TECHNO INDIA UNIVERSITY
WEST BENGAL

SEMESTER 5

RECOMBINANT DNA TECHNOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: RECOMBINANT DNA TECHNOLOGY (Theory)	**Subject Code:** TIU-UMB-MJ-T31301
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the fundamental principles of molecular cloning and its applications in genetic engineering.
2. Demonstrate proficiency in DNA transformation techniques, including chemical transformation and electroporation.
3. Explain the principles and applications of the Polymerase Chain Reaction (PCR) and its variations, including Nested PCR, Inverse PCR, Multiplex PCR, RT-PCR, and Real-Time PCR.
4. Identify and explain the products of recombinant DNA technology, including those of therapeutic importance, such as insulin and human growth hormone (hGH)

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Able to remember restriction enzymes- nomenclature, types	K1
CO-2:	Construct knowledge about gene cloning, expression and gene libraries	K2
CO-3:	Discover PCR amplification process and principles of DNA	K4
CO-4:	Students will study the process of various hybridization techniques	K2
CO-5:	Explain the process of constructing genomic and c-DNA library	K5
CO-6:	Able to apply knowledge of recombinant DNA technology	K6

COURSE CONTENT :

MODULE 1:	**MOLECULAR CLONING: TOOLS AND STRATEGIES**	**10 Hours**
Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs, Use of linkers and adaptors Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors		
MODULE 2:	**METHODS IN MOLECULAR CLONING**	**10 Hours**
Transformation of DNA: Chemical method, Electroporation Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.		
MODULE 3:	**DNA AMPLIFICATION AND DNA SEQUENCING**	**8 Hours**
PCR: Basics of PCR, Types of PCR: Nested PCR Inverse PCR, Multiplex PCR, RT-PCR, Error prone PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing, Primer walking and shotgun sequencing		
MODULE 4:	**CONSTRUCTION AND SCREENING OF GENOMIC AND CDNA LIBRARIES**	**7 Hours**
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping		
MODULE 5:	**APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY**	**10 Hours**
Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, DNA fingerprinting- RAPD, VNTR Typing, site directed mutagenesis, phage Display		

TOTAL LECTURES	45 Hours**

Books:

Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7 th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

6. Brown TA. (2007). Genomes-3. Garland Science Publishers

7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	3	-	2	-	-	2	3	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	3	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	1	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	1	3	-	3	2	3	3	3	-
CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3

RECOMBINANT DNA TECHNOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: RECOMBINANT DNA TECHNOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L31301
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Understand the principles of bacterial transformation, including chemical and electroporation methods.
2. Understand the mechanism and specificity of restriction enzymes in DNA cleavage.
3. Analyze electropherograms, identify base calls, and recognize sequencing errors (e.g., ambiguous peaks, background noise).
4. Utilize bioinformatics tools for primer design, such as GC content optimization, melting temperature (Tm) calculation, and avoidance of secondary structures.
5. Understand the principles of polymerase chain reaction (PCR) and the role of essential components (DNA template, primers, dNTPs, polymerase, buffer).

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Perform bacterial transformation	K3
CO-2:	Calculate transformation efficiency	K4
CO-3:	Performed digestion of DNA and agarose gel electrophoresis	K3
CO-4:	Interpret sequence by gel electropherograms	K4
CO-5:	Design primer	K3
CO-6:	Perform PCR	K4

COURSE CONTENT :

MODULE 1:	**BRIEF OVERVIEW ON THE DNA CLONING AND GENETIC TRANSFORMATION**	**15 Hours**
1. Bacterial Transformation and calculation of transformation efficiency 2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis 3. Interpretation of sequencing gel electropherograms 4. Designing of primers for DNA amplification 5. Amplification of DNA by PCR		
TOTAL LECTURES		**15 Hours****

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3	-	2	-	3	-	2	2	-	2	3	2	3	2	2
CO-2	3	2	3	-	2	2	-	-	3	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	1	-	2	3	3	3	3
CO-4	3	2	3	2	3	3	1	3	-	3	2	3	3	3	-
CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3

FOOD AND DIARY MICROBIOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: FOOD AND DAIRY MICROBIOLOGY (Theory)	**Subject Code:** TIU-UMB-MJ-T31302
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Identify the natural microflora of food and potential sources of microbial contamination in different food products.
2. Examine microbial spoilage mechanisms in vegetables, fruits, meat, eggs, dairy products, bread, and canned foods.
3. Learn about the production and microbial processes involved in yogurt, dahi, and acidophilus milk.
4. Discuss the health benefits and market availability of probiotic foods.
5.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall examples of intrinsic and extrinsic factors that affect microbial growth in foods.	K1
CO-2:	Describe the specific spoilage mechanisms that occur in vegetables, fruits, meat, eggs, milk and butter, bread, and canned foods.	K2

