Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)
Framework of Syllabus

For
B. Sc. (Microbiology)

Choice Based Credit System (CBCS) Syllabus Under National Education Policy (NEP)
To be implemented from Academic Year 2024-2025

Choice Based Credit System (CBCS) Syllabus
Under National Education Policy (NEP)
To be implemented from Academic Year 2024-2025

Level:- 4.5 (First Year) Semester: I

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ (T/P) (2) or T(4)	24ScMicU1101	Fundamentals of Microbiology	2		2		20	30	50
	24ScMicU1102	Lab Course on 24ScMicU1101		2		4	20	30	50
Subject 2 T(2)+ (T/P) (2) or T(4)	24ScBotU1201 / 24ScZooU1201	<<Subject 2 Theory>>	2		2		20	30	50
	24ScBotU1202 / 24ScZooU1202	<<Subject 2 Practical>>		2		4	20	30	50
Subject 3 T(2)+ (T/P) (2) or T(4)	24ScZooU1301/ 24ScCheU1301	<<Subject 3 Theory>>	2		2		20	30	50
	24ScZooU1302 / 24ScCheU1302	<<Subject 3 Practical>>		2		4	20	30	50
IKS T(2)	24CpCopU1901	Generic IKS	2		2		20	30	50
GE/OE (T/P) (2)	24ScMicU1401	History of Microbiology	2		2		20	30	50
SEC (P) (2)	24ScMicU1601	Lab Course on Basic Laboratory Practices		2		2	20	30	50
AEC T(2)	24CpCopU1701 / 24CpCopU1702	MIL-I (Hindi) / MIL-I (Marathi)	2		2		20	30	50
VECT (2)	24CpCopU1801	Environmental Science	2		2		20	30	50
Total			14	08	14	16			550

Level:- 4.5 (First Year) Semester: II

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ T/P(2) or T(4)	24ScMicU2101	Biochemistry and Microbiology	2		2		20	30	50
	24ScMicU2102	Lab Course on 24ScMicU2101		2		4	20	30	50
Subject 2 T(2)+ P(2)	24ScBotU2201 / 24ScZooU2201	<<Subject 2 Theory>>	2		2		20	30	50
	24ScBotU2202 / 24ScZooU2202	<<Subject 2 Practical>>		2		4	20	30	50
Subject 3 T(2)+ P(2)	24ScZooU2301/ 24ScCheU2301	<<Subject 3 Theory>>	2		2		20	30	50
	24ScZooU2302 / 24ScCheU2302	<<Subject 3 Practical>>		2		4	20	30	50
GE/OE (T/P)(2)	24ScMicU2401	Introduction to Microbial World 1	2		2		20	30	50

SEC P(2)	24ScMicU2601	Lab course on Introduction to Microscopy		2		4	20	30	50

AEC T(2)	24CpCopU2703	English Communication Skills I	2		2		20	30	50
VEC T(2)	24CpCopU2801	Democracy, Election and Governance	2		2		20	30	50
CC(2)	24CpCopU2001/ 24CpCopU2011 / 24CpCopU2021 / 24CpCopU2031 / 24CpCopU2041 / 24CpCopU2051 / 24CpCopU2061 / 24CpCopU2071	Physical Education / Cultural Activities / NSS / NCC / Fine Arts / Applied Arts / Visual Arts / Performing Arts	2		2		20	30	50
Total			14	08	14	16			550

Level:- 5.0 (Second Year) Semester: III

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMicU3101	Environmental Microbiology I & Metabolism	4		4		40	60	100
	24ScMicU3102	Lab Course on 24ScMicU3101	2		2		20	30	50
VSC P(2)	24ScMicU3501	Lab Course on Techniques in Microbiology		2		4	20	30	50
IKS (T/P)(2)	24ScMicU3901	Vedic Microbiology	2		2		20	30	50
FP P(2)	24ScMicU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScMicU3301	Soil and Agricultural Microbiology	2		2		20	30	50
	24ScMicU3302	Lab Course on 24ScMicU3301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMicU3401	Introduction to Microbial World 2		2		4	20	30	50
AEC T(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CC T(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			14	08	14	08			550

Level:- 5.0 (Second Year) Semester: IV

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMicU4101	Environmental Microbiology II and Bacterial Genetics	4		4		40	60	100
	24ScMicU4102	Lab Course on 24ScMicU4101		2		4	20	30	50
VSC P(2)	24ScMicU4501	Lab Course on Food Microbiology		2		4	20	30	50
CEP P(2)	24ScCopU4003	Community Engagement Project		2		4	20	30	50

Minor (T/P)(2+2 or 4)	24ScMicU4301	Air and Water Microbiology	2		2		20	30	50
	24ScMicU4302	Lab Course on 24ScMicU4301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMicU4401	Community Hygiene	2		2		20	30	50
SEC T(2)	24ScMicU4601	Lab Course on Dairy Microbiology		2		4	20	30	50
AEC T(2)	24CpCopU4701 / 24CpCopU4702	MIL-II (Hindi) / MIL-II (Marathi)	2		2		20	30	50
CC T(2)	24CpCopU4001	Health and Wellness	2		2		20	30	50
Total			12	10	12	20			550

Level:- 5.5 (Third Year) Semester:-V

Course Type	**Course Code**	**Course Title**	**Credits**		**Teaching Scheme Hr/Week**		**Evaluation Scheme and Max Marks**		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4 + 2+2 or 4 + 4) P(2+2 or 4)	24ScMicU5101	Medical MicrobiologyI	2		2		20	30	50
	24ScMicU5102	Immunology I	2		2		20	30	50
	24ScMicU5103	BiochemistryI	2		2		20	30	50
	24ScMicU5104	Molecular Biology I	2		2		20	30	50
	24ScMicU5105	Lab Course on Medical Microbiology and Immunology (24ScMicU5101 &24ScMicU5102)		2		4	20	30	50
	24ScMicU5106	Lab Course on Biochemistry and Molecular biology I(24ScMicU5103 & 24ScMicU5104)		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScMicU5201	Applied Microbiology I	2		2		20	30	50
	24ScMicU5202	Lab Course on Applied Microbiology I (24ScMicU5201)		2		4	20	30	50
	24ScMicU5203	Biostatistics and Biophysics I	2		2		20	30	50
	24ScMicU5204	Lab Course on Biostatistics and Biophysics I (24ScMicU5203)		2		4	20	30	50
VSC P(2)	24ScMicU5501	Lab Course on Clinical Microbiology and Haematology		2		4	20	30	50
FP (2)	24ScMicU5001	Field Project II		2		4	20	30	50
Minor (T/P) (2)	24ScMicU5302	Introduction to Fermentation	2			4	20	30	50
Total			12	10	10	12			550

Level:- 5.5 (Third Year) **Semester:-VI**

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4+2+2 or	24ScMicU6101	Medical Microbiology II	2		2		20	30	50
	24ScMicU6102	Immunology II	2		2		20	30	50
	24ScMicU6103	Biochemistry II	2		2		20	30	50
	24ScMicU6104	Molecular Biology II	2		2		20	30	50
4+4) P(2+2 or 4)	24ScMicU6105	Lab Course on Diagnostic Microbiology and Immunology(24ScMicU6101 &24ScMicU6102)		2		4	20	30	50
	24ScMicU6106	Lab Course on Biochemistry and Molecular biology II (24ScMicU6103 & 24ScMicU6104)		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScMicU6201	Applied Microbiology II	2		2		20	30	50
	24ScMicU6202	Lab Course on Applied Microbiology II (24ScMicU6201)		2		4	20	30	50
	24ScMicU6203	Biostatistics and Biophysics II	2		2		20	30	50
	24ScMicU6204	Lab Course on Biostatistics and Biophysics II (24ScMicU6203)		2		4	20	30	50
VSC P(2)	24ScMicU6501	Lab Course on Industrial Microbiology		2		4	20	30	50
OJT (2)	24ScMicU6004	On Job Training		4		8	40	60	100
Total			10	12	10	20			550

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Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)

Course Code: 24ScMicU5101

Major Core Paper (Theory): Medical Microbiology I

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objectives:

1. To provide knowledge of human body systems and their role in microbial infections.
2. To explain host–pathogen interactions and mechanisms of bacterial pathogenicity.
3. To study major bacterial diseases with reference to diagnosis, prevention, and treatment.
4. To introduce principles and applications of epidemiology in infectious diseases.

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

1. Explain the relationship between human body systems and microbial infections.
2. Differentiate key concepts of infection, pathogenicity, virulence, and nosocomial infections.
3. Describe the characteristics and diseases caused by different pathogens
4. Interpret basic laboratory diagnostic methods for bacterial diseases.
5. Calculate and interpret disease frequency measures.

