 8, no. 12 (2012): e1002817.

3. Franklin, Trevor John, and George Alan Snow. *Biochemistry of antimicrobial action*. Springer, 2013.

4. Chopra, I. "Molecular mechanisms involved in the transport of antibiotics into bacteria." *Parasitology* 96, no. S1 (1988): S25-S44.

5. Goldstein A., Aronow L. and Kalman S.M. Principles of Drug Action, The Basis of Pharmacology, Harper International Edition, New York, (1969)

MIMiT 534: E 1: SCIENTIFIC WRITING

Course Objectives:

The student should be able to :-

1. Develop advanced proficiency in writing scientific papers and reports.

2. Gain knowledge of data collection and be able to use various tools for scientific writing.
3. Learn familiarity with the publication process and ethical considerations in scientific writing.
4. Enhance skills in using appropriate citation and referencing formats.

CREDIT=2	**SCIENTIFIC WRITING**	**No. of hours =60**
Unit I	**Data Collection & Processing and Tools & Techniques for research**	**15**
	1.1Data Collection and Data Processing: Collection of primary data: Observation Method, Interview Method, through questionnaires, through schedules, difference between questionnaire and schedule Collection of secondary data, Selection of appropriate methods for data collection, Case study method Data processing, processing operations: editing, coding, classification, tabulation, graphical representation, types of analysis, Statistics in research, Dispersion and Asymmetry, Measures of Relationship 1.2 Methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	
Unit II	**Scientific writing and Research ethics**	**15**
	2.1 Introduction to Scientific Writing Overview of the course Principles of scientific writing 2.2 Writing of Review of literature Materials and methods Results Discussion 2.3 Abstract, summary, synopsis Preparation of tables, figures 2.4 Citing and listing references 2.5 Preparing Manuscript for publication Case study report Oral presentation Poster presentation Review paper	

	2.6 Research ethics	

Course Objectives:

student will be able to

1. Understand the principles of scientific writing.
2. Able to use tools and techniques for scientific writing.
3. Apply the ethical principles of scientific writing.
4. Imbibe effective scientific citation techniques.

References:

1. Kothari, C. R. *Research Methodology*. New Age International, 2004.
2. Gurumani, N. *Scientific Thesis Writing and Paper Presentation*. MJP Publisher, 2019.

MIMiT 534 : E2: MEDICAL MICROBIOLOGY

Course Objectives:

The student should be able to -

1. Understand details of emerging microbial diseases
2. Learn the techniques used for laboratory diagnosis of respiratory diseases

3. Study the techniques used for laboratory diagnosis of urinary tract infections
4. Discuss advance trends in diagnostic methods

CREDIT=4	MEDICAL MICROBIOLOGY	No. of hours =60
Unit I	**Emerging microbial diseases in India**	15
	1.1Antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention, control and treatment of diseases caused by- 1.2 Treponema pallidum 1.3 Neisseria gonorrhoeae 1.4 Ebolavirus, 1.5 New Corona 19 virus 1.6 Nipah virus 1.7 Avian influenza (H7N9)	
Unit II	**Clinical Microbiology**	**15**
	2.1 Samples of choice, Collection, transportation and processing of samples for laboratory diagnosis of the following complications: 2.2 Urinary tract infections, Septicemia and bacteremia, Upper Respiratory tract infections, Lower 2.3 Respiratory tract infections, Wound, skin, and deep sepsis, Enteric fever, Pyrexia of unknown origin, 2.4 Genital Tract infections, Meningitis, Gastro intestinal infections, Tuberculosis (Pulmonary and Extrapulmonary) 2.5Trends in clinical microbiology diagnostic methods: MALDI-TOF-MS, Next generation sequencing, Automated PCR	

Course Outcomes:

The student will be able to -

1. Explain detail antigenic property, mode of transmission and other properties of emerging microbial diseases
2. Discuss the techniques used for laboratory diagnosis of respiratory diseases
3. Apply the techniques used for laboratory diagnosis of urinary tract infections

