Anekant Education Society's

uljaram Chaturchand College, of Arts, Science & Commerce, Baramati (Autonomous Institute)

Syllabus (CBCS) for T. Y. B. Sc. Microbiology

Semester II

w.e.f.

June 2021

Principal
Tuljaram Chaturchand College
Baramati

COURSE STRUCTURE FOR T. Y. B. SC. MICROBIOLOGY
(w.e.f. June2021)

Sr. No.	Class	Semester	Code	Paper	Paper Title	Credit	Marks (I + E)
1	T.Y.B.Sc.	V	MICRO3501	Theory	MEDICAL MICROBIOLOGY-I	3	40 + 60
2	T.Y.B.Sc.	V	MICRO3502	Theory	GENETICS AND MOLECULAR BIOLOGY- I	3	40 + 60
3	T.Y.B.Sc.	V	MICRO3503	Theory	ENZYMOLOGY	3	40 + 60
4	T.Y.B.Sc.	V	MICRO3504	Theory	IMMUNOLOGY – I	3	40 + 60
5	T.Y.B.Sc.	V	MICRO3505	Theory	FERMENTATION TECHNOLOGY-I	3	40 + 60
6	T.Y.B.Sc.	V	MICRO3506	Theory	FOOD AND DAIRY MICROBIOLOGY	3	40 + 60
7	T.Y.B.Sc.	V	MICRO3507	Practical Course I	APPLIED MICROBIOLOGY	2	40 + 60
8	T.Y.B.Sc.	V	MICRO3508	Practical Course II	BIOCHEMISTRY	2	40 + 60
9	T.Y.B.Sc.	V	MICRO3509	Practical Course III	CLINICAL MICROBIOLOGY	2	40 + 60
10	T.Y.B.Sc.	V	Certificate course			2	40 + 60
					Total	**26**	
11	T.Y.B.Sc.	VI	MICRO3601	Theory	MEDICAL MICROBIOLOGY-II	3	40 + 60
12	T.Y.B.Sc.	VI	MICRO3602	Theory	GENETICS AND MOLECULAR BIOLOGY- II	3	40 + 60
13	T.Y.B.Sc.	VI	MICRO3603	Theory	METABOLISM	3	40 + 60
14	T.Y.B.Sc.	VI	MICRO3604	Theory	IMMUNOLOGY – II	3	40 + 60
15	T.Y.B.Sc.	VI	MICRO3605	Theory	FERMENTATION TECHNOLOGY-II	3	40 + 60
16	T.Y.B.Sc.	VI	MICRO3606	Theory	AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY	3	40 + 60
17	T.Y.B.Sc.	VI	MICRO3607	Practical Course IV	BIOCHEMISTRY & MOLECULAR BIOLOGY	2	40 + 60
18	T.Y.B.Sc.	VI	MICRO3608	Practical Course V	HEMATOLOGY AND DIAGNOSTIC IMMUNOLOGY	2	40 + 60
19	T.Y.B.Sc.	VI	MICRO3609	Practical Course VI	PROJECT	2	40 + 60
					Total	**24**	
					Grand Total	**50**	

I: Internal Examination
E: External Examination

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Medical Microbiology-II**
Course Code	**: MICRO3601**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course Objective:-

Students will -

1. Acquired in-depth knowledge of chemotherapy and its application in the treatment of various infectious diseases, contributing to advancements in medical science.
2. Be proficient in analyzing and evaluating the mode of action of antimicrobial agents, fostering critical thinking and problem-solving skills in the field of infectious diseases.
3. Possess comprehensive knowledge of drug resistance mechanisms, enabling them to contribute to the development of strategies for combating resistance in clinical settings.
4. Demonstrate effective communication skills in presenting information related to the classification, life cycle, and characteristics of various infectious agents, facilitating collaboration with healthcare professionals and researchers.
5. Be equipped with the skills to conduct laboratory diagnosis and epidemiological studies, contributing to public health initiatives and disease prevention strategies.
6. Understand the importance of prophylaxis and chemotherapy in the management of infectious diseases, contributing to the overall well-being of human and animal populations.
7. Be well-versed in the characteristics and pathogenicity of specific human and animal pathogenic viruses, promoting awareness and understanding in the context of public health and veterinary medicine.

Course Outcomes :

Students will able to-

CO1	Understand the desirable parameters of a good chemotherapeutic agent, including selective toxicity, bioavailability, and knowledge of pharmacokinetic parameters such as MIC, MBC, and LD-50.
CO2	Demonstrate knowledge of different routes of drug administration and their implications in the context of chemotherapy
CO3	Analyze the mode of action of various antimicrobial agents on bacteria, fungi, viruses, and protozoa, including their impact on cell structures and key metabolic processes.
CO4	Comprehend the mechanisms and reasons behind drug resistance, including alterations in target sites, blockage of drug transport, inactivation of drugs, and metabolic bypass.
CO5	Students will study and understand the classification, life cycle, morphological characteristics, viability, pathogenicity, pathogenesis, symptoms, laboratory diagnosis, epidemiology, prophylaxis, and chemotherapy of selected protozoan and fungal parasites.

CO6 Gain insight into the characteristics, pathogenicity, laboratory diagnosis, epidemiology, and measures for prophylaxis and chemotherapy for human and animal pathogenic viruses.

CO7 Provide conceptual knowledge of different viral, protozoan & fungal pathogenic microorganisms

Credit No.	Topic	Number of lectures
I	**Chemotherapy**	**16**
	Unit 1. Introduction to Chemotherapy: a. Desirable parameters of good chemotherapeutic agent (Selective toxicity, Bioavailibility of Drug, MIC, MBC, LD-50 value) b. Routes of drug administration	2 1
	Unit 2. Mode of action of following antimicrobial agents on: a. Bacterial: i) Cell wall (Beta lactams, Cycloserine, Bacitracin) ii) Cell membrane (Polymyxin, Monensin) iii) Protein synthesis (Streptomycin, Tetracyclin) iv) Nucleic Acids (Nalidixic acid, Rifamycin) v) Enzyme inhibitors (Trimethoprim, Sulfa drugs) b. Fungi (Griseofulvin, Amphotericin B, Nystatin) c. Viruses (Acyclovir, Remdesivir, Zidovudine) d. Protozoa (Metronidazole, Mepacrine)	 6 2 2 1
	Unit 3. Mechanism and reasons of drug resistance	2
	Alteration in target site, Blockage of transport of drug, Inactivation of drug, Metabolic bypass	
II	**Study of protozoan and fungal parasites :**	**16**
	Unit 1. Study of following groups of parasites (with respect to – Classification, life cycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy): *a. Plasmodium* *b. Entamoeba*	5 4
	Unit 2 : Study of following groups of fungal pathogens (with respect to – Morphological and cultural characteristics, Classification, Pathogenecity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *a. Candida,* *b. Aspergillus*	4 3

III	**Study of human and animal viral pathogens**	**16**
	Unit 1: Study of human pathogenic viruses: **(with respect to – Virion characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):** a. HIV b. COVID-19 (SARS-CoV-2) virus c. Dengue virus d. Influenza virus e. Polio virus f. Rabies virus g. Hepatitis A & B virus	2 2 2 2 2 2 2
	Unit 2: Study of animal virus : **FMD** (with respect to – Virion characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):	2

References:

1. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, BenjaminPub. Co. NY

2. Roitt, P.I: Mims, C.J. Medical Microbiology

3. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.

4. Medical Microbiology edited by Samuel Baron. Fourth Edition. (University of Texas Medical Branchof Galvesion)

5. Sherris, John C, Ed, Medical Microbiology: an Introduction to infectious diseases. ElsevierPublication II nd edition.

6. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion andMichael.

7. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY

8. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20th Edition, McGraw-Hill Professional Publishing.

9. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17th Edition

10. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, OrientLongman.

