RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

Rathinam Tech Zone, Eachanari, Coimbatore – 641021.

DEPARTMENT OF MICROBIOLOGY

Syllabus for

B.Sc. Microbiology

(I and II Semester)

2024 – 2025 Batch onwards

Vision and Mission of the Institution

Vision

To emerge as a world-renowned Institution that is integrated with industry to impart Knowledge, Skills, Research Culture and Values in youngsters who can accelerate the overall development of India

Mission

To provide quality education at affordable cost, build academic and research excellence, maintain eco-friendly and robust infrastructure, and to create a team of well qualified faculty who can build global competency and employability among the youth of India

Motto

Transform the youth into National Asset

Vision and Mission of the Department

Vision

To cultivate an exemplary department within the institution which seamlessly integrates state of the art industrial knowledge and skills in Microbiology and aspire to be recognized for its academic prowess, research endeavours, innovations and core values, thereby attracting best students and faculty members while making substantial contribution to national development

Mission

To be regarded as equal to any department in terms of the relevance of its teaching and research, the quality of its support and facilities, and the learning opportunities, innovative skills, and knowledge it offers to the future global workforce in the field of Microbiology

Motto

Industry – Ready Education

Program Educational Objectives (PEO)

PEO1	:	Pursue a career as a globally competent and universally employable professional in core and related fields in diverse sectors who accelerates the overall development of India.
PEO2	:	Pursue lifelong learning opportunities including graduate degrees to improve and expand domain specific and professional skills.
PEO3	:	Advance personally and professionally by accepting professional and societal responsibilities, and pursuing leadership roles.

Mapping of Institute's Mission to PEO

Institute's Mission	PEO's
To provide quality education at affordable cost, build academic and research excellence maintain eco-friendly and robust infrastructure, and	PEO1, PEO2
To create a team of well qualified faculty who can build global competency and employability among the youth of India.	PEO2, PEO3

Mapping of Department Mission to PEO

Department Mission	PEO's
Imparting critical thinking	PEO 1, PEO 2
Enhancing research skills	PEO 1, PEO 2
Developing professionalism	PEO 2, PEO 3
Viable technical knowledge and core competency	PEO 1, PEO 3

Program Outcomes (PO):

PO1	:	Demonstrate knowledge competency in core discipline
PO2	:	Apply the appropriate knowledge and suitable skills in solving the complex problems
PO3	:	Conduct investigations of complex problems through various scientific approaches
PO4	:	Design solutions for complex and open ended real-life or real-time problems
PO5	:	Use appropriate and advanced tools for wide range of practices with an understanding on its associated limitations
PO6	:	Work effectively and responsibly as a member or a leader in a team
PO7	:	Express complex concepts within the profession and with society at large
PO8	:	Understand the professional roles and responsibilities
PO9	:	Analyze social and environmental aspects of the professional practices
PO10	:	Practice higher moral and ethical standards during the discharge of professional duties
PO11	:	Incorporate finer finance and business practices in all professional engagements
PO12	:	Identify and address their professional development through lifelong learning

Program Specific Outcomes (PSO):

PSO 1	:	Able to integrate research practices and ethics in the framing of public health, bio-safety and intellectual property rights policy
PSO 2	:	Able to develop newer microbiological technologies with broader industrial and other applications
PSO 3	:	Conduct investigations of complex problems through various scientific approaches
PSO 4	:	Collaborate effectively in interdisciplinary teams, integrating microbiological principles with other scientific disciplines to address contemporary societal issues

Correlation between the PO/PSO and the PEOs

Program Outcomes		PEO 1	PEO 2	PEO 3
PO 1	:	3	1	3
PO 2	:	3	2	3
PO 3	:	1	2	3
PO 4	:	3	1	3
PO 5	:	3	3	2
PO 6	:	2	3	3
PO 7	:	2	3	1
PO 8	:	3	2	1
PO 9	:	2	2	3
PO 10	:	3	2	1
PO 11	:	2	1	1
PO 12	:	3	2	2
PSO 1	:	2	3	1
PSO 2	:	3	2	2
PSO 3	:	2	3	3
PSO 4	:	3	2	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