4. Perform advance trends in diagnostic methods

References:-

1. Davis B. D, Delbacco, J.B. Lippincott Co, Microbiology . NY, 4th edition,1990.
2. Ananthanarayan R. and C.E. Jayaram Paniker,Textbook of Microbiology, Orient Longman publication, 5th edition, 1996.
3. Dey N.C. & Dey T.K.,Medical Bacteriology : Allied Agency, Calcutta,17th edition, 1988.
4. N.C. Dey & T.K. Dey& D. Sinha,Medical Bacteriology including Medical Mycology & AIDS : New Central Book Agency (Delhi), 2013.
5. A. M. Emmerson,Principles and Practice of Clinical Bacteriology ,Wiley - Blackwell Publication, 1997.
6. Dr. Kanal L. Mukherjee and Anuradha Chakravarty,Textbook of Medical Laboratory Technology Vol III :, McGraw Hill Education, 3rd edition, 2013.

MIMiP 535: Research Project (6 Credits)

Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 6 credit Research Project for semester III under the guidance of faculty members. Research project should be subject specific.

Practical Course I: LAB III: MIMiP 536

Course Objectives:

Students will be able to

1.Develop advanced proficiency in writing scientific of research papers and reports and use of reference tools

2.Understand the pharmaceutical analysis and testing.

3. Apply knowledge of microbiological techniques to isolate and characterize beneficial microorganisms for production of industrial important products.

4. Discuss basic principles of microbial growth and metabolism in food and dairy products.

Practicals:

1.Production of mushrooms
2. Production of SPC from Spirulina/ yeast
3. Production of xanthan Gum from Xanthomonas sp.
4.Screening of antibiotic producers – Crowded plate technique and scale up.
5. Isolation of cellulase ;producing organisms.
6. production of biocontrol agents using plants extract.
7.Isolation of Lactic acid bacteria from fermented food.
8.Estimation of lactic acid content.
9. Screening of organic acid producers and amine producers
3. Screening of amylase producers and protease producers
4. Screening of vitamin producers
5. Enrichment and isolation of sulfate reducing bacteria
6. Enrichment and isolation of pesticide resistant bacteria.
7. Enrichment and isolation of phosphate solubilising microorganisms
8. Determination of Epidemiological Ratios:
9. Human Development Index, b) Mortality Ratio, c) Morbidity Ratio
10. Extraction of bioactive ingredients from plant and its activity fraction.
11. Determination of Minimum Inhibitory Concentration (MIC) of drug.
12. Estimation of antimicrobial activity using CLSI.
13.Determination of phenol coefficient.
14. Study of antimicrobial activity of spices.
15.Determination of microbial load of non-sterile products –ointments,capsules.
16. Determination of drug sensitivity of *Streptococcus mutans.*
17. Writing of manuscript.
18. Review paper Writing
19. Demonstration of use of Reference Management Software like Zotero/Mendeley.
20. Designing of graphical abstract.

Course Outcome:

Students will able to

1.Apply tools and techniques for writing scientific research papers and reports.

2.Evaluate the pharmaceutical analysis and testing in industries.

3.Design and conduct experiments to isolate, identify, and evaluate the effectiveness of microorganisms in industrially important products.

4.Imbibe microbiological experiments to develop food and dairy related products.

References:

1. J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Publishers, 2011
2. D. T. Plummer, An Introduction to Practical Biochemistry by TMH Publishers,2017
3. M. D. Trevan,Immobilised Enzymes ,Wiley–Blackwell, 1980
4. N. O. Kaplan, Advances in Enzymology, Academic Press,1960

SEMESTER IV

MIMiT 541 : MICROBIAL TECHNOLOGY

Course Objectives:

The student should be able to :-

1.Apply theoretical knowledge to select and design appropriate bioreactors for specific fermentation processes

2.Understand the environmental and genetic factors influencing metabolic pathways in fermentation processes

3.Discuss the composition and optimization of fermentation media for microbial growth and product formation