Unit I	**Introduction to human body systems and Host pathogen interactions**	**No. of lectures**
	Introduction to human body systems: a. Respiratory system b. Digestive and excretory system c. Renal and urinary system **Host pathogen interactions:** Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Opportunistic infections, Nosocomial infections.	7
Unit II	**Study of bacterial diseases**	**No. of lectures**

	Classification and Biochemical characters, Antigenic structure, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Prophylaxis and Chemotherapy a. Enteric pathogens: *E. coli* b. Pyogenic organisms: *Staphylococcus aureus* c. Pneumococci: *Streptococcus pneumonia* d. *Mycobacterium tuberculosis* *e. Acinetobacter baumannii* f. Venereal Disease: *Treponema pallidum*	12
Unit III	**Epidemiology**	**No. of lectures**
	a. Definition, scope and applications a. Incidence and prevalence rates, mortality and morbidity rates b. Descriptive epidemiology-Disease distribution based on time, place and person c. Analytical epidemiology- Study design of Case control studies	7
Unit IV	**Introduction to Medical Coding**	**No. of lectures**
	a. Concept of Medical Coding b. Basics of Medical Data Management	4

References:

1. Ananthanarayan, R., & Paniker, C. K. J. (2020).*Textbook of Microbiology* (11th ed., revised by Reba Kanungo). Universities Press.
2. Brooks, G. F., Carroll, K. C., Butel, J. S., Morse, S. A. (2024).*Jawetz, Melnick & Adelberg's Medical Microbiology* (29th ed.). McGraw-Hill.
3. Carroll, K. C., Butel, J. S., Morse, S. A., Mietzner, T. A. (2019).*Jawetz, Melnick & Adelberg's Medical Microbiology* (28th ed.). McGraw-Hill.
4. Goering, R., Dockrell, H., Zuckerman, M., & Roitt, I. (2018).*Mims' Medical Microbiology* (6th ed.). Elsevier.
5. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2016).*Medical Microbiology* (8th ed.). Elsevier.
6. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. (2020).*Medical Microbiology* (9th ed.). Elsevier.
7. Ryan, K. J., Ray, C. G. (2022).*Sherris Medical Microbiology* (8th ed.). McGraw-Hill.
8. Tille, P. (2017).*Bailey & Scott's Diagnostic Microbiology* (14th ed.). Elsevier.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)
Course Code: 24ScMicU5102
Major Core (Theory): Immunology I

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objectives:

1. To introduce the fundamental concepts of immunity, its definition and classification.
2. To explain the structure and function of primary and secondary lymphoid organs and the cellular components of the immune system.
3. To describe innate immune mechanisms, including physical, chemical, humoral and cellular defences.
4. To analyse the processes of phagocytosis, complement activation, inflammation and cytokine-mediated regulation in innate immunity.

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

1. Define immunity and classify its types with clarity.
2. Identify and describe the cells and organs of the immune system, including their roles in haematopoiesis and lymphatic function.
3. Explain the first and second lines of defence in innate immunity, covering barriers, humoral and cellular components.
4. Demonstrate understanding of immune functions such as phagocytosis, complement pathways, inflammation and cytokine activity in host defence.

Unit I	**Immunity**	**No. of lectures**
	1. Immunity: Definition and Classification **2. Cells and Organs of immune system:** a. Primary lymphoid organs Haematopoiesis and its kinetics: Formation of myeloid and lymphoid cell lineages, Lymphatic system b. Primary lymphoid organs: Thymus and Bursa Secondary lymphoid organs: Spleen, Lymph nodes, lymphoid tissues.	10
Unit II	**First and Second line of defence**	**No. of lectures**

	Innate immunity: Non-specific mechanisms of defence 1. First line of defence – Physical, chemical and biological barriers 2. Second line of defence: a. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, acute phase reactants. b. Cellular components: Phagocytic cells – PMNL, macrophages (reticuloendothelial cell system) and dendritic cells c. Functions: Phagocytosis (oxygen dependent and independent systems), Complement activation (Classical, Alternative and lectin pathway),Inflammation (cardinal signs, mediators, vascular and cellular changes, role of Toll-like receptors) d. Innate Immunity cytokines. (Interleukins and TNFs)	20

References:

1. Abbas, A. K., Lichtman, A. H., Pillai, S., and Henrickson, S. (2025). *Cellular and molecular immunology* (11th ed.). Philadelphia, PA: Elsevier. ISBN: 9780323952736
2. Anantha Narayan, R., and Panikkar, C. K. J. (2024). *Textbook of microbiology* (13th ed.). Hyderabad, India: Universities Press. ISBN: 9789393330466
3. Delves, P. J., Martin, S. J., Burton, D. R., and Riott, I. M. (2025). *Roitt's essential immunology* (13th ed.). Hoboken, NJ: Wiley-Blackwell. ISBN: 9781118415771
4. Punt, J., Stranford, S., Jones, P., and Owen, J. A. (2023). *Kuby immunology* (8th ed.). New York, NY: Macmillan. ISBN: 9781319498658

Progressive Education Society's
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Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)
Course Code: 24ScMicU5103
Major Core (Theory): Biochemistry I

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objective:

1. To learn about the structure and function of the enzyme active site.
2. To understand the kinetics of enzymes with respect to mathematical expression.
3. To understand purification methods for proteins, enzymes and the principles of enzyme assays.
4. To introduce the transport of molecules in cells.

Course Outcomes:

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

1. Explain understanding of the enzymology concepts
2. Derive mathematical expression of enzyme kinetics.
3. Explain the effect of enzyme inhibitors on the kinetic parameters of an enzyme
4. Develop a broader perspective about purification and application of enzymes in diverse areas
5. Summarise the ways of transport of molecules in cells

Unit I	Enzymes	No. of lectures
	A. Enzymes: Introduction to enzymes, coenzymes, cofactors, prosthetic groups, Structure of active site in enzymes, Introduction to protein sequencing, Active site determination by chemical methods-use of substrate analogue, trapping of ES complex **B**. Enzyme Kinetics **a.** Concept and use of initial velocity **b.** Michaelis Menton equation for the initial velocity of a single substrate enzyme catalysed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Menton plot, Definition with significance of Km, Ks, Vmax **c.** Different plots for plotting Kinetic data: i. Lineweaver and Burk plot **ii.** EadieHofstee plot **d.** Introduction to enzyme inhibition	**6**
Unit II	**Enzyme purification and Enzyme assays**	**No. of lectures**
	A. Enzyme purification: a. Methods of cell fractionation b. Principles and methods of enzyme purification: i. Based on molecular size ii. Based on charge iii. Based on solubility differences iv. Based on specific binding property and selective adsorption c. Criteria for purity: SDS-PAGE, ultracentrifugation, and construction of purification chart d. Characterization of enzymes: Determination of Molecular weight based on- Ultracentrifugation, SDS-PAGE, gel filtration B. Enzyme assays: a. Principles of enzyme assays: Sampling methods and types of enzyme assays b. Enzymes assays with examples by: Spectrophotometric methods	**17**
Unit III	**Immobilization**	**No. of lectures**
	A. Introduction to immobilization of enzymes B. Concept, methods of immobilization and application	**2**

Unit IV	Membrane transport in bacteria	No. of lectures
	A. Passive transport - Diffusion, Osmosis, Facilitated transport B. Active transport - Active transport systems in bacteria C. Group translocation of sugars in bacteria D. Ionophores: Mechanism and examples	**5**

References:

1. Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (2016) *Outlines of Biochemistry* (6th Ed) John Wiley and Sons, New Delhi.
2. Garrett, R. H. and Grisham, C. M. (2016) Biochemistry. (6th Ed.) Brooks/Cole, Publishing Company, California.
3. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira,David Baltimore, and James Darnell (2021) *Molecular Cell Biology*, (9th ed), W. H. Freeman &co., New York.
4. Nelson D. L. and Cox M. M. (2021) *LehningerPrinciples of Biochemistry* (8th ed.), Mac MillanWorth Pub. Co. New Delhi
5. Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology and Clinical chemistry,* (2nd ed.) Horwood Pub. Co. Chinchester, England.
6. Segel Irvin H. (2025). *Biochemical Calculations,* (2nd ed.) John Wiley and Sons, NewYork.
7. White David (2024) *Physiology and Biochemistry of Prokaryotes.* (4th ed.) Oxford University Press, New York.