CO-3:	Explain the principles behind physical methods of food preservation and their effects on microorganisms.	K4
CO-4:	Describe the production processes of yogurt, dahi, and acidophilus milk.	K3
CO-5:	Recall the causative agents of common food intoxications and infections.	K1
CO-6:	Describe the principles behind molecular methods for detecting foodborne pathogens.	K2

COURSE CONTENT :

MODULE 1:	**FOOD AS A SUBSTRATE FOR MICROORGANISMS**	**10 Hours**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.		
MODULE 2:	**MICROBIAL SPOILAGE OF VARIOUS FOODS**	**10 Hours**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods		
MODULE 3:	**PRINCIPLES AND METHODS OF FOOD PRESERVATION**	**15 Hours**
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.		
MODULE 4:	**FERMENTED DAIRY PRODUCTS**	**10 Hours**
Dairy starter cultures, yogurt, dahi, acidophilus milk.		
MODULE 5:	**PREBIOTICS AND PROBIOTICS**	
Prebiotics: definition, types, microorganisms, benefits, Fructo-oligosaccharides (FOS) from GRAS organisms (commercial prebiotic). Probiotics: definition, essential features of a probiotic, types of microorganisms used, health benefits, probiotic foods available in market.		
MODULE 6:	**FOOD BORNE DISEASES (CAUSATIVE AGENTS, FOODS INVOLVED, SYMPTOMS AND PREVENTIVE MEASURES)**	**10 Hours**
Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.		

MODULE 7:	CULTURAL AND RAPID DETECTION METHODS OF FOOD BORNE PATHOGENS IN FOODS AND INTRODUCTION TO PREDICTIVE MICROBIOLOGY	10 Hours
Culture and microscope methods – standard plate count, microscopic counts Molecular methods: PCR based detection. Biosensor based methods: optical biosensor, electrochemical biosensor, mass-based biosensor Immunological based methods: ELISA.		
TOTAL LECTURES		**45 Hours****

Books:

1. Adams MR and Moss MO. (1995) Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987) Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993) Antimicrobials in Foods. Marcel Dekker, New York. Publishing, Oxford, U.K.
4. Dillion VM and Board RG. (1996) Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992) Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition, Pearson Education.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	3	-	2	2	-	2	3	2	3	2	2
CO-2	3	2	3	-	2	2	-	-	3	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	3	1	1	2	3	3	3	3
CO-4	3	2	3	2	3	3	1	3	-	3	2	3	3	3	-
CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3	3	3

CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3

FOOD AND DIARY MICROBIOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: FOOD AND DIARY MICROBIOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L31302
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Perform microbiological quality assessment of milk using the Methylene Blue Reduction Test (MBRT) and Standard Plate Count (SPC) methods, and interpret the results.
2. Isolate and characterize spoilage microorganisms from various food sources (milk, vegetables/fruits, and bread) using appropriate microbiological techniques
3. Apply aseptic techniques to prepare culture media, inoculate samples, and obtain pure cultures of microorganisms.
4. Analyze and compare the morphological and cultural characteristics of microorganisms isolated from different food sources.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Analyze the microbial quality of milk by performing the Methylene Blue Reduction Test (MBRT) and evaluate bacterial load using the standard plate count method.	K4
CO-2:	Demonstrate proficiency in the isolation and identification of spoilage microorganisms from contaminated vegetables and fruits, and interpret their role in food spoilage	K3
CO-3:	Investigate the microbial contaminants responsible for bread spoilage and differentiate between fungal and bacterial spoilage based on morphological and biochemical characteristics.	K2
CO-4:	Apply microbiological techniques to prepare fermented dairy products such as yogurt and dahi, and assess the role of lactic acid bacteria in the fermentation process.	K3
CO-5:	Illustrate the significance of microbial spoilage in food safety and recommend strategies for minimizing contamination and foodborne illness	K2

CO-6:	Develop technical expertise in microbial analysis of food products and demonstrate problem-solving skills in identifying and controlling spoilage microorganisms	K6

COURSE CONTENT :