4.Learn the principles and methods of product recovery and purification in bioprocess engineering

CREDIT=4	**MICROBIAL TECHNOLOGY**	**No. of hours per =60**
Unit I	**Bioreactor design and types**	**15**
	1.1 Design of bioreactor 1.2 Design of other fermentation vessels: Airlift fermenter, tower fermenter Continuous fermenter, fed batch fermenter, Waldhof type fermenter 1.3 Sterilization of fermentation equipment, air and media 1.4 Fermentation broth rheology and power requirements, concepts of Newtonian and non-Newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity 1.5 Development of industrial fermentation processes 1.6 Screening 1.7 Stock culture maintenance 1.8 Inoculum development for yeast process, bacterial processes and mycelial process 1.9 Scale up of fermentation 2.0 Contamination problems in fermentation industry	
Unit II	**Metabolic Pathway Control**	**15**

	2.1 Environmental control of metabolic pathways 2.2 Genetic Control of Metabolic pathways 2.3. Growth and product formation: Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics 2.4 Computer applications in fermentation technology- General applications and specific applications.	
Unit III-	**Fermentation media**	**15**
	3.1 Fermentation media- Types of fermentation media, 3.2 sources of carbon, nitrogen trace elements, growth factors, precursors, buffers, antifoam agents 3.3 sterilization of media 3.4 screening for Fermentation media. 3.5 Saccharification and utilization of cellulosic wastes.	
Unit IV	**Product recovery and purification**	**15**
	4.1 Product recovery and purification – Precipitation, filtration, centrifugation, solvent recovery, 4.2 chromatography 4.3 ultrafiltration 4.4 crystallization 4.5 whole broth processing 4.6 Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects	

Course Outcomes:

Student will be able to :-

1. Evaluate bioreactor design principles to optimize mass and heat transfer in fermentation processes
2. Analyze the impact of environmental and genetic factors on metabolic pathways in fermentation
3. Formulate fermentation media tailored to specific microorganisms and desired products
4. Apply appropriate recovery and purification methods to optimize yield, purity, and efficiency of bioproducts

References:-

1. Casida, L. E., and Wiley. Industrial Microbiology. John Wiley & Sons, 1986.

2. Perlman, D. Annual Reports on Fermentation Processes. Elsevier, 2014.

3. Prescott, Samuel Cate, Cecil Gordon Dunn, and Gerald Reed. Prescott & Dunn's Industrial Microbiology. A V I Publishing Company, 1982.

4. Marwaha, S. S., and Jatinder Kaur Arora. Food Processing, 2000.

5. Peppler, H. J., and D. Perlman. Microbial Technology. Academic Press, 2014.

6.Stanbury, Peter F, Allan Whitaker, and Stephen J Hall. Principles of Fermentation Technology. Butterworth-Heinemann, 2016.

7. John Robert. Essays in Applied Microbiology. John Wiley & Sons, 1981.

8.Demain, Arnold L., and Nadine A. Solomon. Biology of Industrial Microorganisms. Benjamin-Cummings Publishing Company, 1985.

9. Vanek, Zdenko, and Zdenek Hostalek. Overproduction of Microbial Metabolites. Butterworth-Heinemann, 1986.

10.El-Mansi, Mansi, Jens Nielsen, David M. Mousdale, and Ross Carlson. Fermentation Microbiology and Biotechnology, Fourth Edition. CRC Press, 2020.

11. Saliwanchik, Roman. Legal Protection for Microbiological and Genetic Engineering Inventions. Addison Wesley Publishing Company, 1982.

MIMiT 542 : FOOD AND DAIRY MICROBIOLOGY

Course Objectives:

Student should be able to: -

1. Understand the significance of starter culture in the food and dairy industry.
2. Study the concept of prebiotic and probiotics.
3. Learn the techniques used in food preservation.
4. Discuss the Artificial intelligence in the food industry and food safety and standards.

