GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: Undergraduate

Branch: Food Engineering & Technology

Course / Subject Code: BE04051051

Course / Subject Name: Food and Industrial Microbiology

w. e. f. Academic Year:	2024-25
Semester:	04
Category of the Course:	Basic Science Courses

Prerequisite:	Basic understanding of Food and Industrial Microbiology
Rationale:	**Rationale:** Food and industrial microbiology is the study of the microorganisms that play a vital role in the preparation of foods at small and large scales. It includes the propagation and preservation of microorganisms on a large scale. Another indispensable aspect of food and industrial microbiology is screening of microorganisms for desirable characteristics essential at the industrial level (example: metabolite, and enzyme production), separation and purification of particular bio-substance using chromatography, blotting, centrifugation, precipitation etc. The subject aims to improve the safety of food for human health, enhance the shelf life and quality of food products.

Course Outcome:

After Completion of the Course, the Student will be able to:

No	Course Outcomes	RBT Level
01	Explain microbial growth kinetics and environmental factors influencing microbial proliferation.	Remember / Understand
02	Identify major spoilage microorganisms in different food commodities	Understand
03	Demonstrate knowledge of industrially important microorganisms used in fermentation.	Apply /
04	Evaluate microbial standards for food safety	Analyze
05	Use instruments such as a laminar air flow, an autoclave, a spectrophotometer, and pH meter in microbiological studies	/ Evaluate
06	Assess the role of microbes in environmental sustainability, bioremediation, and food waste valorisation.	Understand / Analyze

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per	Total	Assessment Pattern and Marks	

Semester)					Credits = TH/30						Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L=Lecture, T=Tutorial, P=Practical, TW/SL=Term-Work/Self-Learning, TH=Total Hours, ESE=End-Semester Examination, PA = Progressive Assessment

***Problem-Based Learning (PBL) aims to accommodate learning beyond the syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamentals of microbiology and techniques** Classification of microorganisms (Prokaryotes and Eukaryotes, emphasizing Bacteria, Fungi, and Yeast), Fluorescence, and Electron Microscopy (SEM & TEM); Simple, Differential (Gram, Acid-Fast), Isolation of pure cultures (Streak, Pour, Spread Plate); Types of Culture Media (synthetic, complex, selective, differential), Phases of microbial growth (Lag, Log, Stationary, Death); Growth Curve and measurement methods (direct and indirect), Mathematical expression of growth rate and generation time.	10	20
2.	**Microbial spoilage of food products:** Spoilage microorganisms for Milk and Milk Products: sources of contamination, pasteurisation of milk and defects in milk and milk products. Spoilage of canned foods, aerobic and anaerobic microbial spoilage of food. Spoilage microorganisms for fruit juices, beverages and carbonated drinks. Foodborne Infections (e.g., *Salmonella*, *Listeria*, pathogenic *E. coli*); Foodborne Intoxications (e.g., *S. aureus*, *C. botulinum*); Aflatoxins and mycotoxins; Investigation of foodborne outbreaks.	7	20
3.	**Preservation strategies for microbial spoilage** Use of Chemicals and Radiation: Types of chemical preservatives (Sulfites, Nitrites, Sorbates, mode of action and industrial applications. Food Preservation by use of Low Temperature, High Temperature and drying: types of low temperature preservation. Principles of Thermal Processing (D, Z, and F values); Irradiation; High-Pressure Processing (HPP), Controlled Atmosphere Storage.	8	20
4.	**Isolation screening and strain improvement of microorganisms:** Isolation techniques, screening methods for industrial applications	7	15

	(Exopolysaccharide, amylase and beta-galactosidase). Improvement and Preservation of Industrial cultures: Importance, development of strains, Preservation methods, microbial growth kinetics.		
5.	**Fermentation and bioprocess technology** General components of fermentation media (Carbon, Nitrogen, Growth Factors); Types of fermentation processes: Submerged vs. Solid-State; Aerobic vs. Anaerobic. Types of Fermenters (batch, fed batch and continuous) /Bioreactor (Stirred-tank, Air-lift); Functions of Sparger, Impeller, and Baffles; Sterilization of fermenters and media.	5	10
6.	**Production of microbial products** Primary Metabolites: Production of Lactic Acid, Citric Acid, and Ethanol (Brewing and Fuel); Production of Amino Acids (Lysine, Glutamic acid). Single-Cell Protein (SCP); glutamic acid, microbial polysaccharides (Xanthan gum, Dextran).	5	10
7.	**Recovery and purification of microbial metabolites.** Procedure and techniques for recovery and purification of fermentation products based on their size, polarity, solubility, and binding. 1-D and 2-D electrophoresis.	3	5
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
35	**35**	**10**	**10**	**10**	**00**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:
(a) Books:

1. Modern Food Microbiology, James M. Jay, CBS Publishers & Distributors, Delhi.
2. Food Microbiology, W C Frazier and D C Westhoff, McGraw Hill Book Company, NY.
3. Industrial Microbiology, S C Prescott and C G Dunn, McGraw Hill Book Co.
4. Industrial Microbiology, A H Patel Mac Millan Press
5. Normal and Therapeutic Nutrition – Corinne H. Robinson & Marilyn Lawler
6. Frazier's A Textbook of Food Microbiology by KR Anija
7. Industrial and food microbiology by Rekha Yadav

8. Handbook of Industrial Food Microbiology by Manju Nehra & Vikash Nain
9. Textbook of Industrial Microbiology by Renu Agrawal

(b) Open-source software and website:

- NOC: **Food Microbiology for Safe and Sustainable Food Systems** (IIT Kharagpur) — course page
- NPTEL / Swayam: **Industrial Biotechnology** (bioprocesses, fermenters, etc.)
- Archive version of **Industrial Biotechnology** lectures and resources
- NPTEL / Swayam: **Thermal Processing of Foods** (covering heat-treatments, pasteurisation, etc.)

Suggested Course Practical List

1. To determine the quality of milk by the methylene blue reduction test
2. Microbiological examination of foods.
3. Preparation of Sauerkraut
4. Sterilization of microbial growth media using different methods
5. To identify the fungal contamination in the given food sample
6. To study the sugar utilisation patterns by microorganisms
7. To determine the starch hydrolytic activity of microorganisms
8. To determine β-galactosidase activity of microorganisms
9. To determine the thermal death point of microorganisms
10. To determine the thermal death time of microorganisms

List of Laboratory/Learning Resources Required: Equipment

- Incubator

- Laminar air flow cabinet
- Colony counter
- Nutrient agar / Plate Count Agar
- Autoclave

***List of suggested activities for Problem-Based Learning:**

Sr. No.	Activity Name	Suggested Topics / Focus Area	Hours	Evaluation Criteria
1	Industry/Research Laboratory Visit	Visit to an Industrial Fermentation Unit (e.g., brewing, enzyme production)	10 h (Visit +Report)	Report with observations, flowchart, supervision notes
2	Technical Video- Based Learning	Bioreactor Operation & Aseptic Design; Thermal Inactivation of food pathogens;	10 h	Report, answer sheet, learning points
3	Assignment Writing (Theoretical)	Calculation of Fermentation Kinetics parameters (e.g., specific growth rate, or D- and Z-values for thermal sterilization).	10 h	Presentation, content accuracy
4	Problem Solving/ Coding	Simulating microbial growth or toxin production in food) or Fermentation Optimizations (e.g., yield prediction)	10 h	Solution development, assessment output
5	Online Course (MOOCs)	MOOC on Industrial Enzyme/Antibiotic Production	10 h	Based on completion and reflective submission
6	Complex Problem Solving	Case: Contamination in a large-scale antibiotic fermenter; identify source and propose sterilization protocol.	10 h	Assessment of accuracy and creativity
7	Literature Review	Biosafety Levels and Containment in industrial processes; Hygiene and Sanitation standards (e.g., HACCP) in a food plant	8 h (+4 papers)	Critical review, report submission

8	Research Paper Discussions	Microbial Production of Bioplastics or Biofuels; Research on Probiotics, Prebiotics, and the Gut Microbiome	20 h (5 papers×4 h)	Discussion and reflective notes
9	Poster/Chart/Power Point Presentation	Microbes in Dairy Fermentation (Lactic Acid Bacteria); Industrial Production of Citric Acid	6 h	Clarity, creativity, external feedback
10	Model Development (Working/Non-working)	Design a Benchtop Bioreactor/Fermenter Model (including agitation and aeration)	8–12 h	Functionality and usability check
11	Industrial Exposure (2–3 Days)	Observe processes in the food Microbiology lab, pathogen detection and identification, and colony counting	20 h	Critical review, participation certificate
12	Group Discussion (Tech Trends)	Biosafety Levels and Containment in industrial processes; Hygiene and Sanitation standards (e.g., HACCP) in a food plant	1h per GD	Technical input, communication skill rating
13	Case Study/Regulatory Aspect	Microbial Production of Bioplastics or Biofuels; Research on Probiotics, Prebiotics, and the Gut Microbiome; Molecular Typing of foodborne pathogens	10 h	Report with analysis and regulation linkage
14	Application/Software Development	Microbes in Dairy Fermentation (Lactic Acid Bacteria); Industrial Production of Citric Acid or Wine; Downstream Processing	10 h	Based on functionality and usability

- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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