Progressive Education Society's
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Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)
Course Code: 24ScMicU5104
Major Core (Theory): Molecular Biology I

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objective:

1. To enrich the knowledge of students with respect to gene linkage and crossing over
2. To provide a deeper insight into the DNA damage and repair
3. To learn and understand the central dogma process in Eukaryotes

Course Outcomes:

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

1. To enrich the knowledge of students with respect to gene linkage and crossing over
2. To provide a deeper insight into the DNA damage and repair

Unit I	Central Dogma Processes	No. of lectures
	A. Eukaryotic Replication a. Single replicon b. Bidirectional movement of replication fork c. Origin site d. Pre priming and Priming reaction e. DNA polymerases f. DNA synthesis of leading, lagging strand g. Termination **B. Transcription (Prokaryotic & Eukaryotic)** a. Structure of Promoters b. Structure and role of RNA polymerases c. Initiation, elongation and termination d. Introduction to post transcriptional modification **C. Translation (Prokaryotic & Eukaryotic)** a. Role of mRNA, tRNA and Ribosomes in translation b. Synthesis of aminoacyl tRNA c. Initiation, elongation, translocation and termination of protein synthesis	**20**
Unit II	**Recombination and DNA repair mechanisms**	**No. of lectures**
	A. Recombination a. Cell cycle (basics of Mitosis and Meiosis) b. Gene linkage and crossover c. Recombination frequency, Map unit, Chromosome mapping d. Recombination in prokaryotes (RecBCD pathway and phage λ Redpathway) **B. DNA Damage & Repair** a. Photoreactivation b. Mismatch repair c. Base excision repair and nucleotide excision repair d. Recombinational repair e. Translesion DNA synthesis	**10**

References:

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell* (7th ed.). Garland Science, New York.
2. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
3. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2016). *Principles of Genetics* (7th ed.). Wiley
4. Glick, B. R., & Patten, C. L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (5th ed.). ASM Press.
5. Lewin, B., Krebs, J., Goldstein, E., & Kilpatrick, S. (2017). *Genes XII*. Jones & Bartlett Learning, Burlington, MA.

6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular Cell Biology* (9th ed.). W. H. Freeman / Macmillan Learning.
7. Primrose, S. B., & Twyman, R. M. (2013). *Principles of Gene Manipulation and Genomics* (8th ed.). Wiley-Blackwell.
8. Streips, U. N., & Yasbin, R. E. (2002). *Modern Microbial Genetics* (2nd ed.). Wiley-Liss. (Still widely cited; newer comprehensive replacements include modern microbial genetics texts.)
9. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular Biology of the Gene* (7th ed.). Pearson / Benjamin Cummings.

Progressive Education Society's
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Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Courseunder NEP2020)
Course Code: 24ScMicU5105
Course Name: Major Core (Practical): Lab Course on Medical Microbiology
(24ScMicU5101 & 24ScMicU5102)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**

Course objectives:

1. To train students in the physical, chemical and microscopic examination of clinical samples for diagnostic purposes.
2. To introduce Bergey's Manual and its application in designing identification keys for pathogenic bacteria.
3. To develop skills in isolation and identification of clinically relevant pathogens using selective and differential media.
4. To analyse growth characteristics of pathogens on specialized culture media for diagnostic microbiology.

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

1. Perform systematic examination of urine and other clinical samples for diagnostic evaluation.
2. Utilize Bergey's Manual to design identification keys and classify pathogenic bacteria.
3. Isolate and identify pathogens from clinical specimens.
4. Interpret growth patterns of pathogens on selective media for diagnostic conclusions.

Sr. No	Name of the practical	No.of practical's
1	Physical, Chemical and Microscopic examination of Clinical sample: Urine	3

2	i. Introduction to Bergey's Manual and its use to design keys for identification of pathogenic bacteria ii. Isolation, identification of following pathogens from clinical Samples *E. coli, Salmonella* spp., *Pseudomonas* spp., *Klebsiella* spp., *Staphylococcus* spp. (for identification use of keys as well as Bergey's Manual is recommended)	10
3	Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella-Shigella agar, Cetrimide agar, TSI agar	2

References:

1. Cappuccino, J. G., & Welsh, C. T. (2017).*Microbiology: A Laboratory Manual* (11th ed.). Pearson.
2. Johnson, T. R., & Case, C. L. (2018).*Laboratory Experiments in Microbiology* (12th ed.). Pearson.
3. Cappuccino, J. G., & Welsh, C. T. (2019).*Microbiology: A Laboratory Manual* (12th ed.). Pearson.
4. Pandya, H. P. (2021).*Microbiology: Competency-Based Practical Book.* Himanshu Publications.
5. Palanisamy, S., Venkatachalam, S. K. T., & Babu, S. (2022).*Handbook on Practical Microbiology.* Royal Book Publishing.
6. Mridushri (2022).*Medical Microbiology Practical Manual.* Blue Rose Publishers.
7. Arora, D. R., & Arora, B. (2023).*Practical Microbiology* (3rd ed.). CBS Publishers.
8. Godkar B. P and Godkar P. D (2014). Textbook of Medical Laboratory Technology. Edition 3. Volume 1 & 2. Bhalani Publishing House. ISBN 8185578583, 9788185578583.
9. Procop, G. W., Church, D. L., Hall, G. S., & Janda, W. M. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. Jones & Bartlett Publishers.

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Second Year of B.Sc.
(2024 Courseunder NEP2020)
Course Code: 24ScMicU5106
Course Name: Major Core (Practical): Lab Course on Biochemistry and Molecular biology I (24ScMicU5103& 24ScMicU5104)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**
Course objectives:

1. To introduce the concepts related to production and purification of enzymes.
2. To enrich students with knowledge about biomolecules and their importance in living cells and in the human body.

Course outcomes:

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

1. Isolate, produce and purify industrially important enzymes from microorganisms.
2. Correlate effect of factors on enzyme activity.
3. Isolate bacterial DNA from broth culture.
4. Detect the biomolecules in the given samples.

Sr. No	Name of the practical	No.of practical's
1	Buffer preparation with numerical	2
2	Quantitative analysis of biomolecules: 1. Sugar- DNSA 2. Proteins- Folin Lowry method	2
3	Enzymology: 1. Isolation and identification of amylase producing bacteria 2. Production of amylase 3. Purification of amylase by salt precipitation 4. Effect of pH, temperature on enzyme activity	7
4	DNA isolation and estimation by DPA and Purity check by 260/280 ratio	4

References:

1. D.T. Plummer (2000). *An Introduction to Practical Biochemistry* (5th ed.). McGraw-Hill education, London. ISBN: 9780070841659.
2. David L. Nelson & Michael M. Cox (2021). *Lehninger Principles of Biochemistry* (8th ed.). W. H. Freeman and Company, New York. ISBN: 9781319228002.
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4. Keith Wilson & John Walker (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press, Cambridge. ISBN: 9781107162273.
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7. T. A. Brown (2020). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell, Oxford. ISBN: 9781119072560.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Courseunder NEP2020)
Course Code: 24ScMicU5201
Course Name: Applied Microbiology I (Major Elective I)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Semester: 30 Marks
Teaching Scheme (TH): 2 Hours/Week Credit: 02
Course Objectives:

1. To understand the principles of microbial biomass production, including yeast, mushrooms, and dairy fermentation.
2. To study large-scale enzyme production and microbial transformation of industrially important compounds like steroids.
3. To learn process control, downstream processing, and formulation techniques for microbial products.
4. To introduce statistical tools such as Plackett–Burman Design (PBD) and Response Surface Methodology (RSM) for process optimization.
5. To explore modern trends in microbial biotechnology, including biosurfactants and bio-emulsifiers

Course Outcomes:

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

1. Describe microbial product formation and cultivation techniques for biomass, dairy, and enzymes.
2. Gain knowledge of industrial-scale production, process control, and downstream processing methods.
3. Apply statistical optimization techniques (PBD, RSM) to improve microbial product yield.
4. Understand microbial transformation of steroids and production of modern bioproducts such as biosurfactants and bio-emulsifiers.
5. Develop the ability to integrate bioprocess concepts for industrial applications of microbial products.

Unit 1	**Process control and product recovery**	**No. of Lectures**

	A. Process control and product recovery Criteria for control and monitoring of critical parameters- Aeration, agitation, rheology, sterilization B. Principles and methods of Downstream processing 1. Concentration: cell disruption, filtration, centrifugation 2. Purification: liquid- liquid extraction, distillation, ion exchange chromatography, drying 3. formulation C. Overview of Plackett–Burman Design (PBD) and Response Surface Methodology (RSM).	18
Unit 2	**Industrial Microbial Products**	**No.of Lectures**
	A. Biomasses Based products 1. Baker's yeast and Distiller's yeast. 2. Mushroom Cultivation: Edible mushroom species, preparation of substrate- composting- phase I and phase II, factors affecting composting, preparation of spawn, casing, induction of fruiting body formation, harvesting. B. Milk product production: cheese and yoghurt C. Large scale production of enzymes: 1. Amylase 2. Esterases 3. Proteases D. Microbial transformation of steroids. E. Modern trends in microbial production: Biosurfactant and Bio-emulsifier	12

References:

1. Glazer, A. N., & Nikaido, H. (2020). *Microbial Biotechnology: Fundamentals of Applied Microbiology* (3rd ed.). Cambridge University Press.
2. Montgomery, D. C. (2019). *Design and Analysis of Experiments* (9th ed.). Wiley.
3. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). *Microbiology* (10th ed.). McGraw-Hill.
4. Santos, D. K. F., Rufino, R. D., Sarubbo, L. A., & Banat, I. M. (2021). *Biosurfactants: Production and Applications*. Springer.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of Fermentation Technology* (3rd ed.). Elsevier.
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Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Courseunder NEP2020)
Course Code: 24ScMicU5202
Course Name: Lab Course on Applied Microbiology I(24ScMicU5201)
Applied Microbiology Practical (Major Elective I)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**

Course Objectives:

1. To provide hands-on training in isolation, identification, and cultivation of microorganisms such as yeast.
2. To familiarize students with the production of microbial products like cheese, yoghurt, and organic acids.
3. To teach laboratory techniques including paper chromatography, antibiotic assay, and growth factor assay.
4. To introduce basic biostatistics for analysis of experimental data, including mean, median, and mode.