CREDIT=4	FOOD AND DAIRY MICROBIOLOGY	No. of hours =60
Unit I	**Microbiology of Starter Cultures and fermented dairy products**	15
	1.1 Introduction and annual utilization of starter cultures; History and taxonomy 1.2 Starter cultures; Classification of starter organisms: Starter types: single, mixed and multiple strain starter cultures; 1.3 Propagation and preservation of starter cultures; commercial starter preparations: concentrated and super concentrated starters 1.4 Metabolism of starter Organisms: biochemical characterization of lactic acid bacteria; carbohydrates, citrate and protein metabolism of starter cultures 1.5 Role of starter cultures in the preparation of various fermented milk 1.6 Microbiology of fermented milk products: their nutritional and therapeutic significance.	
Unit II	**Probiotics and functional food**	15
	2.1 Introduction and history of Probiotics, safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection. 2.2 Tolerance to additives, stability during storage, stability during passage to intestinal sites, Role of probiotics in health and disease, minimum effective dose, maintenance of probiotic microorganisms. 2.3 Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora, Prebiotics and health benefits: prebiotics in foods 2.4 Health benefits of functional fermented dairy products: such as dahi, lassi, yoghurt, kefir, cheese, koumiss, Yakult, fermented whey	

	drinks, and dairy based cereal foods, soy-based yoghurt containing probiotics.	
Unit-III	**Microbiology in Food**	15
	3.1 Microorganism in food spoilage: Types of foods and their spoilage 3.2 Microbial, biochemical aspect of food spoilage 3.3 Physiology of food spoilage organisms : Importance, Response of microbes, future prospectus. 3.4 Food Preservation Control of spoilage: By physical removal, heat, low temperature, reduced aw, low pH, organic acids, modified atmosphere, anti - microbial preservatives, irradiation, canning. 3.5 Control by combination of methods (Hurdle concept) Novel emerging techniques of preservation – Bacteriocin - Introduction, types, mode of action, applications.	
Unit IV-	**Artificial intelligence in food industry**	**15**
	4.1 Artificial intelligence in food industry and food safety and standards-Introduction, Applications of artificial intelligence in food industry 4.2 Quality control and Regulations of food industry: Microbiological quality control of milk and milk products: ISI standards, FAO/WHO regulations, FDA regulations and APHA/IDF regulations. Principles of HACCP in Food industries, Quality Manuals and documentations for different products, Basic GMP in the industry.	

Course Outcomes:

Student will be able to :-

1. Describe the significance of starter culture for in food and dairy industry
2. Apply the techniques in food preservation
3. Imbibe the basics of artificial intelligence in the food industry.
4. Perform food safety and regulations in the food industry.

REFERENCES:

1. Ramesh, K Vijaya. Food Microbiology. MJP Publisher, 2019.
2. Swaminathan. Essentials of Food and Nutrition (An Advanced Textbook), 2015.
3. Modi, Hasmukh Amrutlal. Dairy Microbiology, 2009.
4. Yadav, J. S., Sunita Grover, and V. K. Batish. A Comprehensive Dairy Microbiology, 1993.

5. Vanitha, William C Frazier Dennis C Westoff, K N. Food Microbiology, 5e. McGraw-Hill Education, 2023

MIMiT 543 : MICROBIOLOGICAL QUALITY CONTROL AND ASSURANCE

Course Objectives:

The student should be able to :-

1. Know specific requirements for production of different products in the pharmaceutical industry.
2. Learn the techniques and tools for facility and instrument qualification.
3. Understand the concept of clean room technology and culture maintenance and disposal.
4. Discuss the quality management system in the pharmaceutical industry.