Components considered for Course Delivery is listed below:

a. Class room Lecture
b. Laboratory class and demo
c. Assignments
d. Mini Project
e. Project
f. Online Course
g. External Participation
h. Seminar
i. Internship

Mapping of POs with Course Delivery:

Program Outcome	Course Delivery								
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**
PO1	3	3	1	1	2	1	3	3	1
PO2	3	3	2	3	3	1	1	2	3
PO3	3	3	1	3	1	1	1	2	3
PO4	2	3	2	3	3	1	1	3	1
PO5	3	2	1	3	1	3	3	3	3
PO6	2	3	1	3	3	1	2	3	3
PO7	2	3	1	3	1	1	2	3	3
PO8	2	2	1	2	3	3	2	3	3
PO9	1	1	2	3	3	3	2	3	3
PO10	2	1	2	3	2	2	2	2	2
PO11	1	1	2	2	2	3	3	3	3
PO12	1	2	3	2	2	2	3	3	3
PSO1	2	3	1	3	2	3	1	3	3
PSO2	3	2	2	3	3	2	2	3	2
PSO3	2	3	3	2	2	3	3	2	3
PSO4	3	2	2	1	3	2	2	1	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

B.SC. MICROBIOLOGY DEGREE PROGRAMME

B. Sc (MB) Curriculum Structure - Regulation – 2024

(For students admitted from 2024-2025 and onwards)

S.No.	Sem	Part	Sub Type	Course Code	Course Name	Credit	Hours	INT	EXT	Total
1	1	1	L1		Language - I	3	5	50	50	100
2	1	2	L2		English - I	3	5	50	50	100
3	1	3	Core		Core Course – I **Theory**	4	5	50	50	100
4	1	3	Core		Core Course – II **Theory / Practical**	4	4	50	50	100
5	1	3	Allied		Allied-I	4	5	50	50	100
6	1	4	SEC		Skill Enhancement Courses – I **Practical / Training**	4	4	50	50	100
7	1	4	AEC		Ability Enhancement Course I Environmental Studies **or** Universal Human Values & Professional Ethics	2	2	50	0	50
						24	**30**	**350**	**300**	**650**
1	2	1	L1		Language - II	3	5	50	50	100
2	2	2	L2		English - II	3	5	50	50	100
3	2	3	Core		Core Course – III **Theory**	4	5	50	50	100
4	2	3	Core		Core Course – IV Theory / **Practical**	4	4	50	50	100
5	2	3	Elective		Elective - I Entrepreneurship Development	4	4	50	50	100
6	2	3	Allied		Allied-II	4	5	50	50	100
7	2	4	AEC		Ability Enhancement Course II Design Thinking	2	2	50	0	50
8	2	5	Ext		Extension Activity - I (NASA)	1	0	25	0	25
						25	**30**	**375**	**300**	**675**
1	3	1	L1		Language - III	3	4	50	50	100
2	3	2	L2		English - III	3	4	50	50	100
3	3	3	Core		Core Course – V **Theory**	4	6	50	50	100
4	3	3	Core		Core Course – VI **Theory** / Practical	4	4	50	50	100
5	3	3	Allied		Allied-III	4	5	50	50	100
6	3	4	SEC		Skill Enhancement Courses – II Practical / Training	4	5	50	50	100
7	3	4	AEC		Ability Enhancement Course III Soft Skill-1	2	2	50	0	50
8	3	3	ITR		Internship / Industrial Training (Summer vacation at the end of II semester activity)	2	0	50	0	50
9	3	5	Ext		Extension Activity - II **(NASA)**	1	0	25	0	25
						27	**30**	**425**	**300**	**725**
1	4	1	L1		Language - IV	3	4	50	50	100

