B.Sc.(Microbiology) Semester V

Course Code	US05MAMIC01	Title of the Course	Bacterial Genetics
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	• The course is structured with the aim to fulfil the objective of introducing basic concepts of molecular biology to the under graduate students of Microbiology. • Toimpart detailed knowledge regarding flow of genetic information in prokaryotes, steps of central dogma of life, replication of genetic material, transcription and translation. • To know about mutations in genetic material and its repair mechanisms. • Tomake students understand that knowledge of molecular genetics helps to understand mechanisms of gene transfer among prokaryotes, evolution, cellular regulations and many other biological processes.

Course Content		
Unit	Description	Weightage* (%)
1.	**Gene structure and Replication in prokaryotes** a) DNA as genetic material b) Structure and chemistry of DNA, forms of DNA c) DNA replication in bacteria: DNA replication is semi conservative, DNA replication initiates from a single origin, replication machinery, events at replication fork, termination of replication, and replication of linear chromosomes. d) Models ofreplication:Cairn's (Ø) model and Rolling Circle (σ) model. e) Bacterial gene structure	25%

2.	**Gene Expression** a) Central Dogma of gene expression and Teminism b) Transcription in bacteria: Introduction, Bacterial RNA polymerase, and promoter, stages of transcription: initiation, elongation, rho factor dependent and factor independent termination of transcription. c) Introduction to t-RNAand Ribosome: structure and role d) Genetic code: Introduction, Triplet nature, Polarity, Degeneracy, Wobble phenomenon, near universality, Initiation and termination codons. e) Translation: Activation of amino acids and charging of t-RNA, Initiation of protein synthesis, elongation of polypeptide chain, termination of protein synthesis. f) Regulation of transcription initiation : Lactose operon 1.Negative Transcriptional Control of Inducible Genes 2. Catabolite repression in and positive control in *E.coli*	25%
3.	**Gene Variation (mutations) and repair.** (a) Introduction, spontaneous mutations, induced mutations, Evidence of spontaneous mutation (fluctuation test, replica plate technique) (b) Types of mutations (c) Chemical and physical mutagenic agents: U.V. radiation, 5BU, Nitrous acid, EMS, acridine dyes (d) Detection and isolation of mutants: auxotrophic mutants, antibiotic resistance mutants. (e) Mutagen and carcinogen identification (Ame's test) (f) DNA repair: Proof reading, mismatch, Excision, Direct, Recombination and SOS.	25%

4.	**Genetransfer among bacteria** (a) Fundamentals: Zygote, Allele, Recombination, Horizontal and Vertical gene transfer, formation of merozygote and its fate. b) Bacterial plasmids: General properties, functional types of plasmid, maintenance of plasmids c)Transposable elements: Insertion sequences, composite transposons, Mechanisms of transposition: simple and replicative transposition d) Gene transfer mechanisms i) Transformation: Introduction, Definition, competence, mechanism of transformation in *Streptococcuspneumoniae, Neisseria gonnorhea* and *Haemophillus influenzae* ii)Transduction: Introduction, Generalized and Specialized transduction iii) Bacterial Conjugation: Introduction, Role of F-plasmid and secretary system, $F^+X\ F^-$, Hfr Conjugation, F' conjugation.	25%

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such as chalk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject. Model making of DNA and RNA structures, Seminars, poster presentations, Visualization of various mechanisms by showing educational videos from internet. Arranging debates in class. Performing experiments in laboratory.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the importance of the master molecule "nucleic acid", get knowledge of DNA and RNA structures, genome organization of prokaryotes, gene structure and function.
2.	Understand about mechanism of prokaryotic DNA replication and machinery of DNA replication.
3.	Gets knowledge regarding Central Dogma of gene expression and all steps of the central dogma in detail like transcription, translation, replication and reverse transcription. Know about regulation of gene expression.
4	Understand about various RNAs, Ribosome, genetic code and their role in protein synthesis.
5	Understand how mutations and repair of genetic material influence evolutionary process. And will get information regarding chemical and physical mutagenic agents, types of mutations and DNA repair.
6	Understand recombination of bacteria. Understand about the three well known mechanisms by which the genetic material is transferred among the microorganisms namely transformation transduction and conjugation.
7	Are able to describe different types of plasmids and transposable elements and understand the consequences of recombination