CREDIT=4	MICROBIOLOGICAL QUALITY CONTROL AND ASSURANCE	No. of hours =60
Unit I	**Pharmaceutical Industry-Schedule M Indian FDA**	**15**
	1.1 Part I-A: Specific Requirements for Manufacture of Sterile Products, Parenteral Preparations, and Sterile Ophthalmic Preparations. 1.2 Part I-B: Specific Requirements for Manufacture of Oral Solid Dosage Forms (Tablets and Capsules). 1.3 Part I-C: Specific Requirements for Manufacture of Oral Liquids (Syrups, Elixirs, Emulsions, and Suspensions). 1.4 Part I-D: Specific Requirements for Manufacture of Topical products i.e. External Preparations (Creams, Ointments, Pastes, Emulsions, Lotions, Solutions, Dusting Powders, and Identical Products). 1.5 Part I-E: Specific Requirements for Manufacture of Metered Dose-Inhalers (MDI). 1.6 Part I-F: Specific Requirements of Premises, Plant, and Materials for Manufacture of Active Pharmaceutical Ingredients (Bulk Drugs)	
Unit II	**Facility and Instrument Qualification**	**15**
	2.1 Introduction: URS, IQ, OQ, PQ. 2.2 HVAC Qualification: Heating Ventilation Air Conditioning System Constituents of the System– Temperature, Relative Humidity, Air Velocity, Differential Pressure and Room to Room Air Balancing, HEPA Filtration, LAF, Viable Count. 2.3 Instrument Qualification: Autoclave, Dry heat sterilizer, Incubator, Laminar Air Flow Cabinet.	
Unit III	**Maintenance of Clean Room & Microbiological Laboratory**	**15**
	3.1 Facility Requirements: Introduction and guidelines. 3.2 Gowning Requirements: Introduction and guidelines.	

	3.3 Disinfectant Qualification: Introduction, Types of Disinfectants, Disinfectant Efficacy Testing. 3.4 Clean-in-Place (CIP) and Sterilize-in-Place (SIP): Introduction, Principle, Protocol and Applications of CIP and SIP. 3.5 Culture Maintenance: Reference cultures used in the pharmaceutical industry, maintenance. 3.6 Disposal Systems: Disposal protocols and systems for cultures and media.	
Unit IV	**Quality Management Syastem**	**15**
	4.1 Six System Inspection model: Quality Management system, Production system, Facility and Equipment system, Laboratory control system, Materials system, Packaging and Labeling system. Concept of self-inspection. 4.2 Quality systems: Change Management/ Change control. Deviations, Out of Specifications (OOS), Out of Trend (OOT), Complaints - evaluation and handling, Investigation and determination of root cause, Corrective & Preventive Actions (CAPA), Returns and Recalls, Vendor Qualification, Annual Product Reviews, Batch Review and Batch Release. Concept of IPQC, area clearance/ Line clearance.	

Course Outcomes:

Student will be able to:-

1. Understand specific requirements for production of different products in the pharmaceutical industry.
2. Comprehend the techniques and tools for facility and instrument qualification.
3. Imbibe the concept of clean room technology and culture maintenance and disposal.
4. Use a quality management system in the pharmaceutical industry.

References:-

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2. Administration, United States Food And Drug. Pharmaceutical Microbiology Manual. Createspace Independent Publishing Platform, 2017.

3. Indian Pharmacopoeia, 1996: P-Z, Appendices, 1996.

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5. Baird, Rosamund M., Norman A. Hodges, and Stephen P. Denyer. Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices. CRC Press, 2000.

6. Avery, Christine, and Diane Zabel. The Quality Management Sourcebook. Routledge, 2002.

7. Endres, Al. Implementing Juran's Road Map for Quality Leadership. John Wiley & Sons, 2000.

8. Antony, Jiju, and David Preece. Understanding, Managing and Implementing Quality. Routledge, 2002

MIMiT 544 : E 1: FERMENTATION TECHNOLOGY II

Course Objectives:

The student should be able to :-

1. Understand the metabolic pathways and genetic mechanisms involved in microbial production of vitamins, Antibiotics and toxoids.
2. Learn the metabolic pathway of microbial bioproducts.
3. Discuss the role and benefits of biofertilizers in sustainable agriculture.
4. Describe different types of biofertilizers, their modes of action, and their application methods.