2	4	2	L2		English - IV	3	4	50	50	100
3	4	3	Core		Core Course – VII **Theory**	4	6	50	50	100
4	4	3	Core		Core Course – VIII Theory / **Practical**	4	4	50	50	100
5	4	3	Allied		Allied-IV	4	5	50	50	100
8	4	3	Elective		Elective - II	4	5	50	50	100
7	4	4	AEC		Ability Enhancement Course IV Soft Skill-2	2	2	50	0	50
8	4	5	Ext		Extension Activity - III **(NASA)**	1	0	25	0	25
						25	**30**	**375**	**300**	**675**
1	5	3	Core		Core Course – IX Theory	4	6	50	50	100
2	5	3	Core		Core Course – X **Theory** / Practical	4	6	50	50	100
3	5	3	Elective		Elective - III	4	6	50	50	100
	5	3	PRJ		Project	0	6	0	0	0
4	5	4	SEC		Skill Enhancement Courses – III Practical / Training	4	6	50	50	100
5	5	3	ITR		Internship / Industrial Training - (Summer vacation at the end of IV semester activity)	2	0	50	0	50
6	5	5	Ext		Extension Activity - IV (**NASA**)	1	0	25	0	25
						19	**30**	**275**	**200**	**475**
1	6	3	Core		Core Course – XI Theory	4	6	50	50	100
2	6	3	Core		Core Course – XII Theory / **Practical**	4	4	50	50	100
3	6	3	Elective		Elective – IV	4	6	50	50	100
4	6	3	PRJ		Core Project	8	8	100	100	200
5	6	4	SEC		Skill Enhancement Courses – IV Practical / Training	4	6	50	50	100
						24	**30**	**300**	**300**	**600**
					Total credit	**144**	**180**	**2100**	**1700**	**3800**

Core - Theory						
S. No	**Sem**	**Pre-requisite**	**Course Code**	**Course Name**	**Offering Department**	**Type Theory / Practical**
1	1	Nil		Fundamentals of Microbiology	Microbiology	Theory
2	1			Microbial Taxonomy and Diversity		Theory
3	2			Microbial Physiology and Metabolism		Theory
4	3			Molecular Biology and Microbial Genetics		Theory
5	3			Immunology and Immuno-technology		Theory
6	4			Medical Bacteriology		Theory
7	5			Medical Mycology and Parasitology		Theory
8	5			Medical Virology		Theory
9	6			Environmental and Agricultural Microbiology		Theory

Core - Practical						
S. No.	**Sem**	**Pre-requisite**	**Course Code**	**Course Name**	**Offering Department**	**Type Theory / Practical**
1	2	Nil		Fundamentals of Microbiology, Microbial Taxonomy and Diversity, Microbial Physiology and Metabolism Practical	Microbiology	Practical
2	4			Microbial Genetics, Immunology and Medical Microbiology Practical	Microbiology	Practical
3	6			Environmental and Agricultural Microbiology Practical	Microbiology	Practical

Allied						
S.No.	**Sem**	**Pre-requisite**	**Course Code**	**Course Name**	**Offering Department**	**Type Theory / Practical**
1	1			Bioinstrumentation	Microbiology	Theory
2	2			Biomolecules	Microbiology	Theory
3	3			Biostatistics and Computer Application	Microbiology	Theory
4	4			Research Methodology	Microbiology	Theory

Skill Enhancement Course						
S. No	**Sem**	**Pre-requisite**	**Course Code**	**Course Name**	**Offering Department**	**Type Practical / Training**
1	1			Clinical Lab technology	Microbiology	Training
2	3			Vaccine Technology	Microbiology	Practical
3	5			Bioethics IPR and Biosafety	Microbiology	Training
4	6			Project Control System - Quality Control and Testing	Microbiology	Practical

Elective						
S. No	**Sem**	**Pre-requisite**	**Course Code**	**Course Name**	**Offering Department**	**Type Practical / Training**
1	2			Bio-entrepreneurship (NME) /Applied Microbiology (DSE)	Microbiology	Training
2	4			Pharmaceutical Microbiology (NME) / rDNA Technology (DSE)	Microbiology	Practical
3	5			Bioinformatics (NME) / Marine Microbiology (DSE)	Microbiology	Training
4	6			Nutrition and Hygiene Practices (NME) / Food and Industrial Microbiology (DSE)	Microbiology	Practical