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

1. Isolate, identify, and characterize yeast from natural samples.
2. Gain practical knowledge in producing microbial products such as cheese, yoghurt, and organic acids.
3. Learn and apply key laboratory techniques, including chromatography and diffusion assays.
4. Perform basic statistical calculations and analyze laboratory data effectively.

Sr. No	Name of the practical	No. of practical's/ Hours
1	Isolation and identification of yeast from molasses sample.	3(12)
2	Production of cheese and yoghurt	3(12)
3	Paper chromatography (amino acid and sugar)	2(8)
4	a. Antibiotic assay (agar well diffusion technique) b. Growth factor assay (agar well diffusion technique).	3(12)
5	Production of organic acid.	3(12)
6	Biostatistics – Mean, Mode, Median	1(4)

References:

1. Cappuccino, J. G., & Sherman, N. (2019), *Microbiology: A Laboratory Manual*
Yeast isolation, enrichment techniques *Microbiology: A Laboratory Manual*. Microbial diversity, cell structure of yeast
2. Montgomery, D. C., & Runger, G. C. (2020), *Applied Statistics and Probability for Engineers*, 7th Edition.
3. Pelczar, M. J., Reid, R. D., & Chan, E. C. S. (2022), *Microbiology: Concepts and Applications*. Basic principles of growth factors in microbiology.
4. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021), *Microbiology*, 10th Edition. Microbial fermentation pathways producing organic acids, regulation, and industrial applications.
5. Tortora, G. J., Funke, B. R., & Case, C. L. (2023). *Microbiology: An Introduction* (14th ed.). Pearson**.**

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Course under NEP2020)
Course Code: 24ScMicU5203
Course Name: Biostatistics and Biophysics I
(Major Elective II)

Examination Scheme: CIA: 20 Marks End Semester: 30 Marks

Teaching Scheme (TH): 2 Hours/Week Credit: 02

Prerequisite Courses: Second Year B.Sc. Microbiology

Course Objectives:

1. To introduce the fundamental concepts in Mathematics and Statistics, including essential statistical methods for data analysis.
2. To understand the key instrumentation techniques used in scientific research and industry.
3. To know the applications, working principles, and calibration protocols of various analytical instruments.
4. To develop knowledge of commonly used techniques in industrial and research laboratories.

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

1. Explain the principles, operational mechanisms, and applications of various scientific instruments used in research and industry.
2. Demonstrate proficiency in handling and utilizing key laboratory instruments with appropriate technical understanding.
3. Apply statistical methods to analyse data and solve numerical problems effectively.
4. Select and apply appropriate statistical tools to determine the significance of experimental results.

5. Interpret data, draw valid conclusions, and apply analytical methods to real-life situations.
6. Describe vectors, enzymes, and advanced techniques used in genome sequencing and microbial identification.
7. Understand fundamental bioinformatics concepts, including databases, sequence analysis tools, and their application in microorganism identification.

Unit 1	**Concepts in Mathematics**	**No. of lectures**
	A. Concepts in Mathematics **a.** Sets, Scientific notations and metric prefixes b. Dilutions, Percent solution calculations c. Converting Molarity to percent and vice versa. d. Mathematical functions and graph of a function: Linear function, Power,Exponential function, Periodic function, Logarithmic function (Illustration ofthese functions in biological systems) e.Limits and idea of derivative f.Derivative of simple and exponential function g. Integration as reverse concept of differentiation (Emphasis on examples from biological system) **B.Introduction to Statistics** a. Definitions, importance and Scope of statistics b.Data condensation and graphical methods c. Graphical representation of frequency distribution i. Histogram ii. Bar diagram iii. Dot diagram iv. Pie diagram v. Frequency curve	12
Unit -2	**Concepts in Biophysics and Bioinformatics**	**No. of lectures**

	A.Definition and History of Biophysics (Physical properties applied tobiology- Surface tension, Viscosity, adsorption, diffusion, osmosis, dialysisand colloids) B. **Cell:** Animal and plant cell, types of cells and composition, Functionalaspects of cell membrane, cytoplasm, nucleus, mitochondria, chloroplast(Bioenergetics of mitochondria and chloroplast) **C. Biophysical techniques** Basic principle, Construction and working of i. Colorimeters and pH meter ii. Centrifugation Basic principle, Relation between RCF and RPM (with numericals),Preparative and analytical centrifugation, fixed angle and swinging bucketrotors, differential centrifugation, density gradient centrifugation and ultracentrifugation. iii. Chromatography Principles and applications of Paper chromatography, Thin layer chromatography. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC. **D.Bioinformatics** 1. Basic principles and concepts in bioinformatics: Data, database,biological sequences, sequence alignments and analysis 2. Introduction to nucleotide databases: Various types of databases based on nature and source of data, their significance 3. Types of sequence alignments i. Local sequence alignment ii. Global sequence alignment 4. BLAST analysis and identification of bacteria	18

References:

1. Campbell, A. M., & Heyer, L. J. (2018).*Discovering Genomics, Proteomics and Bioinformatics* (3rd ed.). Pearson.
2. Daniel, W. W., & Cross, C. L. (2018).*Biostatistics: A Foundation for Analysis in the Health Sciences* (11th ed.). Wiley.
3. Montgomery, D. C., & Runger, G. C. (2019).*Applied Statistics and Probability for Engineers* (7th ed.). Wiley.
4. Pagano, M., & Gauvreau, K. (2021).*Principles of Biostatistics* (3rd ed.). CRC Press.
5. Rosner, B. (2023).*Fundamentals of Biostatistics* (9th ed.). Cengage.

6. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018).*Principles of Instrumental Analysis* (6th ed.). Cengage.
7. Triola, M. F., & Triola, M. M. (2020).*Biostatistics for the Biological and Health Sciences* (2nd ed.). Pearson.
8. Wayne W. Daniel (2022).*Biostatistics: Basic Concepts and Methodology for the Health Sciences* (10th ed.). Wiley.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Course under NEP2020)
Course Code: 24ScMicU5204
Course Name: Lab course onBiostatistics and Biophysics I (24ScMicU5203)
(Major Elective II)

Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**
Prerequisite Courses: Second Year B.Sc. Microbiology

Course objectives:

1. To develop hands-on skills in chromatographic separation and biomolecular analysis.
2. To apply statistical tools and Microsoft Excel for data analysis and graphical representation.
3. To isolate and characterize bacterial pigments using spectrophotometric techniques.
4. To introduce students to nucleotide databases and sequence analysis using bioinformatics tools.

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

1. Perform paper and thin layer chromatography and calculate Rf values accurately.
2. Analyse and represent statistical data graphically and compute mean, median, and mode.
3. Isolate bacterial pigments and determine molar extinction coefficient Retrieve and interpret nucleotide sequences from databases
4. Conduct sequence similarity analysis and interpret alignment results.

Sr. No	Name of the practical	No. of practical's/ hours
1.	Paper chromatography	01(4)
2.	Separation of amino acids and sugars by thin layer chromatography and calculation of its Rf value	04(16)

3.	Diagrammatic and Graphical representation of statistical data using excel	02(8)
4.	Mean, Median, Mode from grouped and ungrouped Dataset using Microsoft excel	02(8)
5.	Isolation of bacterial pigment and its characterization using molar extinction coefficient	03(12)
6.	Use of nucleotide databases (various databases and features available on database websites, sequence retrieval, steps in sequence submission to NCBI, reading sequence descriptions)	02(8)
7.	Sequence matching by BLAST analysis.	01(4)

References:

1. Campbell, A. M., & Heyer, L. J. (2018). *Discovering Genomics, Proteomics and Bioinformatics* (3rd ed.). Pearson.
2. Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W. H. Freeman and Company.
3. Plummer, D. T. (2006). *An Introduction to Practical Biochemistry* (5th ed.). Tata McGraw-Hill.
4. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). *Principles of Instrumental Analysis* (6th ed.). Cengage Learning.
5. Triola, M. F. (2022). *Elementary Statistics* (14th ed.). Pearson.
6. Wilson, K., & Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press.
7. National Centre for Biotechnology Information (NCBI).