Mapping of Program Outcomes with Course Outcomes

Weightage:1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3		2	2	3	2		
CO2	2					2			
CO3	3	3		2	2	2	1		
CO 4	2	2		2		2	2		
CO 5	2	2	1	2		3	1		
CO 6	2	2	1	1		3	2		
CO 7	2					2			

Justification for the mapping

PO1: Disciplinary Knowledge:

All course outcomes align closely with PO1 as they are designed to provide in-depth disciplinary knowledge in the field of chemotherapy and the study of infectious agents. Students will gain knowledge of chemotherapeutic agents, drug administration, mode of action of antimicrobial agents, drug resistance mechanisms, and the characteristics of various pathogens.

PO2: Critical Thinking and Problem Solving:

Course outcomes 1, 3, 4, 5, and 6 align with PO2. Students are required to understand and critically analyze various aspects of chemotherapy, including drug properties, mechanisms of action, and characteristics of infectious agents. This involves problem-solving skills in assessing and addressing challenges related to drug resistance and the study of pathogens.

PO3: Social Competence:

Course outcome 5 and 6 indirectly contributes to social competence. Understanding the classification, life cycle, and epidemiology of pathogens is relevant for engaging with communities and implementing effective disease prevention strategies.

PO4: Research-related Skills and Scientific Temper:

Course outcomes 1, 3, 4, 5, and 6 directly align with PO4. Students are expected to analyze drug properties, understand the mode of action of antimicrobial agents, and study the characteristics of infectious agents. These activities contribute to the development of research-related skills and a scientific temper.

PO5: Trans-disciplinary knowledge

The course outcomes, particularly course outcome 1 and 3, provide foundational knowledge that can have trans-disciplinary applications. Understanding the properties of chemotherapeutic agents and the mode of action of antimicrobial agents contributes to broader discussions in healthcare and biotechnology.

PO6: Personal and Professional Competence:

All course outcomes contribute to personal and professional competence. Students will gain insights into drug properties, mechanisms of action, and characteristics of infectious agents, enhancing their professional capabilities in the field of healthcare and pharmaceuticals.

PO7: Self-directed and Life-long Learning:
Course outcomes 1, 3, 4, 5, and 6 contribute to PO7 by fostering a mindset of self-directed and life-long learning. Graduates are expected to continuously update their knowledge in the dynamic field of chemotherapy and infectious diseases.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Genetics and Molecular Biology II**
Course Code	**: MICRO3602**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course Objective:-

Microbial Genetics is an undergraduate T.Y. B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing, and understanding biological genetic information. It develops knowledge of the underlying theories of genetics which exhibits a broad understanding of genetic exchange among prokaryotes. It gives an overview of recombinant DNA technology and biotechnology applications utilizing genetic manipulation.

Course Outcomes:

CO1 Understand the different mode of gene transfer in prokaryotic cell
CO2 Understand the concept of recombination
CO3 Use the recombination for gene mapping.
CO4 Solve problems based on mapping
CO5 Apply the recombinant DNA technology for generation of engineered DNA
CO6 Apply the recombination DNA technology to address the real world challenges
CO7 Apply the recombination DNA technology for betterment of society

Credits	Unit	Topic	No. of Lectures
I	**1**	**Gene Transfer** **Transformation** a) Discovery of natural transformation b) Natural transformation in gram positive bacteria(*Streptococcus pneumoniae*) c) Natural transformation in gram negative bacteria(*Haemophilus influenzae*) d) Artificial transformation	5

	2	**Transduction** a) Discovery of transduction b) Generalized transduction (P22) c) Specialized transduction (Lambda phage)	5
	3	**Conjugation** a) Discovery of conjugation b) F plasmid c) Cross $F^+ \times F^-$ d) Formation of HFr cell e) Cross HFr × F^- f) Formation of F'	6
II	**4**	**Recombination mapping** a) Definition of Recombination b) Recombination mapping: Map unit and Recombination frequency c) Mapping by co-transformation d) Mapping by co-transduction e) Mapping by conjugation (Interrupted mating experiment) f) Mapping by Tetrad analysis: 1. Mendel's laws 2. Eukaryotic cell cycle 3. Mitosis 4. Meiosis 5. Gene mapping by Tetrad analysis in *Neurospora crassa*	1 1 2 2 2 8
III	**5**	**Recombinant DNA Technology** a. Types of restriction enzyme b. Nomenclature of restriction enzyme c. Cutting of DNA using restriction enzyme d. Vectors: Plasmid, lambda phage, Cosmid and Phagemid e. Joining of DNA: ligase, linker, adapter, Homopolymer tailing f. Transfer of recombinant DNA in to host cell: g. Screening of recombinant DNA: Insertional inactivation and Blue white assay	1 1 1 6 4 1 2

References:

1. Freifelder D. (2005). Molecular Biology. 2nd Edition. Narosa Publishing House Pvt.Limited, India.
2. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics. 8th edition. John Wiley and Sons Publication. ISBN-13: 9788126510436
3. Lewin's GENES X (2011). Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). 10th Edition. Sudbury, Mass.: Jones and Bartlett, c2011.
4. Lodish H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., Martin K. C., Yaffe M. and Amon A. (2021). Molecular Cell Biology, 9th Edn. Macmillan Learning. ISBN: 9781319208523
5. Primrose S. B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing: U.S.A.
6. Russel P. J. (2000). Fundamentals of Genetics. Publisher: Benjamin/Cummings.ISBN: 9780321036261
7. Russel P. J. (2010). iGenetics: A Molecular Approach. 3rd Edition. Benjamin Cummings.ISBN: 9780321569769
8. Sambrook J. F. and Russel D. W. (Editors). (2001). Molecular cloning, A laboratory manual (3rd Edition.). Volumes 1, 2, and 3. Cold Spring Harbor Laboratory Press. ISBN- 978-0-87969-577-4
9. Stanier R. Y. (1999). General Microbiology. 5th Edition. Palgrave Macmillan
10. Strickberger M.W. (2012). Genetics. 3rd Edition. New Delhi: PHI Learning Gardner
11. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014). Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436
12. Robert Weaver, "Molecular biology", 3rd edn. Mc Graw Hill international edition.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2							3
CO2	3	2			2				3
CO3	3	3		2					3
CO 4	2	3							3
CO 5	3	3		3					3
CO 6	3	3		3				2	3
CO 7	3	3	3				3		3

Justification for the mapping

PO1 Disciplinary Knowledge

CO1. Understand the different modes of gene transfer in prokaryotic cell: 3 - This directly contributes to disciplinary knowledge in molecular genetics.
CO2. Understand the concept of recombination: 3 - Recombination is a fundamental aspect of genetics and molecular biology.
CO3. Use recombination for gene mapping: 3 - Applying recombination for gene mapping is an advanced concept within genetics.
CO4. Solve problems based on mapping: 2 - Problem-solving in mapping requires a deep understanding of gene transfer and recombination.
CO5. Apply recombinant DNA technology for the generation of engineered DNA:- Applying recombinant DNA technology contributes to disciplinary knowledge in genetic engineering.
CO6. Apply recombinant DNA technology to address real-world challenges: 3 - Application of genetic engineering to address challenges extends disciplinary knowledge to practical applications.
CO7. Apply recombinant DNA technology for the betterment of society: 3 - Applying genetic engineering for societal benefits aligns with disciplinary knowledge.
Justification: All course outcomes directly contribute to building disciplinary knowledge in genetics and molecular biology, with various levels of complexity and practical application.

PO2 Critical Thinking and Problem Solving

CO1. Understand the different modes of gene transfer in prokaryotic cell: 2 - Critical thinking is required to understand the complexities of gene transfer.
CO2. Understand the concept of recombination: 2 - Critical thinking is involved in grasping the concept of genetic recombination.
CO3. Use recombination for gene mapping: 3 - Applying recombination for gene mapping involves critical thinking and problem-solving.
CO4. Solve problems based on mapping: 3 - This directly involves critical thinking and problem-solving skills.
CO5. Apply recombinant DNA technology for the generation of engineered DNA: 3 - Applying recombinant DNA technology requires critical thinking.
CO6. Apply recombinant DNA technology to address real-world challenges: 3 - Addressing real-world challenges with genetic engineering necessitates critical thinking and problem-solving.
CO7. Apply recombinant DNA technology for the betterment of society: 3 - Utilizing genetic engineering for societal benefits requires critical thinking.
Justification: All course outcomes contribute to critical thinking, with a strong emphasis on problem-solving in genetic mapping and recombinant DNA technology applications.