CREDIT=4	E 1: FERMENTATION TECHNOLOGY II	No. of hours=60
Unit I	**Microbial Production of Vitamins:**	**15**
	1.1 Microbial Production of Vitamins:Vitamin C-Organism used production method, process, recovery and assay, Vitamin A-Organism used, production method, process, recovery, and assay 1.2 Production of Antibiotics-Production of Antibiotics: Organism used, production process and recovery of Chloramphenicol 1.3 Production of toxoids:Diphtheria,Tetanus	
Unit II	**Microbial production**	**15**
	2.1 Vinegar Production:Introduction, Production Process, Quality, Grades & uses of Vinegar 2.2 Production of biofuels: Ethanol-microorganisms used, fermentation condition, recovery, purification of Ethanol, Biogas- Biomass used, Microbiology & Biochemistry of biogas production, models used, uses of biogas, Biodiesel production from algae 3.3 Microbial Production of Amino Acids: Production of lysine, Microbial Production of Protease, Lipase and Amylase, Solvents-Glycerol, Acetone butanol	
Unit III	**Biofertilizers: I**	**15**
	3.1 Bio fertilizers: Concept & its need in organic farming 3.2 Rhizobium Biofertilizer: Characteristics, Host Rhizobium interaction, N_2 fixation in root-nodules, Production, Methods of application 3.3 Azotobacter Biofertilizer: Characteristics, N_2 fixation process, Production, Methods of application 3.4 Azospirillum Biofertilizer: Characteristics, Association with plants, Production, Methods of application	

Unit IV	**Biofertilizers: II**	**15**
	4.1 VAM Biofertilizer: Characteristics & types of association, production ,methods of application 4.2 PSB Biofertilizer (Phosphate solubilising Bacteria): Mechanism of phosphate solubilisation, Production, Methods of application 4.3 Quality control of Bio fertilizers as per FCO (Fertilizer Control Order): Introduction of FCO specifications for bio fertilizers, Sampling procedure, Method of analysis	

Course Outcomes:

Student will be able to:

1. Apply microbial cultivation techniques and process optimization strategies to enhance vitamin Antibiotics and toxoids yields and purity.
2. Implement microbial bioproduction methods effectively to achieve desired yields, purity, and quality of vinegar, biofuels, amino acids, enzymes, and solvents.
3. Imbibe biofertilizer knowledge to design and implement sustainable soil fertility management practices in agricultural systems.
4. Evaluate the ecological and agricultural benefits of incorporating biofertilizers into farming practices, considering factors such as soil health, crop yield.

References:

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4. Peppler, H. J., and D. Perlman. Microbial Technology. Academic Press, 2014.

5. Sikyta, B. Methods in Industrial Microbiology, 1983.

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9. Norris, John Robert. Essays in Applied Microbiology. John Wiley & Sons, 1981.

10. Perlman, D. Annual Reports on Fermentation Processes. Elsevier, 2014.

MIMiT 544 E2 : WASTE MANAGEMENT SYSTEM

Course Objectives:

The student should be able to :-

1. Understand characteristics of wastes of different industries.
2. Know the environmental legislation related to prevention and control of industrial effluents.
3. Study methods for waste treatment.
4. Learn advanced wastewater technologies implemented today.

CREDIT=4	WASTE MANAGEMENT SYSTEM	No. of hours=60
Unit I	**Industrial waste**	**15**
	Types and Characterization of industrial wastes: 1.1 Types of industrial wastes : solid, liquid and gaseous (PAH, radioactive waste, heavy metals, xenobiotic compounds, etc.) 1.2 General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon. 1.3 Detailed discussion on the type of industry and the waste from the industry. 1.4 Environmental legislation related to prevention and control of industrial effluents and hazardous wastes. 1.5 Biomedical waste and its management	
Unit II	**Industrial Waste Treatment**	**15**
	2.1 Methods of industrial waste treatment:Biological methods I:Activated sludge process, Trickling filters,Sludge bulking - Process, microbiology, applications. 2.2 Methods of industrial waste treatment: Biological methods II: Lagooning- Aerobic and anaerobic, applications, Anaerobic digestion- Process, microbiology of biogas formation,Applications	