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Courseunder NEP2020)
Course Code: 24ScMicU5501 Practical) (VSC)

Course Name: Major Core (Practical): Lab Course on Clinical MicrobiologyandHaematology

Prerequisite Courses: Second Year B.Sc. Microbiology

Examination Scheme: CIA: 20 Marks **End Sem: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**
Course objectives :

1. To train students in fundamental haematological techniques for clinical diagnosis.
2. To develop competence in epidemiological survey methods, including data analysis and reporting.
3. To provide practical skills in antibiotic sensitivity testing of pathogens.
4. To equip students with the ability to determine MIC and MBC of antibacterial compounds following standard guidelines**.**

Course Outcomes:

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

1. Perform haemoglobin estimation, ESR, PCV, RBC/WBC counts and haematological indices accurately.
2. Design and conduct epidemiological surveys, analyse data statistically and prepare scientific reports.
3. Carry out antibiotic sensitivity testing using disc diffusion methods and interpret results for Gram-positive and Gram-negative bacteria.
4. Calculate MIC and MBC values of antibacterial agents against clinical isolates in compliance with CLSI standards.

Sr. No	Name of the practical	No. of practical's
1	**Haematology** a. Estimation of haemoglobinCyanmethemoglobin method) b. ESR and PCV determination c. White blood cell differential count from peripheral blood d. Counting of RBCs and WBCs using counting chamber e. Calculation of haematological indices	7
2	Epidemiological survey: Development of hypothesis, Data collection, organization, statistical analysis, graphical representation using computers and interpretation, Preparation of report	3
3	Antibiotic sensitivity testing of the pathogens by antibiotic sensitivity disc (for Gram negative and Gram Positive)	2
4	Clinical data management Introduction Medical coding 1. Basic Disease Coding Using ICD-10 2. Laboratory Report Coding & Data Entry 3. Drug Coding and Classification	3

References:

1. Cheesbrough, M. (2005). District laboratory practice in tropical countries, part 1 & part 2. Cambridge university press.
2. Gladwin, M., Trattler, B., & Mahan, C. S. (2004). Clinical microbiology made ridiculously simple (pp. 114-132). Med Master.
3. Godkar B.P. and Godkar P. D. (2014). Textbook of Medical Laboratory Technology. Edition 3. Volume 1 & 2.Bhalani Publishing House. ISBN 8185578583, 9788185578583.
4. Kindt, T., Goldsby, R., Osborne, B., and Kuby, J., (2019). Kuby immunology. 8th edition, New York: W.H. Freeman.ISBN: 9781319114701.
5. Procop, G. W., Church, D. L., Hall, G. S., & Janda, W. M. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. Jones & Bartlett Publishers.

Progressive Education Society's

Modern College of Arts, Science and Commerce(Autonomous),

Shivajinagar, Pune - 5

Second Year B.Sc. Microbiology

(2024 course under NEP 2020)

Course Code: 24ScMicU5302

Course Name: Introduction to Fermentation

Examination Scheme: CIA: 20 Marks **End Semester :30 Marks**

Teaching Scheme: 2 Hours/ Week **Credit 02**

Course Objectives:

1. To understand the different types of fermentation processes.
2. To evaluate optimization of fermentation parameters and the downstream process of fermentation.

Course Outcomes:

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

1. Understand the basics of large-scale fermentation processes with respect to constituents of media and types of crude media.
2. Understand the control and monitoring aspects in commercial bioprocess technology.

Unit - 1	**Introduction to Industrial Microbiology**	**No. of Lectures**

	A. **Design, operations and processes involved in Fermenters** Design of the equipment and operations of the parts, screening of microorganisms and strain improvement **B. Media used in fermentation industry and sterilization** a.Constituents of media b. Media optimization: Classical Approach, PB design, RSM, Taguchi design and Central Composite Design **C. Types of fermentations** SSF, SmF, Batch, fed batch and continuous fermentation	12
Unit 2	**Media Sterilization and Contamination**	**No. of Lectures**
	A. **Sterilization of media** ● Methods of sterilization ● Batch and Continuous sterilization ● Concept of Del factor B. **Contamination** ●Sources, Effects and Precautions C. **Concept of Scale up and Scale down** ● Introduction to different levels of fermentation	18

References:

1. Casida JR L. E. (2019) Industrial Microbiology, Second Edition, New Age InternationalPublishers, New Delhi, India
2. Patel. A. H. (2011) Industrial Microbiology, Second edition, Macmillan India Ltd.
3. Prescott and Dunn's (2004), Industrial Microbiology, Edited by Reed, Fourth Edition,CBS
4. Publications and Distributors, New Delhi, India
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevie.
6. Latest Indian Pharmacopoeia : https://www.pharmdinfo.com/pharmacoepidemiology-and-pharmacoeconomics-f65/topic2081.htm

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)
Course Code: 24ScMicU6101

Major Core Paper (Theory): Medical Microbiology II
Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Sem: 30 Marks

Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objectives:

1. To provide comprehensive knowledge of viral, fungal, and protozoal diseases.
2. To explain mechanisms of antimicrobial chemotherapy and drug resistance.
3. To develop understanding of pathogen biology, diagnosis, prevention, and treatment strategies.
4. To familiarize students with emerging resistance patterns and global health concerns

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

1. Learn about details of different microbial diseases
2. Understand about the concepts in chemotherapy
3. Interpret mechanisms of action of major antimicrobial agents and their clinical applications.
4. Analyse mechanisms of antimicrobial resistance.

Unit I	**Study of viral diseases**	**No. of lectures**
	1.Introduction to Baltimore classification 2.Study of following viral pathogens (with respect to – Virion characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Prophylaxis and Treatment): Retrovirus – Human immunodeficiency virus (HIV) Enteric virus – Rotavirus Arbovirus – Dengue virus Respiratory virus – Influenza virus DNA viruses – Hepatitis B virus	10
Unit II	**Study of fungal and protozoal diseases**	**No. of lectures**
	Study of following groups of pathogens (with respect to – Morphological characteristic, life cycle and classification, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Prophylaxis and Chemotherapy) 1) *Giardia, Plasmodium* 2) *Candida, Cryptococcus*	06
Unit III	**Chemotherapy**	**No. of lectures**

	1.Introduction to chemotherapy with desirable parameters of chemotherapeutic agent: Selective toxicity, Bioavailability of Drug, MIC and MBC 2.Mode of action of antimicrobial agents on: **a. Bacteria:** 1.Cell wall-Beta lactams 2.Cell membrane-Polymyxin 3.Protein synthesis- Streptomycin 4.Nucleic acids-Ciprofloxacin, Rifamycin 5.Enzyme inhibitors-Trimethoprim **b. Fungi:Fluconazole** **c. Viruses: Acyclovir** **d. Protozoa: Metronidazole** 3. Resistance to antibiotics: Development of antibiotic resistance (e.g. ESBL, VRE, MRSA, CRE), WHO priority pathogen list	14

References:

1. Brooks, G. F., Carroll, K. C., Butel, J. S. (2024).*Jawetz, Melnick & Adelberg's Medical Microbiology* (29th ed.). McGraw-Hill.
2. Carroll, K. C., Morse, S. A., Mietzner, T. (2019).*Jawetz, Melnick & Adelberg's Medical Microbiology* (28th ed.). McGraw-Hill.
3. Goering, R., Dockrell, H., Zuckerman, M. (2016).*Mims' Medical Microbiology* (6th ed.). Elsevier.
4. Greenwood, D., Slack, R., Barer, M., Irving, W. (2017).*Medical Microbiology* (18th ed.). Elsevier.
5. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. (2020).*Medical Microbiology* (9th ed.). Elsevier.
6. Procop, G. W., Church, D. L., Hall, G. S., Janda, W. M. (2017).*Koneman's Color Atlas and Textbook of Diagnostic Microbiology* (7th ed.). Jones & Bartlett.
7. Ryan, K. J., Ray, C. G. (2022).*Sherris Medical Microbiology* (8th ed.). McGraw-Hill.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Third Year of B. Sc. Microbiology
(2024 Course under NEP2020)
Course Code: 24ScMicU6102

Major Core Paper (Theory): Immunology II

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Sem: 30 Marks**
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objectives:

1. To explain the principles of adaptive immunity, including antigen properties, immunogenicity and antigen-antibody interactions.
2. To describe the structure, functions and applications of immunoglobulins, monoclonal antibodies and the major histocompatibility complex (MHC).
3. To analyse T and B cell activation, differentiation and cytokine regulation in adaptive immune responses.
4. To introduce clinical immunology concepts, including diagnostic techniques, transplantation immunology, hypersensitivity, autoimmunity and therapeutic immunosuppression.

Course Outcomes:

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

1. Define and classify antigens, explain factors affecting immunogenicity and describe antigen-antibody interactions.
2. Demonstrate understanding of immunoglobulin structure, hybridoma technology and applications of monoclonal antibodies.
3. Explain the role of MHC molecules in antigen processing and presentation and evaluate T and B cell responses in adaptive immunity.
4. Apply immunological knowledge to clinical contexts such as diagnostic assays, transplantation, hypersensitivity reactions, autoimmune disorders and immunosuppressive therapies.