Suggested References:	
Sr. No.	References
1.	Prescott L, Harley J P, and Klein D A, Microbiology, 9th edition. Wm C.Brown - McGraw Hill, Dubuque, IA ltd.
2.	General Microbiology, by C.B. Powar and H.F. Daginawala, volume-I, Himalaya Publishing House, Reprint-2002
3.	Principles of Molecular Biology by Veer Bala Rastogi Revised and enlarged 2nd edition, MEDTECH.
4.	Biochemistry by Lehninger, Nelson and Cox, 4th Edition.
5.	Principles of Microbiology 2nd edition– R.M. Atlas

B.Sc.(Microbiology)Semester– V

Course Code	US05MAMIC02	Title of the Course	Microbial Metabolism
Tota lCredits of the Course	4	Hours per Week	4

Course Objectives:	To make the students familiar with: • Microbial Metabolism • Principle of Thermodynamics • The structure, Role and Different modes of ATP generation in bacteria. • The enzymes, enzyme kinetics and their regulation. • The introduction of the Biochemical pathways for degradation and biosynthesis of Carbohydrate, Lipid & Proteins as well as biosynthesis of peptidoglycan • Photophosphorylation and CO_2 Assimilation

CourseContent

Unit	Description	Weightage* (%)
1.	**Principles of bioenergetics** a) Biochemical thermodynamics b) ATP (Structure and role) c) Biochemical mechanisms of ATP generation: -Oxidative phosphorylation:- ETC: organization, components and Mechanism of oxidative phosphorylation includes- Chemiosmotic theory, ATP Synthase & Rotational catalysis d) Substrate level phosphorylation e) photophosphorylation (cyclic and non-cyclic)	25
2.	**Enzymology:** **a) Enzyme Kinetics** i. Definition : Zero and First order reaction ii. Substrate saturation curve: Michaelis -Menten Equation- Equilibrium and Steady state assumption, significance of M-M equation iii. Definition of Km, Turn over number (K_{cat}),Specificity constant(Kcat/Km) iv. Double reciprocal plot **b) Regulation of enzyme action:** i. Allosteric, Covalent modification, Feedback inhibition ii. Enzyme inhibition : Reversible-(Competitive, Non-Competitive, Uncompetitive and Mixed), Irreversible iii. Introduction to Zymogen and Isoenzymes iv. Multi substrate reactions	25

3.	**Catabolism** a) **Introduction** i. Introduction to Metabolism, Catabolism and Anabolism ii. Role of precursor metabolites in metabolism **b) Carbohydrate Catabolism :** i. EMP pathway, Regulation of Glycolysis, PP Pathway, ED pathway ii. TCA cycle and its energetic, Regulation of TCA, Anaplerotic reactions, Glyoxylate cycle **c) Lipid Catabolism:** i. α ,β and ω oxidation of fatty acids ii. Beta oxidation of saturated fatty acids-Palmitic acid and its energetics. **d) ProteinCatabolism:** i. Deamination: - Oxidative deamination, Transamination, Stickland reaction ii. Urea cycle **e) Fuelling reaction in Anaerobic chemotrophs:** Anaerobic respiration, Fermentation	25

4	**Anabolism:-** a) **Introduction** i. Strategies of biosynthesis ii. Methods of studying intermediary metabolism (Use of Biochemical mutants, Pulse labeling technique) **b) Carbohydrate Biosynthesis:-** i. Gluconeogenesis , ii. Reductive TCA cycle iii. Calvin-Benson cycle **c) Lipids Biosynthesis:-** i. Biosynthesis of saturated fatty acid **d) Biosynthesis of aminoacids:-** i. Aromatic family **e) Biosynthesis of peptidoglycan**	25