Unit III	**Waste treatment of different industries**	**15**
	3.1 Industrial waste treatment: methods of treatment of wastes from Dairies,Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries 3.2 Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.	
Unit IV	**Advanced wastewater treatment**	**15**
	4.1 Introduction, Nutrient removal - nitrification, denitrification. Biological phosphate removal (BPR) 4.2 Membrane processes - Fundamentals, membranes - types, classifications, microfiltration, ultrafiltration, nanofiltration and reverse osmosis, electrodialysis, Membrane fouling. cleaning and mitigation techniques, lon exchange, 4.3 Advanced oxidation process: Photocatalysis, ozonation ozone/UV, ozone /hydrogen peroxide, hydrogen peroxide /UV. 4.4 Applications 4.5 Oxidation of refractory organic compounds	

Course Outcomes:

Students will be able to

1. Characterize wastes of different industries
2. Apply environmental legislation related to prevention and control of industrial effluents
3. Apply methods of waste treatment for various industries.
4. Discuss advanced wastewater technologies implemented today.

References:

1. Middlebrooks, E. Joe. Industrial Pollution Control, n.d.

2. Besselievre, Edmund Bulkley, and Max Schwartz. The Treatment of Industrial Wastes. McGraw-Hill Companies, 1976.

3. Jogdand, S. N. Environmental Biotechnology, 2010.

4. Water and Water Pollution Handbook. CRC Press, 1972.

5. Rao, M. Narayana, and Amal K. Datta. WasteWater Treatment : Rational Methods of Design and Industrial Practices, 2005.

6. Sax, Newton Irving. Industrial Pollution, 1974.
7. Kumar, Ram. Encyclopaedia of Environmental Science and Technology, 2001.
8. Mitchell, R. Water Pollution Microbiology, 1976.
9. Gehm, Harry W., and Jacob I. Bregman. Handbook of Water Resources and Pollution Control, 1976.
11. Sharma, P. D. Environmental Microbiology. Alpha Science Int'l Ltd., 2005.

MIMiP 545: On Job Training (OJT) (4 Credits)

OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engage with the employability opportunities. Students will undergo 4 credit work based learning/OJT/internship.

Practical Course II : LAB IV: MIMiP 546

1. Thermal Death Time (TDT) of microorganisms.
2. Determination of bioburden on textile material by AATCC 101- 2004 method.
3. Determination of Thermal Death Point (TDP) and 4. Evaluation of sanitary status of eatery by swab technique.
5. In-house determination of aerobic count of microbial load by settle plate technique.
6. Sterility testing of autoclave using *Bacillus stearothermophilus.*
7. Determination of efficacy of isopropyl alcohol.
8. Preservative Efficacy Testing.
9. Instrument Qualification of: a) Incubator, b) Hot air oven.
10. Determination of bioburden of non sterile product.
11. Isolation,charcterization and identification of Azotobacter .
12. Laboratory production of Azo fertilizer using microbial consortia.
13. Laboratory production of Rhizobium fertilizer using microbial consortia.
14. Detection of food adulteration.
15. Estimation of sodium benzoate from food
16. Detection of aflatoxins from food.
17. Detection of lactic acid from curd.
18. Estimation of beta amylase from sweet potatoes.
19. Laboratory production of probiotic curd and its physical and chemical analysis.
20. Estimation of pectin from plant material.

Course Outcome:

Students will be able to

1. Apply process to determine bioburden on textile material
2. Perform sterility testing of autoclave using *Bacillus stearothermophilus.*
3. Apply methods to carry out instrument qualification
4. Use methods to determine food adulteration

References:

1. Administration, United States Food And Drug. Pharmaceutical Microbiology Manual. Createspace Independent Publishing Platform, 2017

2. Manual of Methods of Analysis of Foods – Microbiological Testing – Food, Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, New Delhi, 2012.