Unit I	**Antigen, Immunoglobulins and Third line of defence**	**No. of lectures**
	Adaptive Immunity: Specific mechanisms of defence **1. Antigen:** a. Concepts and factors affecting immunogenicity b. Antigenic determinants, haptens and cross-reactivity, adjuvants c. Types of antigens: Thymus-dependent and thymus-independent antigens **2. Immunoglobulins:** a. Structure of basic unit, chemical and biological properties b. Hybridoma Technology and Monoclonal Antibodies i. Preparation, HAT selection ii. Applications of monoclonal antibodies **3. Major Histocompatibility Complex:** a. Structure and functions of MHC class–I and class–II molecules b. Polymorphism of MHC molecules c. Antigen processing and presentation **4. T and B cell response:** a. Activation and differentiation of T and B cells, **5.Adaptive immunity cytokines (IL-2 and IL-4)**	15
Unit II	**Clinical Immunology**	**No. of lectures**

	a. Diagnostic Immunology **Antigen-Antibody interactions** Concept of antibody avidity, affinity and cross-reactivity, Precipitation reactions, Agglutination reactions, Immunofluorescence, ELISA and its modifications **b. Clinical Immunology** **1. Transplantation:** Types of Grafts, Allograft rejection mechanisms, Prevention of allograft rejection; HLA typing **2. Hypersensitivity**: Gell and Coombs classification of hypersensitivity, 3. **Autoimmunity:** Theories of origin of autoimmunity, Types: Organ specific and Systemic. **4. Therapeutic immunosuppression**	15

References:

1. Abbas, A. K., Lichtman, A. H., Pillai, S., and Henrickson, S. (2025). *Cellular and molecular immunology* (11th ed.). Philadelphia, PA: Elsevier. ISBN: 9780323952736
2. Ananthanarayan, R., and Paniker, C. K. J. (2024). *Textbook of microbiology* (13th ed.). Hyderabad, India: Universities Press. ISBN: 9789393330466
3. Delves, P. J., Martin, S. J., Burton, D. R., and Roitt, I. M. (2025). *Roitt's essential immunology* (13th ed.). Hoboken, NJ: Wiley-Blackwell. ISBN: 9781118415771
4. Punt, J., Stranford, S., Jones, P., and Owen, J. A. (2023). *Kuby immunology* (8th ed.). New York, NY: Macmillan. ISBN: 9781319498658

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
(2023 Course under NEP2020)
Course Code: 24ScMicU6103
Major core theory: Biochemistry II

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Semester:30 Marks
Teaching Scheme (TH): 2 Hours/Week Credit: 02

Course Objective:

1. To learn bioenergetics and metabolic patterns for macromolecules in living cells.
2. To learn the process of photosynthesis in bacteria.
3. To understand the cell cytology and protein trafficking in eukaryotic cells

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

1. Explain basic principles of bioenergetics in living cells.
2. Acquire knowledge of metabolism in the living cells for macromolecules.
3. Develop perspective about photosynthesis and energetics in bacterial cells.
4. Apply bioenergetics concepts in relation to metabolic regulation.
5. Summarise the cell cytology, role of organelles in eukaryotic cells and significance of protein trafficking in cells.

Unit1	Bioenergetics	No. of lectures
	Principles of Bioenergetics (in reference to mitochondria) a. Introduction to free energy, entropy, b. high energy compounds, c. substrate level Phosphorylation**,** d. Oxidative Phosphorylation, e. Shuttle system, f. Regulation of oxidative phosphorylation g. Role of mitochondria in thermogenesis	**08**
Unit2	**Macromolecule metabolism**	**No. of lectures**
	A. Biosynthesis and Degradation of Macromolecules: a. Introduction to chemotrophy b. Chemistry, concept of polymerization of macromolecules: Polysaccharides-glycogen, Lipid -TAG c. Degradation of macromolecules – Polysaccharides-glycogen), Lipids (fatty acids beta-oxidation) and Proteins (urea cycle) **B. Photosynthesis & Phototrophy in Microbes** a. Introduction to phototrophy b. Habitat and examples of photosynthetic bacteria c. Photosynthetic apparatus d. Oxygenic and Anoxygenic mechanisms e. Calvin cycle and its regulation **C. Metabolic regulation** a. Enzyme compartmentalization at cellular level b. Allosteric enzymes and Feedback mechanisms c. Covalently modified regulatory enzymes (e.g. Glycogen phosphorylase) d. Proteolytic activation of zymogens e. Isozymes - concept and example-LDH	**15**

Unit-3	Structural organization of eukaryotic cell	No. of lectures
	a. Introduction to structure of: Cytoskeleton, Cell junctions, Endoplasmic Reticulum, Golgi apparatus, Chloroplast, Mitochondria (w.r.to. apoptosis) b. Introduction to Protein trafficking among various cellular compartments c. Gated transport and its role in metabolism	**07**

References:

1. Alberts Bruce (2022) Molecular Biology of Cell, (7the ed) W.W. Norton & Company (Garland Science).
2. Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (2016) Outlines of Biochemistry (6th ed) John Wiley and Sons, New Delhi.
3. Garrett, R. H. and Grisham, C. M. (2016) Biochemistry. (6th ed.) Brooks/Cole, Publishing Company, California.
4. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira,David Baltimore, and James Darnell (2021) Molecular Cell Biology, (9thed), W. H. Freeman &co.,New York.
5. Nelson D. L. and Cox M. M. (2021) Lehninger's Principles of Biochemistry (8th ed), Mac Millan Worth Pub. Co. New Delhi
6. Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, (2nd ed) Horwood Pub. Co. Chinchester, England.
7. Segel Irvin H. (2025). Biochemical Calculations, (2nd ed) John Wiley and Sons, NewYork.
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Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
(2024 Course under NEP2020)
Course Code: 24ScMicU6104
Course Name: Major core theory: Molecular Biology II

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Semester: 30Marks
Teaching Scheme (TH): 2 Hours/Week Credit: 02

Course Objectives:

1. To enrich the knowledge of the students with respect to Horizontal Gene Transfer methods.
2. To develop an interest in the recombinant DNA technology.

Course Outcomes:
On completion of the course, student will able to –

1. Learn about the recombinant DNA technology
2. Developed a fairly good knowledge about the three well known horizontal gene transfer mechanisms by which genetic material is transferred among the microorganisms namely, transformation, transduction and conjugation.
3. Illustrate the process for recombinant DNA technology.

Unit I	**Horizontal Gene transfer**	**No. of lectures**
	A. Transformation a. Development of competence in Gram positive and Gram-negative bacteria b. Process of transformation in Gram positive and Gram negative bacteria c. Factors affecting transformation **B. Conjugation** a. F^+, F^-, Hfr and F′strains b. Process of conjugation between $F^+$and $F^-$and Hfr and F^- **C. Transduction** a. Introduction to bacteriophages, lytic & lysogenic cycle of bacteriophages b. Process of generalized transduction. c. Process of specialized transduction. **D. Problem solving on Chromosome mapping byCo-transformation, Co-transduction and interrupted mating experiment**	**18**
Unit II	**Procedure and Tools of Recombinant DNA technology**	**No. of lectures**
	A. Cutting and joining the DNA molecules - i. Restriction Enzymes ii. Introduction to types of vectors used: a. Overview of Plasmids, Cosmids, Phagemids concept of Expression vectors b. BACs, PACs, YACs iii. Ligases **B. Methods to transfer recombinant DNA into host cells.** i. Insertion of foreign DNA in hosts (Physical transformation by using Electroporation& Heat shock, Gene gun, Transfection, Chemical transformation by using $CaCl_2$) **C. Introduction to different methods of screening the cells containing the recombinant DNA** a. Blue white screening	**12**

References:

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell* (7th ed.). Garland Science, New York.
2. Brown, T. A. (2016). *Gene Cloning and DNA Analysis:* An Introduction (7th

ed.). Wiley-Blackwell.
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4. Glick, B. R., & Patten, C. L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (5th ed.). ASM Press.
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6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular Cell Biology* (9th ed.). W. H. Freeman / Macmillan Learning.
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8. Streips, U. N., & Yasbin, R. E. (2002). *Modern Microbial Genetics* (2nd ed.). Wiley-Liss. (Still widely cited; newer comprehensive replacements include modern microbial genetics texts.)
9. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular Biology of the Gene* (7th ed.). Pearson / Benjamin Cummings.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
(2024 Course under NEP2020)
Course Code: 24ScMicU6105
Course Name:Lab course on Diagnostic Microbiology and Immunology
(24ScMicU6101 & 24ScMicU6102)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Semester:30 Marks
Teaching Scheme (TH): 4 Hours/Week Credit: 02

Course objectives:

1. To develop the ability to identify human blood groups (ABO and Rh systems) and demonstrate fundamental antigen-antibody interactions through immunoprecipitation.
2. To train students in immunoelectrophoresis methods, including serum protein separation and rocket immunoelectrophoresis, for the characterization and analysis of antigen-antibody reactions.
3. To provide practical skills in performing and interpreting serological tests and quantification of antigens and antibodies.
4. To familiarize students with rapid lateral flow assays and Clinical and Laboratory Standards Institute (CLSI) guidelines.

Course Outcomes:

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

1. Apply slide agglutination techniques to identify ABO and Rh blood groups and analyse antigen-antibody interactions using immunoprecipitation and agglutination assays.