Additional Credits										
S.No.	**Sem**	**Part**	**Sub Type**	**Course Code**	**Course Name**	**Credit**	**Hours**	**INT**	**EXT**	**Total**
1	2	6	VAC		VAC - Microsoft CoE Course / NPTEL	2	2	50	0	50
3	4	6	IDC		VAC - Microsoft CoE Course / NPTEL	2	2	50	0	50
4	5	6	VAC		VAC - Microsoft CoE Course / NPTEL	2	2	50	0	50

Parts	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Sem V**	**Sem VI**	**Total Credits**
Part I	3	3	3	3			12
Part II	3	3	3	3			12
Part III	12	16	15	16	15	20	94
Part IV	6	2	6	2	4	4	24
Part V		1	1	1	1		4
Total	**24**	**25**	**28**	**25**	**20**	**24**	**146**

CORE COURSES

Semester 1

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core I - Fundamentals of Microbiology	4	5	-	-	**Theory**

Course Introduction

This course enables the student to explore the foundational principles of microbiology covering various contributions by scientists, various microscopes, staining techniques, sterilization principles thereby providing a strong foundation for aspiring biologists.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Study the historical events that led to the discoveries and inventions in Microbiology
CO 2:	Gain Knowledge of detailed structure and functions of prokaryotic cell organelles.
CO 3:	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO 4:	Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.
CO 5:	Understand the concept of asepsis and modes of sterilization and disinfectants.

Unit I:	**History and Scope of Microbiology**	**[12 Periods]**

Spontaneous generation theory – conflict – Contributions of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman, John Tyndall, Paul Ehrlich, Watson and Crick, and Miescher.

Unit II:	**General Characteristics of Microbes**	**[12 Periods]**

General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between prokaryotic and eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores, and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.

Unit III:	**Culture Media preparation:**	**[12 Periods]**

Solid and Liquid–Types of Media – Semi–Synthetic, Synthetic, Enriched, Enrichment, Selective and Differential media, Natural components as media and Special Purpose Media (one example for each type). Anaerobic culture technique – Wright's tube, Roll tube, Mclntosh fildes jar method. Pure culture techniques –Serial dilution, Pour plate, Spread plate, Streak plate techniques.

Unit IV:	**Microscopy**	**[12 Periods]**

Simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM, Confocal microscopy, and Atomic Force Microscopy. Stains and staining methods – Principles – Simple and Differential staining techniques (Gram, Endospore Stain, Acid Fast), Capsule staining (Positive and Negative), Giemsa staining, Lacto Phenol Cotton Blue and KOH Mount. Preparation of permanent stained slide cultures.

Unit V:	**Sterilization and Disinfection**	**[12 Periods]**

Sterilization–moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic; Antimicrobial agents.

Text Books:

1. Pelczar. M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition., McGraw –Hill, New York.
2. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International edition.
3. Tortora, G.J., Funke, B.R., Case, C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson.
4. Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc. New York.
5. Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby College Publishing, St Louis.

Reference Books:

1. Jeffrey C. Pommerville., Alcamo's Fundamentals of Microbiology (9th Edition). Jones &Bartlett

learning 2010.
2. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5th Edition., MacMillan Press Ltd
3. Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11th Edition., Benjamin Cummings.
4. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5th Edition., McGraw Hill Publications.
5. Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13th Edition Benjamin-Cummings Pub Co.

Web Resources:

1. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	1	1	1	2	1	1	1	2	3	1	3
CO2	3	2	3	1	1	3	2	1	2	1	1	1	3	2	2	3
CO3	3	3	2	1	2	2	1	3	2	1	2	1	2	3	3	2
CO4	1	1	3	3	1	3	2	3	1	2	2	2	3	2	2	1
CO5	3	1	3	1	3	2	2	3	1	2	2	1	1	2	3	2

Semester 1

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core II - Microbial Taxonomy and Diversity	4	4	-	-	**Theory**

Course Introduction

This paper has been structured to make the students familiarize with fundamental knowledge on the classification and diversity of microorganisms.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the principle of microbial taxonomy and it's types.
CO 2:	Describe common classification of bacteria and archaea in different ecosystems.
CO 3:	Describe general characteristics of fungi, algae, protozoa, and virus in different ecosystems.
CO 4:	Evaluate, synthesize and present scientific studies of genetic and functional microbial diversity.
CO 5:	Explain the taxonomy of viruses.