Teaching-LearningMethodology	The major teaching- learning consists of lectures and discussions (large group) in which the teacher makes a use of chalk and talk as well as powerpoint presentation and Video animation to introduce the learning objectives related to the basic concepts of the subject. These sessions incorporate space for participation and involvement of students through questions. The student's participation in laboratory on related theoretical concept is also required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University External Examination	50%

Course Outcomes :Having completed this course, the learner will be able to	
1.	Conceptualize their understanding of Microbial Metabolism
2.	Understand the Principle of Thermodynamics
3.	Describe the structure, role and different modes of ATP generation in bacteria.
4.	Gain knowledge of Enzymes, Enzyme kinetics and their regulation.
5.	Understand the Biochemical pathways for degradation and biosynthesis of carbohydrate, lipid & proteins and also biosynthesis of peptidoglycan
6.	Understand the photophosphorylation and CO_2 Assimilation

SuggestedReferences:	
1.	Biochemistry by Lehninger, Nelson and Cox (4^{th} edition)
2.	Principles of Biochemistry by Zubey G. L.(1^{st}edition)
3.	General microbiology by Stanier R.Y. (5^{th} edition)
4.	Biochemistry, by U. Satyanarayan (5^{th} edition)
5.	Microbiology by Pelczar,Kreig&Chan (5^{th} edition)
6.	Enzymes Biochemistry, Biotechnology, Clinical chemistry by T. Palmer (2^{nd} edition)
7.	Outline of Biochemistry by Conn and Stumpf (5^{th} edition)
On-liner e sources to be used if available as reference material	

B.Sc. (Microbiology) Semester V

Course Code	US05MAMIC03	Title of the Course	Microbiology Practical
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	• Some basic techniques to study mutation, are given with the aim to full fill the objective of introducing basic concepts of molecular biology to the under graduate students of Microbiology. • To conceptualize their understanding of Microbial Metabolism,qualitative and quantitative analysis of bio molecules through various fundamental techniques like titrimetric estimation, colorimetric estimations and chromatographic techniques are kept. • To gain knowledge of enzymes, enzyme kinetics, enzyme assays, exercise is introduced.

Course Content based on core theory papers		
No	**Practical Section-1**	Weightage* (%)
1.	Study of microbicidal effect of UV rays	100%
2.	Isolation of anantibiotic resistant mutant bacterium. (gradient/ replica/ grid plate technique)	
3	Isolation of pigment less mutant of *Serratia marcescens* using UV radiations as mutagen	
4.	Isolation of *lac*— mutants of *Escherichia coli* using UV radiations as mutagen.	
5	Reducing sugar(Glucose/ Jaggery) estimation by Cole's method	
6	Reducing sugar (Glucose) estimation by DNS method	
7.	Protein estimation by Folin's method	
8	Separation and identification of amino acids by Thin layer chromatography(TLC) and determination of Rf value.	
9	Substrate saturation curve: study of Km and Vmax for invertase. (Group experiment)	
10	Study of Minimum inhibitory concentration (MIC) of an antibiotic for a well isolated bacterium.	

No	Practical Section-2	
11	Study of Biochemical reactions Based on Carbon source 1. Oxidative and fermentative breakdown of glucose 2. Fermentation of Sugars: Glucose, Lactose, 3. Glucose break down products: Methyl red test, Voges Proskauer's test 4. Citrate utilization test	
12	Study of Biochemical reactions Based on Nitrogen source I. Indole production test 2. H_2S production test 3. Urea utilization test 4. Casein hydrolysis test 5. Gelatin Hydrolysis test 6. Deamination test 7. Ammonia production test 8. Nitrate reduction test	
13	Study of Biochemical reactions : Other tests 1. Catalase test 2. Dehydrogenase test 3. Oxidase test	

Teaching-Learning Methodology	• By briefing them with the theoretical aspects as well as providing them with the protocol (Aim, Requirements and Procedure) of the experiment to be performed using chalk and duster as well as power point presentation. • Students are trained for microscope observations and its handling. • Demonstrations of the practical are also carried out and care is taken for aseptic handling and skill development for microbiological work in the laboratory