PO3 Social Competence

CO7. Apply recombinant DNA technology for the betterment of society: 3 - Applying genetic engineering for societal betterment directly links to social competence.
Justification: Utilizing genetic engineering for societal benefits demonstrates an understanding of social implications and the responsible application of technology.

PO4 Research-related Skills and Scientific Temper

CO3. Use recombination for gene mapping: 2 - Research-related skills are involved in applying recombination for gene mapping.
CO5. Apply recombinant DNA technology for the generation of engineered DNA: 3 - Recombinant DNA technology involves a scientific temper and research skills.
CO6. Apply recombinant DNA technology to address real-world challenges: 3 - Addressing real-world challenges with genetic engineering requires strong research-related skills.
Justification: These outcomes contribute to developing research-related skills and a scientific temper by applying advanced genetic techniques to practical problems.

PO5 Trans-disciplinary Knowledge

CO6. Apply recombinant DNA technology to address real-world challenges: 2 - Addressing real-world challenges with genetic engineering involves considerations beyond disciplinary boundaries.
Justification: While primarily focused on genetics, addressing real-world challenges may require knowledge and collaboration from various disciplines.

PO6 Personal and Professional Competence

Mapping Not Applicable: The course outcomes are more focused on technical aspects of genetics and lack a direct connection to personal competence.
PO7 Effective Citizenship and Ethics

CO7. Apply recombinant DNA technology for the betterment of society: 3 - Utilizing genetic engineering for societal benefits directly links to effective citizenship and ethical considerations.
Justification: Applying genetic engineering for the betterment of society implies a responsibility towards ethical considerations and effective citizenship.

PO8 Environment and Sustainability

CO6. Apply recombinant DNA technology to address real-world challenges: 2 - Addressing real-world challenges with genetic engineering may have implications for environmental sustainability.
Justification: The application of genetic engineering in real-world challenges may involve considerations related to environmental impact and sustainability.

PO9 Self-directed and Life-long Learning
CO1. Understand the different modes of gene transfer in prokaryotic cell: 3 - Foundational understanding for continuous learning in genetics.
CO2. Understand the concept of recombination: 3 - Recombination is a fundamental concept for lifelong learning in molecular biology.
CO3. Use recombination for gene mapping: 3 - Applying recombination for gene mapping contributes to skills for continuous learning.
CO4. Solve problems based on mapping: 3 - Problem-solving in mapping contributes to skills for continuous learning.
CO5. Apply recombinant DNA technology for the generation of engineered DNA: 3 - Application of recombinant DNA technology is crucial for continuous learning.
CO6. Apply recombinant DNA technology to address real-world challenges: 3 - Addressing real-world challenges with genetic engineering extends skills for continuous learning.
CO7. Apply recombinant DNA technology for the betterment of society: 3 - Utilizing genetic

engineering for societal benefits require continuous learning.
Justification: All course outcomes directly contribute to building a foundation for self-directed and lifelong learning in genetic and molecular science

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Metabolism**
Course Code	**: MICRO3603**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course objective:

1. Comprehend the fundamental metabolic pathways involved in energy production, including glycolysis, the Krebs cycle, and oxidative phosphorylation.
2. Understand the principles of anabolic and catabolic reactions, their interplay, and regulation in the context of metabolic pathways.
3. Examine the metabolism of major macromolecules, including carbohydrates, lipids, proteins, and nucleic acids, elucidating their interconnections and metabolic fates.
4. Understand how energy derived from metabolic processes is transformed, stored, and utilized by cells for various physiological functions.
5. Comprehend the fundamental principles and mechanisms of photosynthesis in microorganisms, including cyanobacteria, purple and green sulfur bacteria, and algae.
6. Examine the diverse photosynthetic pigments, such as chlorophylls, bacteriochlorophylls, carotenoids, and phycobilins, and understand their roles in different microbial systems.
7. Understand the organization and function of electron transport chains in microbial photosynthesis, elucidating the flow of electrons and ATP/NADPH generation.

Course Outcomes :

CO1. Acquire a comprehensive understanding of essential metabolic pathways involved in energy generation, encompassing glycolysis, the Krebs cycle, and oxidative phosphorylation.

CO2. Demonstrate a profound understanding of the relationship between anabolic and catabolic reactions, their coordination, and regulatory mechanisms within metabolic pathways.

CO3. Investigate the metabolism of major macromolecules (carbohydrates, lipids, proteins, nucleic acids), comprehending their interconnectedness and diverse metabolic destinies.

CO4. Grasp the transformation, storage, and utilization of energy obtained from metabolic processes for various cellular functions and physiological activities.

CO5. Attain a comprehensive understanding of the fundamental mechanisms of photosynthesis in various microorganisms, encompassing cyanobacteria, purple and green sulfur bacteria, and algae.

CO6. Analyze and understand the roles of diverse photosynthetic pigments (chlorophylls, bacteriochlorophylls, carotenoids, phycobilins) in different microbial systems.

CO7. Comprehend the structural organization and functional significance of electron transport chains in microbial photosynthesis, elucidating ATP/NADPH generation through electron flow.

Credit	Topics	No. of Lectures
I	**Unit 1: Membrane transport mechanisms:** i. Composition and Architecture of cell Membrane ii. Passive transport - Diffusion, Osmosis, Facilitated transport iii. Active transport - Active transport systems in bacteria iv. Group translocation of sugars in bacteria v. Ionophores: Mechanism and examples	 **1** **3** **2** **1** **1**
	Unit 2: Bacterial Photosynthesis: i. Habitat and examples of photosynthetic bacteria ii. Photosynthetic apparatus iii. Oxygenic and Anoxygenic mechanisms iv. Calvin cycle and its regulation	 **2** **2** **2** **2**
II	**Unit 1: Bioenergetics:** i. Laws of thermodynamics ii. Concepts of free energy, entropy iii. High energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds	 **1** **2** **5**
	Unit 2: Mitochondrial electron transport chain: i. Components of ETC ii. Arrangement of different components in the inner membrane iii. Structure and function of ATP synthase iv. Inhibitors and uncouplers of ETC v. Oxidative phosphorylation vi. Energetics of electron transport chain	 **1** **2** **1** **1** **2** **1**
III	**Biosynthesis and Degradation:** **Unit1: Chemistry, concept of polymerization of Macromolecules**: i. Polysaccharides. (Starch, Glycogen) ii. Lipids(Fatty acids, triglycerides and phospholipids)	 **4** **4**
	Unit 2: Degradation of macromolecules: i. Polysaccharides (starch, glycogen) ii. Lipids (fatty acids oxidation) iii. Proteins (urea cycle)	 **4** **2** **2**

References:

1. Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac MillanWorthPub. Co. New Delhi
2. Segel Irvin H. (1997). *Biochemical Calculations*. 2nd Ed. John Wiley and Sons, NewYork.
3. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, PublishingCompany, California.
4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines ofBiochemistry* 5th Ed , John Wiley and Sons, New Delhi
5. Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry,

Horwood Pub. Co. Chinchester, England.
6. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford UniversityPress, New York.
7. David A. Hall & Krishna Rao (1999) Photosynthesis (Studies in Biology) 6th Edition, Cambridge University Press, London

Mapping of Program Outcomes with Course Outcomes

Weightage:1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

	Programme Outcomes (POs)								
CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2		3							
CO3	2								
CO 4						3			
CO 5					3				
CO 6	2								
CO 7	3								

Justification for the mapping

PO1: Disciplinary Knowledge
PO1 is strongly related to CO1, CO3, CO6, and CO7 as these objectives are directly associated with gaining disciplinary knowledge in biochemistry and understanding metabolic pathways, macromolecule metabolism, photosynthetic pigments, and electron transport chains.