2. Demonstrate immunoelectrophoresis methods (serum protein separation, rocket immunoelectrophoresis) and evaluate antigen-antibody reaction patterns for quantitative and qualitative analysis.
3. Perform serological tests and interpret results to diagnose infectious diseases based on antigen/antibody detection.
4. Utilize rapid lateral flow assays for antigen/antibody detection
5. Assess MIC and MBC values of antibacterial compounds against clinical isolates following CLSI guidelines.

Sr. No	**Name of the practical**	**No. of practical's/ Hours**
1	Identification of human blood groups by Blood group typing by slide test for **ABO and Rh systems**	1(4)
2	**Immunoprecipitation:** Demonstration of Antigen-Antibody Reactions by a. Radial Immunodiffusion b. Ouchterlony Double Diffusion	2(8)
3	**Agglutination:** a. Detection of antigen-antibody Reactions using latex agglutination b. latex agglutination inhibition	2(8)
4	**Immunoelectrophoresis:** a. Separation and analysis of serum proteins by electrophoresis b. Rocket Immunoelectrophoresis	2(8)
3	**Serological diagnosis** a. Enteric fever by rapid Widal Test b.Serological detection of Syphilis by Rapid Plasma Reagin (RPR) test	2(8)
5	**ELISA** (Enzyme Linked Immunosorbent Assay) a. Direct ELISA Detection of Antigens by Direct ELISA Method b. Indirect ELISA Detection of Antibodies by Indirect ELISA Method c. Sandwich ELISA Quantitative Estimation of Antigens by Sandwich ELISA Method	3(12)
6	Detection of antigens and antibodies using **rapid lateral flow assay**	1(4)
7	Introduction to **Clinical and Laboratory Standards Institute** Determination of MIC and MBC of Antibacterial Compounds Against Clinical Isolates Following CSLI guidelines	3(12)

8	**Demonstration of permanent slides** of following parasites: *a. Entamoeba histolytica* *b. Ascaris spp.* *c. Plasmodium spp.* *d. Mycobacterium(M.tuberculosis and M. leprae)*	1(4)

References:

1. Figge CD. *Clinical Immunology and Serology: A Laboratory Perspective*. 5th ed. Philadelphia, PA: F.A. Davis Company; 2020.
2. Kindt TJ, Goldsby RA, Osborne BA, Kuby J. *Kuby Immunology*. 7th ed. New York, NY: W.H. Freeman and Company; 2013.
3. Roitt's IM, Brostoff J, Male DK. *Essential Immunology*. 13th ed. Hoboken, NJ: Wiley-Blackwell; 2017.
4. Turgeon ML. *Immunology & Serology in Laboratory Medicine*. 7th ed. St. Louis, MO: Elsevier; 2022.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2023 Course under NEP2020)
Course Code: 23ScMicU6106
Course Name:Lab course onBiochemistry and Molecular biology II
(23ScMicU6103 & 23ScMicU6104)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks End Semester:30 Marks
Teaching Scheme (TH): 2 Hours/Week Credit: 02

Course Objectives:

1. To enrich students with the knowledge of molecular biology-basedpracticals.
2. To introduce the concepts related to horizontal gene transfer and its use in recombinant DNA technology.
3. To learn about bacteriophages.
4. To know the importance of clinical estimations from serum
5. To learn concept of absorption and its relation to molar extinction coefficient

Course Outcomes:

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

1. Isolate, detect and purify DNA (Genomic DNA, Plasmid) from microorganisms.
2. Design an experiment for horizontal gene transfer
3. Enumerate the bacteriophages.
4. Correlate clinical biochemistry with preliminary diagnosis of diseases.
5. Design an experiment for different molecules with respective to their absorption spectra

Sr. No	Name of the practical	No. of practical's/Hours
1	Determination of absorption spectra and molar extinction coefficient of dyes	2(8)
2	Bacterial Plasmid isolation and transformation of *E. coli* and selection of recombinants	2(8)
3	Isolation & enumeration of bacteriophages and study of phage morphology	3(12)
4	Perform conjugation process and selection of recombinants	2(8)
5	Clinical Biochemistry - Estimations of: a. Blood sugar b. Blood urea c. Serum cholesterol d. Serum proteins and albumin	4(16)
6	Agarose gel electrophoresis & PCR technique (demonstration)	2(8)

References:

1. Damodaran, G. (2010). *Practical biochemistry*. Jaypee Brothers Medical Publishers.
2. Fields, B. N., & Knipe, D. M. (2013). *Fields virology* (6th ed.). Wolters Kluwer Health/Lippincott Williams & Wilkins.
3. Flint, J., Racaniello, V. R. (2020). *Principles of virology: Volume 1: Molecular biology* (5th ed.). ASM Press.
4. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). *Principles of genetics* (8th ed.). John Wiley & Sons.
5. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology* (2nd ed.). ASM Press.
6. Knard, R., Michael, B., Neils, C., Riedemann, & Hartonga, C. S. (2014). New approaches to sepsis: Molecular diagnostics and biomarkers, *4*, 12–16. *(Note: journal name missing—add if available).*
7. Plummer, D. T. (2000). *An introduction to practical biochemistry* (2nd ed.). McGraw-Hill.
8. Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
9. Wilson, K., & Walker, J. (2018). *Principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge University Press.

Course Code: 24ScMicU6201

Course Name: Applied Microbiology II (Major Elective)

Prerequisite Courses: Second Year B.Sc. Microbiology

Examination Scheme: CIA: 20 Marks **End Sem: 30 Marks**

Teaching Scheme (TH): 2 Hours/Week **Credit: 02**

Course Objectives:

1. To understand the types of fermentation.
2. To understand the optimization of fermentation parameters.
3. To understand the quality assurance tests
4. To learn the concept of Intellectual Property Rights (IPR)
5. To understand the downstream process of fermentation.

Course Outcomes:

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

1. Explain the largescale production of different fermentation products.
2. Understand large scale production of biofertilizers and biocontrol agents.
3. Analysethe quality assurance of fermentation products.
4. Understand detection and quantification of fermentation products.
5. Discuss the concept of Intellectual Property Rights (IPR).

Unit 1	**Large scale production**	**No. of Lectures**
	i.Organicacids: Acetic acid ii. Vitamins: Vit. B2 iii. Amino acids: Glutamic acid iv. Antibiotics: Streptomycin v. Alcoholic beverages: Beer, Wine vi. Vaccines: Polio, Tetanus vii. Immune sera viii.Biofertilizer based on any one example ix. Biocontrol agents based on any one example	18
Unit 2	**Quality Assurance, IPR**	**No. of Lectures**
	a. Quality Assurance of Fermentation Product i. Detection and quantification of the product by physicochemical, biological and enzymatic methods ii. Sterility testing iii. Pyrogen testing – Endotoxin detection iv.Ames test v. Toxicity testing **b. Introduction to Intellectual Property Rights (IPR)**	12

References:

1. Casida, L. E., Jr. (2019). *Industrial Microbiology*. CRC Press.
2. Glazer, A. N., & Nikaido, H. (2020). *Microbial Biotechnology: Fundamentals of Applied Microbiology* (3rd ed.). Cambridge University Press.
3. Gopalakrishnan, S., & Sridharan, R. (2020). *Biotechnology and Intellectual Property Rights*. Springer.
4. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). *Microbiology* (10th ed.). McGraw-Hill.
5. Santos, D. K. F., Rufino, R. D., Sarubbo, L. A., & Banat, I. M. (2021). *Biosurfactants: Production and Applications*. Springer.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of Fermentation Technology* (3rd ed.). Elsevier.
7. Tortora, G. J., Funke, B. R., & Case, C. L. (2023). *Microbiology: An Introduction* (14th ed.). Pearson.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
(2024 Course under NEP2020)
Course Code: 24ScMicU6202
Course Name: Lab Course on Applied Microbiology II (24ScMicU6201)
Applied Microbiology Practical (Major Elective)

Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Sem: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**

Course Objectives:

1. To develop practical skills in isolation and primary screening of antibiotic-producing microorganisms from soil samples using the crowded plate technique.
2. To understand the principles of ethanol fermentation, product recovery, yield estimation (CAN method), and the effect of sugar concentration and temperature on fermentation.
3. To perform analytical and quality control techniques such as thin layer chromatography (TLC), demonstration of Ames test, and sterility testing of non-biocidal injectables as per FDA guidelines.
4. To gain hands-on experience in applied microbiological processes including production of solid and liquid biofertilizers.

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

1. Isolate and screen antibiotic-producing microorganisms from soil samples.
2. Carry out laboratory-scale ethanol fermentation, calculate yield, and analyze the effect of process parameters on enzyme activity.
3. Perform TLC analysis, understand the principle of Ames test, and conduct sterility testing procedures according to regulatory standards.
4. Produce and evaluate solid and liquid biofertilizers using standard microbiological techniques.