Evaluation Pattern		
Evaluation of practical at University levelrequires evaluation for minimum three exercises forperformance, well documented certified Journal and a viva voce.		
Sr. No.	Details of the Evaluation	Weightage
1	Internal Written / Practical Examination (As per CBCS R.6.8.3) Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Journal, Attendance (As per CBCS R.6.8.3)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand effect of mutagenic agents, phenotypic change and the event of mutations. Will get information and experience regarding chemical and physical mutagenic agents
2.	Will get skills for analysis of bio molecules and enzyme assays. Also gets concept of metabolism of various compounds and develops idea regarding metabolic diversity in bacteria.
3.	Skills are developed for estimations of various compounds by titrimatric and colorimetric methods.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories.
2.	Microbiology : A Practical Approach – Dr Bhavesh Patel and Dr Nandini Phanse
3.	Experimental Microbiology - Rakesh J.Patel & Kiran R. Patel, Volume I& II

On-line resources to be used if available as reference material

B.Sc. (Microbiology) Semester V

Course Code	US05MIMIC01	Title of the Course	Methods in Food and Dairy Microbiology
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	• The main objective is to ensure that the student develops a clear comprehension of the concepts of applied areas of food microbiology. The student will get knowledge of various methods employed for food preservation and food quality check.

Course Content		
Unit	Description	Weightage* (%)
1.	a) Food and microbes: i. Food as a substrate for Microorganisms. ii. Microbial flora of food and milk. iii. Microbial Spoilage of food b) Methods of food preservation: i. Use of aseptic handling. ii. High temperature: Pasteurization, sterilization, canning. iii. Low temperature: Refrigeration and freezing. iv. Dehydration v. Osmotic pressure vi. Preservatives vii. Radiations: Ionizing and non-ionizing radiation	50%
2.	a)Bacteriogical analysis of food : i. Direct microscopic examination, colony forming units (CFU) ii. Most probable number (MPN) iii. Identification of specific group or species of microorganisms b). Bacteriological analysis of milk : i. Grading of milk: Methylene Blue Reduction and Resazurin test ii. Determination of efficiency of pasteurization: Phosphatase test iii. Determination of MPN iv. Acid-fast staining	50%

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such as chalk and talk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3) Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Developed understanding of microbial flora of food and milk.
2.	Are able to understand what food spoilage is and how food can be preserved.
3.	Develop, understand and apply methods of food preservation..
4.	Understand the basic steps involved in microbial examination of food and milk.

Suggested References:	
Sr. No.	References
1.	"Microbiology" – Michael J. Pelczar, E.C.S.Chan and Noel R. Krieg, 5th edition, Tata McGRAW –HILL Edition, 1993.
2.	A handbook of elementary Microbiology by H.A. Modi, Shanti Prakashan, Rohtak Haryana
3.	Principles of Microbiology, Ronald m. Atlas, 2nd Edition, Wm. C. Brown publishers, 1995
4	"General Microbiology", by C.B. Powar and H.F. Daginawala, volume-II, Himalaya Publishing House, Reprint-2002
On-line resources to be used if available as reference material	
Lectures and notes of NPTEL.	

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B.Sc. (Microbiology) Semester V

Course Code	US05MIMIC02	Title of the Course	Practical for methods in food and dairy microbiology
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	The main objective is to ensure that the student develops a clear comprehension of the concepts of applied areas of food and dairy microbiology. The student will get knowledge of various methods employed for food preservation and food quality check.

Course Content		
Unit	Description	Weightage* (%)
1.	Isolation of food born bacteria from food products.	
2	Isolation of spoilage microorganisms from bread, fruits and vegetables.	
3	Effect of temperature on the spoilage of food products	
4	Microbiological analysis of food and milk: Standard plate count for milk and food samples (Demonstration)	
5	Microbiological analysis of food and milk: Detection and enumeration of coliforms by MPN	
6	Microbiological analysis of milk : Determination of microbial load by use of MBRT	
7	Microbiological analysis of milk : Detection of acid-fast bacteria in milk.	