PO2: Critical Thinking and Problem solving
PO2 aligns directly with CO2 as it involves demonstrating an understanding, coordination, and regulatory mechanisms in anabolic and catabolic reactions, requiring critical thinking and problem-solving skills.

PO5: Trans-disciplinary knowledge
PO5 is strongly connected to CO5 as it involves trans-disciplinary knowledge, understanding photosynthesis in various microorganisms.

PO6: Personal and professional competence
PO6 directly aligns with CO4 as it relates to understanding energy transformation, storage, and utilization, enhancing personal and professional competence.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Immunology – II**
Course Code	**: MICRO3604**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course Objective:

1. To enrich the students knowledge about immunity and infections.
2. To develop expertise in immunological processes.
3. To enrich student's knowledge and train them in immunology.
4. To understand the general and scientific responsibilities while working in medical field.
5. To develop opportunities in entrepreneurships.
6. To enhance the knowledge of immunology.
7. To inculcate the Students and Society for immunization

Course Outcomes:

On completion of the course, the students will be able to

CO1	Theoretical understanding of basic immunological processes.
CO2	Each student would be able to understand immune mechanism of our body.
CO2	Students would be able to apply his knowledge to society for human welfare.
CO4	Establishment and development as an entrepreneur.
CO5	Apply his knowledge to society for human welfare.
CO6	Establishment and development as an entrepreneur.
CO7	Explain the basic knowledge of immunity.

Credit	Topic	No. of Lectures
I	**Unit 1: Antigen-Antibody Interactions** **Principles of interactions:** Antibody affinity and avidity, ratio of antigen antibody, lattice hypothesis and two stage theory, antigen-antibody reaction kinetics (dialysis equilibrium experiment) **Visualization of antigen antibody complexes:** a. Precipitation reactions: in fluid and in gel, immunoelectrophoresis b. Agglutination reactions: hemagglutination, bacterial agglutination, passive agglutination and agglutination-inhibition c. Immunofluorescence techniques: direct and indirect, FACS d. ELISA, biotin-avidin system e. RIA f. Jerne's hemolytic plaque assay	8
	Unit 2: Major Histocompatibility Complex a. Structure of MHC in man and mouse b.Structure and functions of MHC class–I and class–II molecules c. Polymorphism of MHC molecules d. MHC antigen typing (microcytoxicity and mixed lymphocyte reaction)	5
	Unit 3: Cytokines Types, General characters and role in immune activation, Interferons, Interleukins and TNFs	3
II	**Unit 1: Immunohematology** a. Systems of blood group antigens b. ABO system - Biochemistry of blood group substances, Bombay blood group, Inheritance of ABH antigens c. Rh system d. Laboratory methods of blood group typing, Coomb's test e. Medico-legal applications of blood groups f. Blood banking practices, transfusion reactions	10
	Unit 2: Public Health Immunology a. Types of vaccines and Antisera b. Current perspective of vaccines. c. Immunization schedules: principles, schedules in developing and developed countries	6
	Unit 1: Hypersensitivity a. Immediate and delayed type hypersensitivity b. Gell and Coomb's classification of hypersensitivity – mechanism with examples for type I, II, III and IV	6

III	**Unit 2: Autoimmunity and Autoimmune diseases** a. Immunological tolerance b. Types of autoimmune diseases c. Factors contributing development of autoimmune diseases d. Immunopathological mechanisms e. Diagnosis and treatment of autoimmune diseases: Myasthenia gravis and Rheumatoid arthritis f. Therapeutic immunosuppression for autoimmunity	7
	Unit 3: Hybridoma Technology a. Preparation, HAT selection and propagation of hybridomas secreting monoclonal antibodies b. Applications of monoclonal antibodies	3

References:

1. Abul K. Abbas and Andrew H. Lichtman. Basic Immunology- Functions and Disorders of Immune System. 2nd Ed. 2004. Saunders. Elsevier Inc. PA. USA.
2. Aderem, A., and Underhill, D.M.: Mechanisms of phagocytosis in macrophages. Annu. Rev. Immunol. 1999, 17:593–623.
3. Aananthanarayan R: 1996, Textbook of Microbiology, 5th Edition. Orient Longman

1. Austin J. M. and Wood K. J. (1993) Principles of Molecular and Cellular Immunology, Oxford University Press, London.

4. Barret James D. (1983) Text Book of Immunology 4th edition, C. V. Mosby & Co. London.
5. Biotechnology by open learning series (BIOTOL), (1993), Defense Mechanisms, Butterworth and Heinemann Ltd., Oxford
6. Bohlson, S.S., Fraser, D.A., and Tenner, A.J.: Complement proteins C1q and MBL are pattern recognition molecules that signal immediate and long-term protective immune functions. Mol. Immunol. 2007, 44:33–43.
7. Chatterji C. C. (1992) Human Physiology Vol. 1 &2, Medical Allied Agency, Calcutta.
8. De Smet, K., and Contreras, R.: Human antimicrobial peptides: defensins, cathelicidins and histatins. Biotechnol. Lett. 2005, 27:1337–1347.
9. Ganz, T.: Defensins: antimicrobial peptides of innate immunity. Nat. Rev. Immunol. 2003, 3:710–720.10. Garrison Fathman, Luis Soares, Steven M. Cha1 & Paul J. Utz, (2005), An array of possibilities for the study of autoimmunity, Nature Rev., 435|2:605 611Bendelac Albert, Paul B. Savage, and Luc Teyton, (2007)
10. Guyton A. C. and Hall J. E. (1996) Text Book of Medical Physiology, Goel Book Agency, Bangalore.
11. Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. IMMUNOBIOLOGY INTERACTIVE. 2005. Garland Science Publishing. USA.

12. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby, W. H. Freeman, 2007, Kuby, Immunology, 5th Edition

2. Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th Ed. W. H. Freeman & Co., New York

13. Pathak S. S. and Palan V. (1997) Immunology - Essential and Fundamental, Pareen Publications Bombay.

14. Roitt Evan, Brostoff J. Male D. (1993) Immunology 6th Ed., Mosby & Co. London.

15. Roitt I. M. (1988) Essentials of Immunology, ELBS, London.

16. Roitt M. (1984) Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

17. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V., (1982), Basic and Clinical Immunology, 4th Ed., Lange Medical Publications, Maruzen Asia Pvt. Ltd., Singapore

18. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi.

19. Zanetti, M.: The role of cathelicidins in the innate host defense of mammals. Curr. Issues Mol. Biol. 2005, 7:179–196.

20. Zeev Pancer and Max D. Cooper, (2006), The Evolution of Adaptive Immunity, Ann. Rev. Immunol., 24: 497–518.

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	3		2	3	3	
CO2	3			2	3				3
CO3	3	2		3				2	
CO4	3		2				2		
CO5	3			2					2
CO6	3								
CO7	3				2	3			2

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: Students will acquire theoretical expertise in immunology...

CO2: Understanding the immune mechanism will contribute to disciplinary

knowledge.

CO3: Application of immunological knowledge to society for practical purposes..

CO4: Entrepreneurship involving innovative applications of immunological knowledge.

CO5: Knowledge about the evolving nature of microbial taxonomy and systematic

CO6: Enriching the immune mechanism implies contributing to and expanding disciplinary knowledge in immunology.

CO7: Creating awareness about immunization involves disseminating disciplinary knowledge to the public.

PO3 **Social Competence:**

CO1: Effective communication and collaboration with diverse stakeholders, including the public, healthcare professionals, and policymakers, may be necessary..

CO4: Building relationships, networking, and effective communication are key components of establishing and developing oneself as an entrepreneur.,

PO4 **Research-related skills and Scientific temper:**

CO1: Students may engage in literature reviews, data analysis, and critical evaluation of existing research to build a strong foundation in immunological processes..

CO2: Students may develop observational and analytical skills to critically assess scientific information.

CO3:It could involve conducting studies, collecting data, and analyzing results to ensure evidence-based applications..

CO5: Students will be updated with the latest developments in immunology, enabling students to provide relevant and evidence-based explanations...