MODULE 1:	**STUDY THE SPOILAGE OF FOOD SAMPLES**	**15 Hours**
1. MBRT of milk samples and their standard plate count. 2. Isolation of spoilage microorganisms from spoiled vegetables/fruits. 3. Isolation of spoilage microorganisms from bread. 4. Preparation of Yoghurt/Dahi.		
TOTAL LECTURES		**15 Hours****

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
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CO-2	3	2	3	-	2	2	-	-	3	-	2	3	3	3	3
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CO-4	3	2	3	-	3	3	1	3	-	3	2	3	3	3	-
CO-5	-	2	3	-	3	-	2	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3

INDUSTRIAL MICROBIOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: INDUSTRIAL MICROBIOLOGY (Theory)	**Subject Code:** TIU-UMB-MJ-T31303
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

5. To understand the historical progression of microbiology as a scientific discipline. analyze the nature of problems solved with machine learning techniques

6. Describe the principles of binomial nomenclature in microbial classification.
7. To examine the general characteristics of acellular microorganisms such as viruses, viroids, and prions.
8. To explore the history of phycology with an emphasis on contributions from Indian scientists.
9. To trace the historical developments in mycology and the contributions of notable mycologists.
10. To understand the general characteristics and diversity of protozoa.
11. To explore the diverse applications of microbiology in research and industry.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Remember the Historical Development of Microbiology.	K1
CO-2:	Understand the Microorganisms Using Standard Taxonomic Systems	K2
CO-3:	Describe the General Characteristics of Microbial Groups	K4
CO-4:	Analyze Algae, Fungi, and Protozoa in Detail	K4
CO-5:	Evaluate the Scope and Applications of Microbiology	K5
CO-6:	Apply the research outcomes in everyday research	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO INDUSTRIAL MICROBIOLOGY**	**10 Hours**
Brief history and developments in industrial microbiology		
MODULE 2:	**ISOLATION OF INDUSTRIAL STRAINS AND FERMENTATION**	**Hours**
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates		
MODULE 3:	**TYPES OF FERMENTATION PROCESSES, BIO-REACTORS AND MEASUREMENT OF FERMENTATION**	**7 Hours**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration		
MODULE 4:	**DOWN-STREAM PROCESSING**	**8 Hours**
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying		
MODULE 5:	**MICROBIAL PRODUCTION OF INDUSTRIAL PRODUCTS (MICRO-ORGANISMS INVOLVED, MEDIA, FERMENTATION CONDITIONS, DOWNSTREAM PROCESSING AND USES)**	**7 Hours**
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase), wine, beer		
MODULE 6:	**ENZYME IMMOBILIZATION**	**10 Hours**
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)		
TOTAL LECTURES		**45 Hours****

Books:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2 nd edition. Panima Publishing Co. New Delhi.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**

CO-1	3	-	2	-	3	-	2	2	-	2	3	2	3	2	2
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CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3

INDUSTRIAL MICROBIOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: INDUSTRIAL MICROBIOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L31303
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Identify and describe the components of a fermenter and their roles in microbial growth and product formation.
2. Conduct qualitative assays to detect enzyme activity, including starch hydrolysis for amylase and protein degradation for protease.
3. Perform immobilization techniques such as alginate bead entrapment or adsorption methods.
4. Gain practical exposure to industrial fermentation processes and downstream processing techniques.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Undestand the different parts of a typical laboratory-scale fermenter.	K2
CO-2:	Recall the names of various components (e.g., impeller, sparger, pH probe, temperature control system)	K1
CO-3:	Describe how each component contributes to the overall fermentation process.	K4
CO-4:	Locate and identify components of a fermenter in a laboratory setting.	K3
CO-5:	Explain the purpose and methods of whole cell immobilization.	K4

CO-6:	Recall the different downstream processing operations observed during the visit.	K1

COURSE CONTENT :

MODULE 1:	**DEVELOPMENT OF DIFFERENT FERMENTATION PROCESS AND QUANTITATIVE ANALYSIS**	**15 Hours**
1. Study different parts of fermenter 2. Microbial fermentations for the production and estimation of Enzymes: Amylase (Both qualitative and quantitative only) and Protease (Qualitative only) 3. Whole cell immobilization and detection through any one enzyme assay (Qualitative only) 4. A visit to any educational institute/industry to see the operation of instruments and other downstream processing operations.		
TOTAL LECTURES		**15 Hours****

Course Articulation Matrix:

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CO-3	3	2	3	-	3	-	-	3	1	1	2	3	3	3	3
CO-4	3	2	3	2	3	3	1	3	-	3	2	3	3	3	-
CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3	3	3