Unit I:	**Principles of Taxonomy**	**[12 Periods]**

Taxonomy – Principles – Modern approaches – Numerical, Molecular, Serotaxonomy and Chemotaxonomy. Introduction to Microbial Classification and Taxonomy –Taxonomic ranks.

Unit II:	**Taxonomy of Bacteria**	**[12 Periods]**

Bergey's Manual, Binomial Nomenclature and Universal Phylogenetic tree. Classification system: Phenetic and Phylogenetic, Whittaker's Five Kingdom and Carl Woese's three kingdom classification system and their application. Difference between prokaryotic and eukaryotic microorganism.

Unit III:	**Taxonomy of Fungi**	**[12 Periods]**

General Characteristics of Fungi – Life Cycle of *Aspergillus*, *Mucor*, *Rhizopus, Penicillium, Candida sp.* – Modes of reproduction and its economic importance.

Unit IV:	**Taxonomy of Algae and Protozoa**	**[12 Periods]**

General characteristics of algae including algal cell ultra–structure. Classification of algae–Chlamydomonas, Volvox, Diatoms, red algae and brown algae. Application of Algae in agriculture, industry, environment and food. General characteristics of protozoa with special references with *Entameoba histolytica*, *Trichomonas*, *Giardia* and *Plasmodium*.

Unit V:	**Taxonomy of viruses**	**[12 Periods]**

Virus– Morphology, general characteristics, classification (Baltimore classification) and multiplication of viruses. The structure of viruses – virion size – General structure properties – helical capsids, icosohedral capsid – nucleic acids – Viral envelopes and enzymes.

Text Books:

1. Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition., McGraw –Hill, New York.
2. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International edition.
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3. Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11th Edition., Benjamin Cummings.
4. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5th

Edition., McGraw Hill Publications.
5. Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13th Edition Benjamin-Cummings Pub Co.

Web Resources:

1. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	1	2	1	1	1	1	1	3	2	1	1
CO2	3	2	2	2	2	1	2	1	2	1	1	1	3	2	2	1
CO3	3	2	2	2	2	1	2	1	2	1	1	1	3	2	2	1
CO4	3	3	3	3	2	1	3	1	2	1	1	2	3	2	3	3
CO5	3	2	1	2	2	1	2	1	2	1	1	1	3	2	1	1

Semester 2

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core III - Microbial Physiology and Metabolism	4	4	-	-	**Theory**

Course Introduction

This course deals with the study on how a microbial cell utilizes the available nutrient and obtain energy in nature. Understanding microbial physiology is vital in manipulating both the beneficial and harmful characteristics of microbes.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Study the basic principles of microbial growth.
CO 2:	Understand the basic concepts of aerobic and anaerobic metabolic pathways.
CO 3:	Analyze the role of individual components in overall cell function.
CO 4:	Provide information on sources of energy and its utilization by microorganisms.
CO 5:	Study the different types of metabolic strategies.

Unit I:	**Physiology of microbial growth**	**[12 Periods]**

Microbial Growth, Methods of Cultivation – Batch, continuous, synchronous cultures- diauxic growth; Growth Curve and measurement method (turbidity, biomass, and cell count) – Generation time. Control of microbial growth- factors influencing microbial growth

Unit II:	**Nutritional requirements**	**[12 Periods]**

Nutritional requirements of microorganisms – macro elements, micro elements and growth factors, nutritional groups of microbes – transport mechanisms and types – simple diffusion – facilitated diffusion – active transport – group translocation – Ion transport.

Unit III:	**Metabolic Pathways**	**[12 Periods]**

Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.

Unit IV:	**Photosynthesis**	**[12 Periods]**

Structure of Chloroplast. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.

Unit V:	**Microbial reproduction**	**[12 Periods]**

Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.

Text Books:

1. Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridge.
2. Rajapandian K. (2010). Microbial Physiology, Chennai: PBS Book Enterprises India.
3. MeenaKumari. S. Microbial Physiology, Chennai 1st Edition MJP Publishers 2006.
4. Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.
5. S. Ram Reddy, S.M. Reddy (2008). Microbial Physiology. Anmol Publications Pvt Ltd.