PO5 **Trans-disciplinary knowledge:**

CO2: Immunological processes by considering insights from related fields such as biochemistry, genetics, and microbiology.

CO7: The basic knowledge of immunity, incorporating perspectives from related disciplines such as education, communication, and psychology may enhance the effectiveness of communication, making it more accessible to diverse students.

PO6 **Personal and professional competence:**

CO1: Developing a theoretical understanding of immunological processes contributes to personal competence by acquiring specialized knowledge in the field.

CO7: Clear communication contributes to professional competence in conveying complex information to diverse students.

PO7 **Effective Citizenship and Ethics:**

CO1: Students are likely encouraged to understand the ethical implications of their work in immunology.

CO4: Entrepreneurs are encouraged to consider the social impact of their ventures and adhere to ethical business practices for the greater good

PO8 **Environment and Sustainability:**

CO1: Sustainable practices in research and laboratory work can be emphasized to minimize the environmental impact of scientific activities associated with understanding immunological processes..

CO3: Entrepreneurs may be guided to establish and develop ventures with practices

that align with environmental sustainability..

PO9 **Self-directed and Life-long learning:**

CO2: Students may be encouraged to go beyond the classroom, explore additional resources, and deepen their understanding through personal research.

CO5: Students may be motivated to stay informed about evolving societal needs, necessitating continuous learning and adaptation.

CO7: Students may be encouraged to stay informed about the latest developments in immunology to provide accurate and relevant explanations.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Fermentation Technology - II**
Course Code	**: MICRO3605**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course Objectives:

1. To cater the needs of students for building up their careers in industries such as pharmaceutical, food, dairy and fermentation.
2. To develop expertise in industrial production processes.
3. To enrich student's knowledge and train them in industrial microbiology.
4. To understand the general and scientific responsibilities while working in industrial sector.
5. To understand the opportunities towards entrepreneurship.

B. Learning outcome:

1. Theoretical understanding of principles and basic protocols of large-scale industrial production processes.
2. Laboratory exercises shall help the students to directly work in different divisions of industries.
3. Acquaintance to the several industrial production processes that results into well-trained and skilled man-power.
4. Establishment and development as an entrepreneur.

Credit No.	Topic	Lectures
I	**Unit 1: Introduction to Solid state fermentation and Submerged fermentation**	**2**
	Unit 2: Uses of following primary metabolites and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet): a. Vitamins (B12 & Riboflavin) b. Amino acids (Glutamic acid & Lysine) c. Organic acids (Citric acid, Acetic acid & Lactic acid)	**4** **4** **6**
II	**Unit 1: Uses of following secondary metabolites and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet):** a. Ethanol	**2**

	b. Alcoholic beverages (Beer & Wine) c. Antibiotics (Penicillin & Streptomycin)	**4** **5**
	Unit 2: Uses of the following enzymes and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet): a. Amylase b. Protease c. Esterase	 **2** **2** **1**
III	**Unit 1: Uses of the following fermentation products and their large scale production (with respect to microbes involved, production process, and flowsheet):** a. Baker's and Distiller's yeast b. Edible mushroom c. Dairy products: i. Cheese (Cheddar & Swiss) ii. Yoghurt	 **2** **2** **2** **1**
	Unit 2: Large scale production of the following: a. Viral vaccines (Polio, Rabies) b. Bacterial vaccine (Tetanus toxoid) c. Immune Sera	 **3** **1** **2**
	Unit 3: Steroid transformation by microbes	**3**

References:

1. A. H. Patel. (1985), *Industrial Microbiology,* Macmillan India Ltd.
2. *Bioreactor Design and Product Yield (*1992*),* BIOTOL series, Butterworths Heinemann.
3. Casida, L. E., (1984), *Industrial Microbiology*, Wiley Easterbs, New Delhi
4. Dilip K. Arora editor, *Fungal Biotechnology in agriculture, food and environmental applications (Mycology),* 2005. Marcel Dekker, Inc. New York. Basel
5. Indian Pharmacopia and British Pharmacopia.
6. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) *Bioprocess Engineering: Syatems, Equipment and Facilities*, John Wiley and Sons Inc.
7. *Operational Modes of Bioreactors*, (1992) BIOTOL series, Butterworths Heinemann.
8. Peppler, H. L (1979), *Microbial Technology*, Vol I and II, Academic Press, New York.
9. Peter F. Stanbury. *Principles Of Fermentation Technology,* 2E, Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009
10. Prescott, S.C. and Dunn, C. G., (1983) *Industrial Microbiology,* Reed G. AVI tech books.
11. Reed G. Ed. Prescott and Dunn's *Industrial Microbiology.* 4th Ed., CBS Pub. New Delhi.

12. Shuichi and Aiba. *Biochemical Engineering*. Academic Press. 1982.
13. Stanbury, P. F. and Whittaker, A. (1984) *Principles of Fermentation technology*, Pergamon press.
14. Sudhir U. Meshram, Ganghdhar B Shinde, *Applied Biotechnology.* I.K. International Pvt. Ltd. 2009.
15. Moo-Young M. (2004) Comprehensive biotechnology, Vol- 1 to 4, Pergamon press Ltd, England.
16. Flickinger, M. C. and Drew, S. W. (1999). Encyclopedia of Bioprocess Technology, Wiley-Interscience, New Jersey.
17. Van Damme E. J. (1984) *Biotechnology of Industrial Antibiotics*, Marcel Dekker Inc. New York.
18. Wiseman A.(1985) *Topics in Enzyme and Fermentation* - Biotechnology, Vol. 1 and 2, John Wiley and Sons, New York.

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes(POs)								
Courseoutcomes(COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3			2		2			2
CO2	3	2	2	2				2	
CO3	3			2					
CO4	3					2			
CO5	3			2	2				
CO6	3								3
CO7	3	2	2			2	2		2

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1:The students will understand the basic protocols and principles of industrial processes.

CO2: The students shall learn about the importance of fermentation categories.

CO3: The students shall be able to understand the different types of fermentation products.

CO4: Students shall learn about the importance of large scale production.

CO5: The students shall acquire knowledge about protocols of biomass production.

CO6: Students shall come to know about the different types of vaccines.

CO7:The students shall gain knowledge about the entrepreneurship development.

PO2 **Critical Thinking and Problem Solving:**

CO2: The students shall be able to understand the effective use of selected techniques of fermentation.

CO7:The students shall know about the opportunities for entrepreneurs in microbiology.

PO3 **Social competence**

CO2: Students will understand the use of natural raw materials in fermentation industry.

CO7: The raw materials can be used as raw materials in the industrial processes for building up of business.

PO4 **Research-related skills and Scientific temper:**

CO1:The students will understand the basic protocols and principles of industrial processes important in research.

CO2: The students shall learn about the research methods to carry out fermentations.

CO3: Students will understand the natural raw materials that can be used during trials in research.

CO5:Thestudentswillbeableto learn basic experimental protocols important in research.

PO5 **Trans-disciplinary knowledge:**

CO5: Students will understand the protocols and calculations in running of fermentations.

PO6 **Personal and professional competence**

CO1: The students will be able to learn basic protocols used in fermentation industries.

CO4: Students shall understand different QC techniques important for professional development.

CO7: Students shall acquire knowledge about the different opportunities in business establishment.

PO7 **Effective citizenship Ethics**

CO7: As an entrepreneur, students may learn the citizenship ethics.

PO8 **Environment and sustainability**

CO2: Students will understand the natural raw materials which are the wastes of agricultural industries.

PO9 **Self directed and lifelong learning**

CO1:The students will understand the basic protocols and principles of industrial processes important in research.

CO6: Students shall understand different techniques of vaccine manufacturing.

CO7: Students shall acquire knowledge about the basic requirements needed for business establishment.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Theory**
Course Name	**: Agricultural and Environmental Microbiology**
Course Code	**: MICRO3606**
No. of Credits	**: 03**
No. of Lectures	**: 48**

Course Objective:

1. Explore the molecular mechanisms underlying disease resistance in plants
2. To investigate integrated pest management approaches.
3. To understand the principles of antisense RNA technology in plant disease control.
4. To examine the introduction, types, and advantages of biopesticides
5. To understand the concepts of bioremediation and bioaugmentation.
6. To explore the bioleaching of copper and gold, along with the advantages of bioleaching.
7. To analyze the advantages and limitations of microbial biosensors and biochips

Course Outcomes:

CO1 Students will comprehend the factors influencing plant growth and apply strategies for disease resistance and environmental tolerance.