Sr. No	Name of the practical	No. of practical's/Hours
1.	Isolation and primary screening of antibiotic producing microorganisms from soil samples. (Crowded Plate Technique)	3(12)
2.	**Ethanol Fermentation -** a. Laboratory scale production and product recovery b. Estimation by CAN and yield calculation. c. Effect of Sugar concentration on fermentation of ethanol by yeast. d. Effect of temperature on fermentation of ethanol by yeast (enzyme study)	5(20)
3.	Thin Layer Chromatography (amino acid and sugars)	2(8)
4.	Demonstration of Ames test	1(4)
5.	Sterility testing of non-biocidal injectables (FDA guidelines)	1(4)
6.	Production of biofertilizers (solid and liquid)	3(12)

References:

1. Ames, B. N., McCann, J., & Yamasaki, E. (1975; updated reviews 2020). *Methods for Detecting Carcinogens and Mutagens with the Salmonella/Microsome Mutagenicity Test*.
2. Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A Laboratory Manual*, 12th Edition, Pearson.
3. FDA (U.S. Food and Drug Administration). (2023). *Guidance for Industry: Sterile Drug Products Produced by Aseptic Processing — Current Good Manufacturing Practice (CGMP)*.
4. Harborne, J. B. (2018). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*, Springer.
5. Maheshwari, D. K. (2019). *Biofertilizers and Biopesticides in Sustainable Agriculture*, Springer.
6. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). *Microbiology*, 10th Edition, McGraw-Hill.
7. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of Fermentation Technology*, 3rd Edition, Elsevier.

Course Code: 24ScMicU6203
Course Name: Biostatistics and Biophysics II (Major Elective IV)

Prerequisite Courses: Second Year B.Sc. Microbiology
Teaching Scheme (TH): 2 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**

Course objectives:

1. To understand the important instrumentation techniques
2. To understand applications and calibration protocols of various instruments
3. To understand the routinely used techniques in industry and research

Course outcomes:

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

1. Acquire principles and science behind different instruments, their role, and importance in research as well as in different applications
2. Students will be skilled in using various important instruments with detailed knowledge of each instrument used in research as well as industries.

Unit I	**Concepts in Statistics**	**No. of lectures**
	a. Population and sample i. Population and Sample ii. Types and methods of sampling iii. Limitations of sampling **b. Descriptive statistics** i. Measure of central tendency and dispersion: Arithmetic Mean, Median, Mode ii. Variance and standard deviation iii. Standard Error **c. Probability** i. Random variable ii. Probability distribution (normal, log-normal, binomial, Poisson and exponential). **d. Concept of Skewness and Kurtosis** **e. Introduction to the concept of hypothesis** (Emphasis on examples from biological system)	12
Unit II	**Spectroscopy**	**No. of lectures**

	a.Basics of spectroscopy: i.Simple theory of the absorption of light by molecules, Lambert Beer's law, deviation from Lambert Beer's law, instrumentation for measuring the absorbance of visible light, ii.Factors affecting the absorption properties of a chromophore. b. Introduction, basic principle and applications of following i. UV visible spectroscopy, ii. Fluorescence spectroscopy, iii. Infrared spectroscopy iv. Mass spectroscopy. **b. Radiation Biophysics** i.Definition, Units of Radioactivity and radiation doses, X-Ray Crystallography as a method for a structure determination of biomolecules NMR .(Basic introduction) ii.Nuclear detector (G M Counter), Radioimmunoassays (in brief) **c. Advanced techniques in Microscopy** a. Basic principles of optical microscopy, Concept of resolution and magnification. b. Different contrast enhancing techniques: Phase contrast, dark field, differential interference contrast, fluorescence. c. Concepts of digital microscopy and image analysis d. Confocal microscopy, SEM and TEM	18

References:

1. Campbell, A. M., & Heyer, L. J. (2018).*Discovering Genomics, Proteomics and Bioinformatics* (3rd ed.). Pearson.
2. Montgomery, D. C. (2019).*Design and Analysis of Experiments* (9th ed.). Wiley.
3. Motulsky, H. (2018).*Intuitive Biostatistics* (4th ed.). Oxford University Press.
4. Pagano, M., Gauvreau, K. (2021).*Principles of Biostatistics* (3rd ed.). CRC Press.
5. Rosner, B. (2023).*Fundamentals of Biostatistics* (9th ed.). Cengage.
6. Skoog, D. A., Holler, F. J., Crouch, S. R. (2018).*Principles of Instrumental Analysis* (6th ed.). Cengage.
7. Triola, M. F. (2022).*Elementary Statistics* (14th ed.). Pearson.
8. Zar, J. H. (2019).*Biostatistical Analysis* (5th ed.). Pearson.

Progressive Education Society's
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Shivajinagar, Pune-5
Second Year of B.Sc.
(2024 Course under NEP2020)
Course Code: 24ScMicU6204

Course Name: Lab Course on 24ScMicU6203 (Major Elective IV)
Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester:30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**

Course objectives:

1. To develop practical skills in electrophoretic separation and preparation of laboratory solutions with accurate concentration calculations.
2. To apply statistical tools and survey design methods for biological data collection and analysis.
3. To introduce students to advanced analytical instrumentation such as HPLC and GC and their applications.

Course outcomes:

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

1. Prepare buffers, stock and working solutions.
2. Perform agarose gel electrophoresis and interpret banding patterns for biomolecular analysis.
3. Prepare percent, molar, and normal stock solutions (w/v, v/v) and perform accurate dilution calculations to obtain working solutions.
4. Calculate standard deviation and present survey data using Microsoft Excel with appropriate graphical representation.
5. Explain the principle and working of analytical instruments such as HPLC and GC and interpret their basic output data.

Sr. No	Name of the practical	No. of practical's/Hours
1.	Agarose gel electrophoresis	02(8)
2.	Calculation of standard deviation using Microsoft excel	02(8)
3.	Preparation of Percent, Molar, and Normal stock solutions,w/v, v/v (solid and liquid compounds) and their dilutions to obtain working solutions.	04(16)
4.	Demonstration of working of HPLC, GC	01(4)
5.	Survey (Design, data presentation)	06(24)

References:

1. Montgomery, D. C. (2019).*Design and Analysis of Experiments* (9th ed.). Wiley.
2. Cappuccino, J. G., & Welsh, C. (2019).*Microbiology: A Laboratory Manual* (12th ed.). Pearson.

3. Arora, D. R., & Arora, B. (2023).*Practical Microbiology* (3rd ed.). CBS Publishers.
4. Motulsky, H. (2018).*Intuitive Biostatistics: A Non-Mathematical Guide to Statistical Thinking* (4th ed.). Oxford University Press.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018).*Principles of Instrumental Analysis* (6th ed.). Cengage Learning.
6. Green, M. R., & Sambrook, J. (2016).*Basic Methods in Molecular Biology*. Cold Spring Harbor Laboratory Press.

Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
(2024 Course under NEP2020)
Course Code: 24ScMicU6501
Course Name: Lab Course on Industrial Microbiology
Prerequisite Courses: Second Year B.Sc. Microbiology
Examination Scheme: CIA: 20 Marks **End Semester: 30 Marks**
Teaching Scheme (TH): 4 Hours/Week **Credit: 02**

Course Objectives:

1. To develop skills for isolation and screening of industrially important microorganisms from natural sources.
2. To understand microbial processes involved in production of PHB, pigments, probiotics, and biosynthesis of nanoparticles.
3. To study the application of immobilized microbial cells in bioconversion processes and evaluate the effect of different parameters.
4. To gain practical knowledge of plant tissue culture techniques using maize embryos.

Course Outcomes:

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

1. Isolate and identify industrially important microorganisms from environmental samples.
2. Perform microbial production and screening techniques for PHB, pigments, probiotics, and nanoparticles.
3. Apply immobilization methods for microbial cells and analyze factors affecting bioconversion.
4. Demonstrate plant tissue culture techniques and interpret experimental results in industrial microbiology and biotechnology.

Sr. no.	Name of the practical	No. of practical's/Hours

1.	**Isolation of industrially important microorganisms-** a. Isolation and screening of polyhydroxybutyrate (PHB) producing bacteria b. Isolation and characterization of pigment producing microorganisms from natural sources.	2 (8) 2 (8)
2.	Biosynthesis of silver nanoparticles and evaluation of their antimicrobial activity.	3(12)
3.	Bioconversion using immobilized microbial cells and the effect of parameters.	3(12)
4.	Production and screening of probiotics.	3(12)
5.	Plant tissue culture of maize embryo.	2(8)

References:

1. Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A Laboratory Manual* (12th ed.). Pearson.
2. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2023). *Microbiology: An Introduction* (14th ed.). Pearson.
4. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of Fermentation Technology* (3rd ed.). Elsevier.
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6. Doran, P. M. (2019). *Bioprocess Engineering Principles* (2nd ed.). Academic Press.
7. Trigiano, R. N., & Gray, D. J. (2021). *Plant Tissue Culture, Development, and Biotechnology*. CRC Press.
8. Bhojwani, S. S., & Dantu, P. K. (2013). *Plant Tissue Culture: An Introductory Text*. Springer.