Reference Books:

1. Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.
2. Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.
3. Daniel R. Caldwell. (1995). Microbial Physiology & Metabolism Wm.C. Brown Communications, Inc. USA.
4. Moat, A.G and J.W Foaster (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications.
5. Bhanu Shrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology

and Metabolism. Lambert academic Publication.

Web Resources:

1. https://sites.google.com/site/microbialphysiologyoddsem/teaching-contents
2. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	1	1	1	1	1	1	2	1	2	1	1
CO2	3	2	2	2	2	1	2	1	1	1	1	2	1	2	2	1
CO3	3	3	2	2	2	1	2	1	2	1	1	2	1	2	2	1
CO4	3	3	2	2	2	1	2	1	2	1	1	2	1	2	2	1
CO5	3	3	2	2	2	1	2	1	2	1	1	2	1	2	2	1

Semester 3

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core IV -Molecular Biology and Microbial Genetics	4	5	-	-	**Theory**

Course Introduction

This course is framed to emphasize on the knowledge of the candidate on the types of Genetic material and the regulations under which it acts. Students undertaking this course would be able to study the role of nucleic acids in regulating the microbial cells functions.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Grasp the knowledge on structure and replication of DNA.
CO 2:	Illustrate the significance and functions of RNA in protein synthesis.
CO 3:	Explain the cause and types of DNA mutation and DNA repair mechanisms.
CO 4:	Outline the role of plasmids and phages in genetics.
CO 5:	Examine mechanisms of gene transfer and recombination.

Unit I:	**DNA Structure**	**[12 Periods]**

Salient features of double helix, forms of DNA. Denaturation and renaturation. DNA topology – Supercoiling, linking number, topoisomerases. DNA organization in prokaryotes, viruses, eukaryotes. Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication – enzymes involved – DNA polymerases, DNA ligase, primase. DNA replication modes - rolling circle, D-loop modes.

Unit II:	**Transcription in Prokaryotes**	**[12 Periods]**

Transcription in Prokaryotes. Concept of transcription. RNA Polymerases - prokaryotic and eukaryotic. General transcription factors in eukaryotes. Distinction between transcription processes in prokaryotes versus eukaryotes. Translation in prokaryotes and eukaryotes - Translational machinery - ribosome structure in prokaryotes and eukaryotes, tRNA structure and processing. Inhibitors of protein synthesis in prokaryotes and eukaryotes. Overview of regulation of gene expression - *lac, trp* and *ara* operons as examples. Regulation of gene expression by DNA methylation.

Unit III:	**Mutation**	**[12 Periods]**

Definition and types - base substitutions, frame shifts, deletions, insertions, duplications, inversions. Silent, conditional, and lethal mutations. Physical and chemical mutagens. Reversion and suppression. Uses of mutations. Repair Mechanisms - Photo reactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.

Unit IV:	**Plasmid**	**[12 Periods]**

Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2µ plasmid. Bacteriophage-T4, Virulent Phage – Structure and lifecycle. Lambda Phage-Structure, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics.

Unit V:	**Gene Transfer Mechanisms**	**[12 Periods]**

Conjugation and its uses. Transduction - Generalized and Specialized, Transformation - Natural Competence and Transformation. Transposition and Types of Transposition reactions. Mechanism of transposition: Replicative and non- replicative transposition. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons.

Text Books:

1. Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. 4th Edition. Narosa Publishing House, New Delhi.
2. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. 8th Edition. Wiley India Pvt. Ltd.
3. Trun N. and Trempy J. (2009). Fundamental Bacterial Genetics. 1st Edition. Blackwell Science Ltd.
4. Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7th Edition). John Wiley and Sons, Ltd.
5. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of

DNA Technology. (3rd Edition). John Wileys and Sons Ltd.