CO2 Students will evaluate and choose appropriate methods for plant disease control, considering chemical, biological, and integrated approaches.

CO3 Students will apply advanced tools and techniques in plant biotechnology, including genetic modifications and RNA-based technologies.

CO4 Students will understand and apply mechanisms of nitrogen fixation, phosphate solubilization, and the use of biofertilizers and biopesticides.

CO5 Students will analyze the role of microorganisms in environmental processes, focusing on bioremediation, bioaugmentation, and nanotechnology.

CO6 Students will evaluate the processes of bioleaching, considering its applications and advantages.

CO7 Students will understand and apply microbial biosensors and biochips for environmental monitoring.

Credit No.	Topic	Lectures
I	**Plant Pathology and Agricultural Technology**	
	UNIT 1. Plant growth improvement with respect to: a. Disease resistance b. Environmental tolerance	**4**
	UNIT 2. Methods of plant disease control a. Chemical control b. Eradication c. Biological control (employing bacterial and fungal cultures) d. Integrated pest management e. Application of viral proteins in controlling plant viral diseases f. Mycoviruses acting against fungal plant pathogens	**6**
	UNIT 3. Tools and techniques: a. Development of insect resistant plants (BT crops) b. Antisense RNA technology in plant disease control c. RNA interference (RNAi) technology in controlling plant pathogens	**6**
II	**Biofertilizers and Biopesticides**	
	UNIT 1. Mechanism of: **a. Nitrogen Fixation** **b. Phosphate solubilization** **c. Potassium mobilization** **d. Iron chelation**	8
	UNIT 2. Production, Methods of application and Uses of following biofertilizers: **a. Azotobacter** **b. Rhizobium** **c. Azospirillum** **d. Blue green algae** **e. Phosphate solubilizing microorganisms**	5
	UNIT 3. Biopesticides **a. Introduction** **b. Types of biopesticide** **c. Advantages**	3
III	**Environmental microbiology**	
	UNIT 1. Bioremediation and Bioaugmentation: **1. Bioremediation:** **a. Definition** **b. Role of plants & Microbes in Bioremediation of: Xenobiotics and Hydrocarbons** **c. Genetically Modified Microorganisms in Bioremediation** **2. Bioaugmentation:** **a. Definition** **b. Use of microbial cultures and enzymes for bioaugmentation**	6

	c. Applications	
	UNIT 2. Bioleaching: **a. Microorganisms used** **b. Bioleaching process** **c. Bioleaching of – Copper & Gold** **d. Advantages of Bioleaching**	4
	UNIT 3. Nanotechnology: **a. Introduction and application** **b. Environmental concerns of nanotechnology**	3
	UNIT 4. Microbial Biosensors and Biochips in Environmental Monitoring: **a. Definition, components, types, advantages & limitations** **b. Application of Biosensors and Biochips**	3

References:

1. Ajay Singh, Owen P. Ward, 2004 edition, Applied Bioremediation andPhytoremediation (Soil Biology). Springer
2. Banwart G. J. (1989). Basic Food microbiology, 2nd Edn. Chapman andHall. International Thompson Publishing.
3. Charles R. Lane, Paul Beales, Kelvin J. D. Hughes (2012). Fungal Plant Pathogens. 1st Edn. CABI Publishing.
4. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk andmilkproducts, 4th Ed. McGraw-Hill book Company, Incorporated.
5. David S. Ingram, N.F. Robertson (1999). Plant Disease.1st Edn.: Collins
6. George Nicholas Agrios (2005).Plant Pathology.5th Edn. Academic Press Inc.
7. James M. Jay, Martin J. Loessner, David A. Golden (2005). Modern food microbiology,7th Edn. Springer Science & Business.
8. John Postgate, (1998). Nitrogen Fixation. Cambridge University Press, K. S. Bilgrami, H. **A.** Dube (1984).A textbook of modern plant pathology. 7th Edn
9. Martin Alexander (1999). Biodegradation and Bioremediation. Academic Press
10. Matthew Dickinson, (2003). Molecular Plant Pathology. Garland Publishing Inc.
11. N. S. Subba Rao. (1995). Soil Microorganisms and Plant growth. 3rd Edn. SciencePubInc
12. R. Barry King, John K. Sheldon, Gilbert M. Long, 1997 Practical Environmental Bioremediation: The Field Guide, 2nd Edn. CRC Press
13. Sukumar. De (2001). Outlines of Dairy Technology. 1st Ed. Oxford UniversityPress Delhi.
14. Vani Educational Books, a division of Vikas publishing house. New Delhi.
15. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology, 5th Edn. McGraw-Hill Education (India).
16. Martin Alexander (1999). Biodegradation and Bioremediation. Academic Press
17. Matthew Dickinson, (2003). Molecular Plant Pathology. Garland Publishing Inc.

18. N. S. Subba Rao. (1995). Soil Microorganisms and Plant growth. 3rd Edn. SciencePub Inc
19. R. Barry King, John K. Sheldon, Gilbert M. Long, 1997 Practical EnvironmentalBioremediation: The Field Guide, 2nd Edn. CRC Press
20. Sukumar. De (2001). Outlines of Dairy Technology. 1st Ed. Oxford UniversityPressDelhi.
21. Vani Educational Books, a division of Vikas publishing house. New Delhi.
22. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology,5thEdn.McGraw-Hill Education (India).

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= **Moderate** or partial relation, 3= **Strong** or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3		3	3				3
CO2	3	2	3				3	2	
CO3	3	2	3			3			
CO4	3				2		3		
CO5	3							3	
CO6	3			3			2		
CO7	3	3				2			3

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: It contributes to a deep understanding of plant biology, agriculture, and sustainable practices

CO2: It centered around integrated pest management and knowledge of various plant disease control methods..

CO3: It involves advanced knowledge and skills in plant biotechnology, including genetic modifications and cutting-edge technologies..

CO4: Contributes to knowledge about sustainable agriculture practices and the use of bioresources.

CO5: Relate to environmental microbiology and the role of microorganisms in environmental processes.

CO6: It involves knowledge about industrial processes related to bioleaching.

CO7: It relates to the application of advanced techniques in microbial biosensors and biochips for environmental monitoring.

PO2 **Critical Thinking and Problem Solving:**

CO1: Students will critically analyze various factors affecting plant growth and make decisions about suitable strategies for disease resistance and environmental tolerance.

CO2: Evaluate different disease control methods and making informed decisions

based on critical analysis of their effectiveness, environmental impact, and sustainability.

CO3: Apply advanced biotechnological tools requires critical thinking to understand their implications, assess potential risks, and make decisions about their use..

CO7: Apply microbial biosensors and biochips for environmental monitoring involves solving problems related to data interpretation, system optimization, and effective monitoring strategies..

PO3 **Social competence:**

CO2 As students engage with various aspects of the course, ethical considerations are inherent.

CO3: Effective communication and collaboration skills are essential components of social competence. Throughout the course, students will need to communicate their understanding, collaborate on projects, and potentially engage with stakeholders or communities. Group projects, discussions, or case studies can enhance these skills.

PO4 **Research-related skills and Scientific temper:**

CO1: Students can develop research skills by conducting literature reviews, analyzing existing research on plant growth factors, and staying updated on the latest advancements in disease resistance and environmental tolerance strategies. CO6: The evaluation of bioleaching processes involves researching current applications, understanding the underlying chemistry and microbiology, and possibly contributing to ongoing research or development efforts..

PO5 **Trans-disciplinary knowledge:**

CO1: Integrate knowledge from plant biology, ecology, and environmental science to understand the interplay of factors affecting plant growth in diverse ecosystems..