Teaching-Learning Methodology	• By briefing them with the theoretical aspects as well as providing them with the protocol (Aim, Requirements and Procedure) of the experiment to be performed using chalk and duster as well as power point presentation. • Demonstrations of the practical are also carried out and care is taken for aseptic handling and skill development for microbiological work in the laboratory. • Possibility of various results and their interpretation can also be discussed.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Analyse quality of various samples of food and milk bacteriologically
2.	Can isolate microbial flora of Food and develops various skill sets for bacteriological analysis.
3	Understands importance of bacteriological analysis in real field.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories
2.	Microbiology : A Practical Approach – Dr Bhavesh Patel and Dr Nandini Phanse
3	Experimental Microbiology - Rakesh J.Patel & Kiran R. Patel, Volume I& II
On-line resources to be used if available as reference material	

B.Sc. (Microbiology) Semester V

Course Code	US05MIMIC03	Title of the Course	Introduction to Industrial Microbiology
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	• The main objective is to make students aware that microorganisms influence many Industries. • Microorganisms are producers of many important compounds. • Also, get concept of screening of industrially important microorganisms.

Course Content		
Unit	Description	Weightage* (%)
1.	**Microorganisms and Industry I** a)Prerequisites to Practical Industrial Microbiological Processes b) Major Classes of Products and Processes c) Microorganisms Used in Industrial Processes d) Criteria for Choice of industrially important microorganisms. d) Industrial Uses of Bacteria: Lactic Acid Production • Vinegar Production • Amino Acid Production • Insulin	50%
2.	**Microorganisms and Industry II** a) Industrial Uses of Yeasts :Alcohol Fermentations • Bakers' Yeast • Food Yeasts b) Industrial Uses of Molds: Penicillin Production • Citric Acid • Enzyme Production c) Primary screening of antibiotic producing, organic acid producing, amylase producing and growth factor producing microorganisms and Significance of secondary screening d) Fermentation process outline.	50%

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such as chalk and talk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject. Video lectures of NPTEL and BISAG.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3) Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Recognize the potential of microorganisms which can produce variety of economically viable products.
2.	Learn how microorganisms can be screened for production of various compounds.

Suggested References:	
Sr. No.	References
1.	"Microbiology" – Michael J. Pelczar, E.C.S.Chan and Noel R. Krieg , 5th edition, Tata McGRAW –HILL Edition,1993.
2.	Principles of Fermentation Technology, 2nd edition P.F. Stanbury, A. Whitaker and S.J. Hall.
3.	Fermentation Technology- Vol I – H.A. Modi.
4	Industrial Microbiology. 1st edition, A.H. Patel.

On-line resources to be used if available as reference material
Lectures and notes of NPTEL.

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B.Sc. (Microbiology) Semester V

Course Code	US05MIMIC04	Title of the Course	Practical for Introduction to Industrial Microbiology
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	The main objective is to ensure that the student develops a clear comprehension of the concepts of applied areas of food and dairy microbiology. The student will get knowledge of various methods employed for food preservation and food quality check.

Course Content		
Unit	Description	Weightage* (%)
1.	Study of Industrially important microorganism: **yeast** : cultivation, isolation, study of morphology and cultural characters.	100%
2	Study of Industrially important microorganism by microscopic examination: molds like M*ucor, Rhizopus, Aspergillus and Penicillium.*	
3	Study of industrially important bacteria: *Bacillus subtilis* and *Bacillus megaterium.* (Isolation, cultivation, morphology and cultural characters.)	
4	Screening of amylase producing bacteria from soil.	
5	Screening of antibiotic producing bacteria from soil by crowded plate method.	
6	Screening of organic acid producing bacteria from soil.	
7	Visit to an Industry involved in production of Microbial products.	