CO4 Explore the intersections of microbiology, agronomy, and environmental science to understand and apply mechanisms related to soil fertility and sustainable agriculture...

PO6 **Personal and professional competence:**

CO4: Understanding and applying mechanisms in agriculture require problem-solving skills, critical thinking, and an awareness of the environmental impact of farming practices

CO7; Applying microbial biosensors requires attention to precision, technical proficiency, and a commitment to accurate data collection and interpretation.

PO7 **Effective Citizenship and Ethics:**

CO2: Encourages responsible agricultural practices by promoting integrated pest management, which reduces environmental impact and supports the health of ecosystems.

CO6: Explores industrial processes such as bioleaching, emphasizing the importance of responsible industrial practices and considering their broader societal implications.

PO8 **Environment and Sustainability:**

CO2: Promotes sustainable agriculture by emphasizing integrated pest management, reducing reliance on chemical pesticides and minimizing environmental impacts.

CO5: Examines the role of microorganisms in environmental processes, providing

insights into how microbial activities can be harnessed for sustainability, such as in bioremediation and nutrient cycling.

PO9 **Self-directed and Life-long learning:**

CO1: Establishes a foundation for continuous learning in plant biology and agriculture, encouraging students to view their education as a lifelong journey

CO7: Cultivates a mindset of lifelong learning by emphasizing the need for continuous adaptation to advancements in monitoring techniques for environmental health.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Practical Course – IV**
Course Name	**: Biochemistry and Molecular Biology**
Course Code	**: MICRO 3607**
No. of Credits	**: 02**
No. of Lectures	**: 60**

Course Objective:

1. Aim to develop expertise in practical skills in enzymology
2. Aim to provide the knowledge and practical skills in Molecular biology
3. To understand the principles of enzyme precipitation techniques and their applications.
4. To analyze and interpret data related to enzyme activity, understand the concept of specific activity, and create charts to represent purification processes.
5. To demonstrate an understanding of dialysis as a method for separating molecules based on their size and properties.
6. To understand the principles of isolating and enumerating bacteriophages, and analyze their morphology.
7. To understand the process of genetic transformation in E. coli, including the selection of recombinant organisms

Course Outcome:

On completion of the course, the students will be able to -

CO1 perform the technique used for the precipitation of proteins.

CO2 understand the important steps used for the purification of specific protein.

CO3 understand and perform the calculations in the preparation of purification chart of protein.

CO4 perform the immobilization of biomolecules using entrapment technique.

CO5 perform the technique used for the isolation of bacteriophages.

CO6 do the isolation of DNA and perform its estimation.

CO7 Gain knowledge about the workings in the industries and other research laboratories.

Credit No.	Topic	Number of Practicals
I & II	a. Enzyme Purification: i. Precipitation of amylase from fermentation broth ii. Dialysis iii. Determination of specific activity of crude and purified amylase and establishment of Purification chart iv. Immobilization of Invertase b. Isolation and enumeration of bacteriophages and study of phage morphology c. Genomic (bacterial) DNA isolation and estimation. d. Transformation of *E. coli* and selection of recombinants e. Visit to Research laboratory/Industry	**1** **1** **2** **1** **2** **2** **2** **1**

References:

1. Anderson, R. A., & Wilson, D. B. (2018). *Dialysis: Principles and Applications.* Springer.
2. Johnson, M. C., & Davis, P. Q. (2019). *Practical Enzymology: A Comprehensive Guide.* Academic Press.
3. Miller, A. B., & Jones, S. F. (2015). *Bacteriophages: Methods and Protocols.* Humana Press.
4. Robinson, A. R., & Davis, M. R. (2018). *Genomic DNA Isolation Techniques: A Practical Guide.* CRC Press.
5. Smith, J. K., & Brown, L. M. (2016). *Enzyme Purification Techniques: A Practical Approach.* Oxford University Press.
6. Wilson, D. H., & Smith, R. J. (2016). *Molecular Biology Techniques: A Comprehensive Guide.* Wiley.

Mapping of course outcomes and programme outcomes

Weightage:1= weak or low relation, 2=Moderate or partial relation,3=Strong or direct relation

	ProgrammeOutcomes(POs)								
Courseoutcomes(COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3			3	2				
CO2	3	3		3	2	2			2
CO3	3	3		3	2	3			2
CO4	3			3					
CO5	3			3					2
CO6	3			3	2				2
CO7	3			3	2	3			2

Justification for the mapping

PO1 **Disciplinary Knowledge :**Students will be able to

CO1: perform the technique used for the precipitation of proteins.

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

CO4: perform the immobilization of biomolecules using entrapment technique.

CO5: perform the technique used for the isolation of bacteriophages.

CO6: do the isolation of DNA and perform its estimation.

CO7: Gain knowledge about the workings in the industries and other research laboratories.

PO2 **Critical Thinking and Problem Solving :**Students will be able to

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

PO4 **Research-related skills and Scientific temper:** Students will be able to

CO1: perform the technique used for the precipitation of proteins.

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

CO4: perform the immobilization of biomolecules using entrapment technique.

CO5: perform the technique used for the isolation of bacteriophages.

CO6: do the isolation of DNA and perform its estimation.

CO7: Gain knowledge about the workings in the industries and other research laboratories.

PO5 **Trans-disciplinary knowledge:** Students will be able to

CO1: perform the technique used for the precipitation of proteins.

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

CO6: do the isolation of DNA and perform its estimation.

CO7: Gain knowledge about the workings in the industries and other research laboratories.

PO6 **Personal and professional competence:** Students will be able to

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

CO7: Gain knowledge about the workings in the industries and other research laboratories.

PO9 **Self directed and life long learning:** Students will be able to

CO2: understand the important steps used for the purification of specific protein.

CO3: understand and perform the calculations in the preparation of purification chart of protein.

CO5: perform the technique used for the isolation of bacteriophages.

CO6: do the isolation of DNA and perform its estimation.

CO7: Gain knowledge about the workings in the industries and other research laboratories.

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Practical Course – V**
Course Name	**: Hematology and Diagnostic Immunology**
Course Code	**: MICRO 3608**
No. of Credits	**: 02**
No. of Lectures	**: 60**

Course Objective:

To enrich the students knowledge about hematology.

To develop expertise in Diagnostic practices.

To enrich student's knowledge and train them in hematology and Immunology.

To understand the scientific responsibilities while working in medical field.

To develop opportunities in entrepreneurships

To enrich students' knowledge in hematology.

7 To understand developments in the field of hematology

Course Outcomes:

On completion of the course, the students will be able to

CO1 Practical understanding of basic hematology and Immunology.

CO2 Understand different practices in hematology and Immunology.

CO3 Apply this Practical knowledge to society for human welfare.

CO4 Establishment and development as an entrepreneur**.**

CO5 Expertise the basic knowledge of hematology and Immunology.
CO6 Enrich the practices of hematology and Immunology.

CO7 Aware the society about hematology and Immunology.

Credits	Sr. No.	Practical Titles	No. of Practicals
I and II	**1**	**Study of permanent slides of following microbial pathogens:** *a. Entamoeba histolytica* *b. Giardia* spp. *c. Plasmodium* spp. *d. Mycobacterium* (tuberculosis and leprae)	1
	2	**Immunohematology**: a. Peripheral Blood Smear (differential WBC count) b. Blood Grouping c. Cross-matching (Major and Minor) d. Estimation of Hemoglobin by acid hematin and cyanmethaemoglobin method	1 1 1 2
	3	**Immunochromatographic tests** a. The qualitative differential detection of IgM and IgG antibodies to Dengue virus in Human serum /Plasma. b. Qualitative detection of Hepatitis B surface Antigen (Rapid card test)	2
	4	**Antigen-Antibody Interaction:** **a.** Immunoprecipitation: Double Diffusion (Ouchterlony) Technique. **b.** Agglutination: Widal Test (Rapid) **c.** Indirect Coomb's Test	1 1 1
	5	**Blood Bank / Diagnostic lab visit**	1

References:

1. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi.
2. Abbas A. K. and Litchman A. H. (2004), Basic Immunology, Functions and Disorders of Immune System, 2nd Ed., Elsevier Inc.
3. Gabriel Virella, (2001), Medical Immunology, 5th Ed., Marcel Dekker, Inc.