Teaching-Learning Methodology	• By briefing them with the theoretical aspects as well as providing them with the protocol (Aim, Requirements and Procedure) of the experiment to be performed using chalk and duster as well as power point presentation. • Demonstrations of the practical are to be carried out and care is taken for aseptic handling and skill development for microbiological work in the laboratory. • Possibility of various results and their interpretation is also discussed.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Analyse quality of various samples of food and milk bacteriologically
2.	Can isolate microbial flora of Food and develops various skill sets for bacteriological analysis.
3	Understands importance of bacteriological analysis in real field.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories
2.	Microbiology : A Practical Approach – Dr Bhavesh Patel and Dr Nandini Phanse
3	Experimental Microbiology - Rakesh J.Patel & Kiran R. Patel, Volume I& II
On-line resources to be used if available as reference material	
Lectures and notes of NPTEL.	

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B. Sc. (Microbiology) Semester V

Course Code	US05SECMIC01	Title of the Course	Tools and techniques of r-DNA technology
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	• The main objective is to ensure that the student develops a clear comprehension of the concepts of recombinant DNA technology. The student will get acquainted with the tools and techniques used such as the enzymes, vectors, and cloning methods that can be used, and the applications of cloning such as creation of DNA libraries and recombinant products

Course Content

Unit	Description	Weightage* (%)
1.	**r DNA technology-I** (a) Outlines of Gene cloning (b) Isolation of DNA and RNA (c) Enzymes and steps in gene cloning: (1) Restriction endonucleases: Types, nomenclature, recognition sequences and cleavage pattern (2) DNA ligase and ligation, Modifications of cut ends (d) DNA sequencing : Maxam Gilbert and Sanger sequencing (e) Salient features of ideal vector (f) Vectors used in genetic engineering plasmids: pBr 322, pUC 18. Bacteriophages : lambda, cosmids. Artificial chromosome vectors: YAC and BAC (g) C-DNA library preparation	50%
2.	**r-DNA technology-II** **(**a) Salient feature of Host (b) Methods of introduction of DNA into Host cell: Transformation, transduction, transfection, electroporation, electron gun, micro injection (c) DNA probes: Definition, radioactive and non- radioactive labeling of probes. (d) Identification of nucleic acid: Southern blotting, Northern blotting, (e) Selection of recombinant clones: Colony hybridization, marker inactivation, Reporter gene (f) DNA fingerprinting and applications (g) Gene amplification using Polymerase chain reaction: Principle, procedure, types, application, advantages and limitations.	50%

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such as chalk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject. Video lectures of NPTEL and BISAG.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	25%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	25%
3.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to

1.	Are able to describe different types of plasmids and understand the consequences of recombination
2.	Develop, understand and apply tools and techniques involved in Genetic engineering.
3.	Understand the basic steps involved in gene cloning and its applications

Suggested References:

1.	Practical Biochemistry: Principles and Techniques – K. Wilson and Walker, 5th Edition, (Cambridge low price ed)
2.	Biotechnology – B.D.Singh, B.Sc edition, Kalyani publishers 3rd revised and enlarged reprint- 2008
3.	Biotechnology: The biological principles, M.D. Trevan and Gould. 11th reprint 2002
4	Concise notes on Biotechnology By Rajni Gupta and Tarun Rajpal, Tata McGraw Hill Education Private Limited, New Delhi, Pages:

On-line resources to be used if available as reference material, lectures and notes of NPTEL.

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B.Sc. (Microbiology) Semester V
Skill Enhancement Course

Course Code	US05SECMIC02	Title of the Course	Cultivation of economically important Fungi (practical)
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	The main objective is to ensure that the student develops skill sets for cultivation of important fungi namely yeast, mold and mushrooms. Student will get knowledge of various methods employed for cultivation and preservation of economically important fungi.

Course Content		
Unit	Description	Weightage* (%)
1	Study of various characters and applications of fungi. By a power point presentation	100%
2	Demonstration of aseptic handling in a microbiology lab and steps to follow for avoid contamination in routine microbiological laboratory work.	
3	Study of Media for cultivation of fungi: yeast, mold and mushrooms.	
4.	Isolation and study of morphology and cultural characters of yeast and mold .	
5	Cultivation of pure / previously isolated yeast and mold like M*ucor, Rhizopus, Aspergillus and Penicillium*.	
6	Preservation of pure cultures of yeast and mold.	
7	Spawn production for white button mushroom: *Agaricus bisporus*	
8	Cultivation of Oyster mushroom	
9	Cultivation of paddy straw mushroom: *Volvariella volvacea*	
10	Mushroom cultivation or visit to a nearby Mushroom cultivation unit to understand commercial cultivation of mushrooms	
11	Study and exhibition of various Mushrooms available in nature and	

	market.	

Teaching-Learning Methodology	• By briefing them with the theoretical aspects as well as providing them with the protocol (Aim, Requirements and Procedure) of the experiment to be performed using chalk and duster as well as power point presentation. • Demonstrations of the practical are to be carried out and care is taken for aseptic handling and skill development for microbiological work in the laboratory. • Possibility of various results and their interpretation are also to be discussed.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Cultivate economically important fungi like yeast, mold and mushrooms.
2.	Get an idea of challenges for mushroom production.
3	Can think for a small start up for mushroom production.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories
2.	Microbiology : A Practical Approach – Dr Bhavesh Patel and Dr Nandini Phanse

3	Experimental Microbiology – Rakesh J.Patel & Kiran R. Patel, Volume I& II
4	Experiments in Microbiology, plant pathology, tissue culture and microbial biotechnology, by K.R. Aneja, New age international publishers, reprint-2025
On-line resources to be used if available as reference material	

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B. Sc. (Microbiology) Semester V

Course Code	US05SECMIC03	Title of the Course	Microbes in Agriculture: microbial fertilizers and microbial insecticides
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	• Aim of this skill enhancement course is to make students ready for organic farming components. How microbes are the major player of organic agriculture for replacement of chemical agents with natural biological agents like bio fertilizers and bio insecticides.

Course Content

Unit	Description	Weightage* (%)
1.	**Biofertilization and Phytostimulation:** a) Biofertilizer: an overview b) Composting :Introduction, types, benifits and role of microbes c) Bacterial Biofertilizers: i) introduction, role in agriculture, production, selection of carrier and future prospects ii) Nitrogen fixing bacteria:characteristics and functions of: Rhizobium, Azotobacter, Azospirillum iii) Phosphate solubilizing , Potassium Mobilizing and micronutrient solubilizing bacteria. d) Blue Green Algae as Biofertilizer: Introduction, `Mechanism of Nitrogen fixation, Heterocytes, Symbiotic Cyanobacteria: Anabaena and Azolla, BGA as biofertilizer and future prospects of BGA. e) Mycorrhizal Biofertilizers: Introduction, Benefits , and future prospects.	50%
2.	**Microbial Control of Soil Borne Plant Pathogens and Insect pests** a) Biological control: Methods and agents. b) Microbial insecticides: (i) Introduction, General features, advantages and disadvantages of microbial insecticides (ii) Fungi as bioinsecticide: characters, mode of action and use of: *Beauveria bassiana, Verticillium lecanii* and *Nematophagous* fungi.	50%

	iii) Bacteria as Bioinsecticides: *Bacillus thuringiensis* (Bt): mass production and field application iv) Viruses as insecticides: Baculovirus, Entomopoxvirus,Cypovirus and Iridovirus.	

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such as chalk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject. Video lectures of NPTEL and BISAG.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	25%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	25%
3.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Are able to describe different types of microbes used as biofertilizers
2.	Know the applications of various microbes as insecticides and in plant disease control.
3.	Understand the importance of biofertilizers and microbial insecticides in sustainable agriculture

Suggested References:	
1.	Biofertilizers and biocontrol agents for organic farming, by Dr. Reeta Kholsa, KoJo Press, 2017
2.	Biofertilizers and Biopesticides, by Krishnendu Acharya, Surjit Sen, Manjula Rai, Techno World publication, 2nd Edition, 2024
On-line resources to be used if available as reference material, lectures and notes of NPTEL.	

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