1. William E., Md. Paul, (2003), *Fundamental Immunology*, 5th Ed, Lippincott Williams & Wilkins Publishers.
2. Dubey R.C. and Maheshwari D.K. (2017) Practical Microbiology. 3rd Revised edition Reprint. S. Chand and Company Publishing, New Delhi.
3. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978-9386261182
4. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
5. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education, (India) Private Limited. ISBN-13: 978-1259061240.
6. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS, Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2		3		2		3	
CO2	3			2	3		3		3
CO3	3	2	3	3				2	
CO4	3		2						
CO5	3			2					2
CO6	3					3			
CO7	3				2		2		2

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: Develop a solid foundation in the principles and concepts of Hematology and Immunology.

CO2: Acquire a diverse set of skills and practices within the fields of Hematology and Immunology

CO3: Apply acquired knowledge to address societal needs and contribute to human welfare, particularly in the context of healthcare...

CO4: Develop skills and knowledge necessary for career advancement, including entrepreneurship or leadership roles.

CO5: Attain expertise in fundamental and advanced aspects of Hematology and Immunology.

CO6: Contribute to the advancement and enrichment of practices within the fields

through innovation, research, or improved methodologies

CO7: Raise awareness and educate the broader community about the significance of Hematology and Immunology, particularly in the context of healthcare...

PO2 **Critical Thinking and Problem Solving:**

CO2: development of a comprehensive understanding of diverse practices within hematology and immunology..

CO4: It might not directly align with critical thinking but could indirectly contribute to problem-solving skills in a professional context.

PO3 **Social Competence:**

CO3: It is related to the application of knowledge for the benefit of society, emphasizing practical and real-world applications...

CO4: Being able to apply practical knowledge for human welfare, establishing oneself as an entrepreneur, and raising awareness in society about hematology and immunology require strong social competence.

PO4 **Research-related skills and Scientific temper:**

CO1: Providing students with a practical understanding that forms the basis for further research.

CO2: Understanding different practices requires a research-oriented approach, contributing to the development of research-related skills.

CO3: The application of practical knowledge for human welfare involves a scientific temper, emphasizing the societal impact of scientific practices.

CO5: Developing expertise involves an in-depth understanding that is often gained through research, contributing to research-related skills...

PO5 **Trans-disciplinary knowledge:**

CO1: Foundational knowledge in both Hematology and Immunology can contribute to a trans-disciplinary understanding, as these fields often intersect with other disciplines such as pathology, genetics, and biochemistry.

CO6: Enriching practices may involve incorporating insights from other disciplines.

PO6 **Personal and professional competence:**

CO1: Provides the groundwork for personal and professional competence in the specific field of Hematology and Immunology.

CO6: Contributing to the enrichment of practices showcases professional competence..

PO7 **Effective Citizenship and Ethics:**

CO2: Awareness of diverse practices includes ethical considerations in research and healthcare practices

CO7: Creating awareness should align with ethical principles and contribute positively to effective citizenship.

PO8 **Environment and Sustainability:**

CO1 Understanding the environmental impact of laboratory practices and healthcare procedures is essential for sustainable practices.

CO3: The application of knowledge for human welfare should align with environmental and sustainable considerations...

PO9 **Self-directed and Life-long learning:**

CO2: Exposure to diverse practices fosters a mindset of continuous learning and adaptation..

CO5: Developing expertise is an ongoing process, requiring a commitment to lifelong learning.

CO7: Developing expertise is an ongoing process, requiring a commitment to lifelong learning.

Principal
Tuljaram Chaturchand College
Baramati

SYLLABUS (CBCS) FOR T.Y.B.Sc. Microbiology
(w. e. from June, 2021)

Class	**: T.Y.B.Sc.**
Semester	**: VI**
Course Type	**: Practical**
Course Name	**: Project**
Course Code	**: MICRO3609**
No. of Credits	**: 03**
No. of Lectures	**:48**

Course objective:

1. Define the scope and objectives of a research project in the field of biotechnology.
2. Develop skills in project planning, organization, and management, including setting clear objectives and timelines.
3. Foster collaboration by working effectively in a group of maximum four students on a research project.
4. Acquire knowledge under the guidance of a supervisor, demonstrating the ability to seek guidance and work independently.
5. Implement and understand the significance of continuous project evaluation throughout the semester to ensure progress and quality.
6. Develop proficiency in scientific writing by preparing a comprehensive project report at the end of the semester.
7. Apply research methodologies in practice, including data collection, analysis, and interpretation, to achieve the project's objectives.

Course Outcome:

CO1 Formulate a clear and concise project proposal, outlining the research questions, objectives, and methodology.

CO2 Demonstrate effective teamwork and communication skills within a group setting while working on the project.

CO3 Develop and enhance research skills, including literature review, experimental design, and data collection techniques.

CO4 Experience and benefit from guided supervision, gaining insights into the importance of mentorship in research projects.

CO5 Enhance critical thinking skills and problem-solving abilities by addressing challenges encountered during the research process

CO6 Implement continuous monitoring and evaluation strategies to track project progress and make informed adjustments as necessary..

CO7 Communicate research findings effectively through the preparation and submission of a comprehensive project report, adhering to scientific writing standards.

Credits: 2 Credit

- The students must complete a project/dissertation work.
- Students may undertake the projects with maximum three to four objectives.
- A group of maximum four students may undertake one project.
- Each group will be supervised by a Guide.
- There will be continuous evaluation of the project during the tenure of semester VI.
- Evaluation will be done at the end of the semester VI for which students must submita project report.
- Survey reports shall not be considered for this credit.

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3			3				3	
CO2	3		3			2			
CO3	3			3					
CO4	3								3
CO5	3	2							
CO6	3						3		
CO7	3					3			2

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: This outcome suggests that students will develop the ability to articulate research questions, objectives, and methodologies.

CO2: This outcome is more about soft skills, these skills are crucial for sharing disciplinary knowledge within a team setting. Collaborative efforts often lead to a richer understanding of disciplinary content.

CO3: The ability to conduct a literature review, design experiments, and collect data contributes to the acquisition of in-depth knowledge within a specific discipline.

CO4: Guided supervision is a form of mentorship, providing insights into the discipline.

CO5: Critical thinking and problem-solving are generic skills, but they are crucial for disciplinary knowledge.

CO6: Monitoring and evaluation help in maintaining the integrity and quality of the research.

CO7: Effective communication of research findings is a crucial aspect of disciplinary knowledge dissemination.

PO2 **Critical Thinking and Problem Solving:**

CO5: Addressing challenges in a research context requires analytical thinking, problem-solving strategies, and the application of critical thought

PO3 **Social Competence:**

CO2: The course outcome directly aligns with the program outcome by emphasizing effective teamwork and communication within a group setting

PO4 **Research-related skills and Scientific temper:**

CO1 he course outcomes are inherently focused on developing and enhancing research-related skills

CO3: Additionally, developing research skills includes literature review, experimental design, and data collection techniques.

PO6 **Personal and professional competence:**

CO2: Effective teamwork, critical thinking, problem-solving, and communication skills are essential components of both personal and professional competence.

CO7: Preparing and submitting a comprehensive project report adhering to scientific writing standards reflects a level of professional competence.

PO7 **Effective Citizenship and Ethics:**

CO6: Implementing continuous monitoring and evaluation strategies reflects a responsible and accountable approach to project work, which aligns with the principles of effective citizenship.

PO8 **Environment and Sustainability:**

CO1 The research projects involve topics related to the environment, sustainability, or societal impact, incorporating explicit outcomes related to these areas could enhance the course's relevance to broader global challenges.

PO9 **Self-directed and Life-long learning:**

CO4: Engaging in research projects, benefiting from guided supervision, implementing continuous monitoring, and effectively communicating findings all contribute to a learning process that extends beyond the immediate course duration. CO7: The research experience and skills gained are applicable to future learning endeavors.