Reference Books:

1. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
2. Russell P.J. (2010). Genetics - A Molecular Approach, 3rd Edition., Pearson New International edn.
3. Nelson, D.L. and Cox, M.M. Lehninger (2017). Principles of Biochemistry. 7th Edition, W.H. Freeman.
4. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria, 4th Edition, ASM Press Washington-D.C. ASM Press.
5. Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing

Web Resources:

1. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2	1
CO2	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2	1
CO3	3	3	3	2	2	1	2	1	2	1	1	2	2	2	3	1
CO4	3	2	2	2	2	1	2	1	2	1	1	2	2	2	2	1
CO5	3	3	3	2	2	1	3	1	2	1	1	2	2	2	3	1

Semester 3

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core V -Immunology and Immuno-technology	4	5	-	-	**Theory**

Course Introduction

This course is framed to introduce the Science of Immunology by imparting knowledge on various types of immune systems their classification structure and mechanism of immune activation.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses.
CO 2:	Investigate the structures of Ag and Ab; Immunization.
CO 3:	Justify the Immunoassay and Immunotechniques.
CO 4:	Explain about the immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation
CO 5:	Analyze the overreaction by our immune system leading to hypersensitive conditions and its consequences.

Unit I:	**Cells and Organs of Immune System**	**[12 Periods]**

History of Immunology - Organs and Cells in Immune System and Immune Response: Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues; T – cell and B –cell membrane bound receptors – apoptosis; T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression; Physiology of immune response- innate, humoral and cell mediated immunity; Immunohematology.

Unit II:	**Antigens and Antibodies**	**[12 Periods]**

Antigens - Properties of haptens, epitopes, adjuvants, and cross reactivity; Antibodies- structure, properties, classes; Antigen and Antibody Reactions: precipitation, agglutination, complement fixation, opsonization, neutralization; Vaccines – active and passive immunization; Classification of vaccines; Other approaches to new vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule.

Unit III:	**Immunoassay and Immunotechniques**	**[12 Periods]**

Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immunofluorescence techniques and Flow cytometry

Unit IV:	**Transplantation and Tumor Immunology**	**[12 Periods]**

MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection; HLA typing; Tumor specific antigens; Immune response to tumors; Immune diagnosis; cancer immune therapy.

Unit V:	**Immunological disorders and diseases**	**[12 Periods]**

Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and non-organ specific.

Text Books:

1. Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5thEdition., Wiley-Blackwell, New York.
2. Judith A. Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7thEdition., W. H. Freeman and Company, New York.
3. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. (2021). Cellular and Molecular Immunology, 10thEdition., Elsevier.
4. Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, Cornelia M. Weyand. (2018). Clinical Immunology: Principles and Practice, 5th Edition. Elsevier.
5. Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.

Reference Books:

1. Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
2. Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition., Wiley-Blackwell.

3. William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York.
4. Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell.
5. Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition.

Web Resources:

1. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
2. Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	2	1	1	2	3	2	2	1
CO2	3	2	3	2	2	1	2	1	2	1	1	2	3	2	3	1
CO3	3	3	3	2	2	1	2	1	2	1	1	2	3	2	3	1
CO4	3	3	3	2	2	1	2	1	2	1	1	2	3	2	3	1
CO5	3	3	3	2	2	1	2	1	2	1	1	2	3	2	3	1

Semester 4

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core VI – Medical Bacteriology	4	5	-	-	**Theory**

Course Introduction

This course provides the ability to characterize, isolate and identify different microbes. It includes a detailed study of characterization, etiology, pathogenicity, clinical systems, and laboratory diagnosis of disease-causing Microorganisms.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.
CO 2:	Explain the various bacterial pathological events during the progression of an infectious disease, and apply the underlying mechanisms of spread of disease and its control.
CO 3:	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.
CO 4:	Compare the morphology and cultural characters of mycobacteria, spirochetes and intracellular parasites.
CO 5:	Appraise the methods of diagnosis of infections.

Unit I:	**Infections and types**	**[12 Periods]**

Normal microflora of human body - Sources and types of infections- methods of transmission – Virulence Factors - adhesion, exotoxins and endotoxins - Epidemic, Endemic and Pandemic diseases- Infectious disease cycle. Factors influencing the Human microflora based on environmental conditions.

Unit II:	**Gram Positive Organisms**	**[12 Periods]**

Gram positive organisms - Morphology, cultural characteristics, pathogenicity *Staphylococcus aureus*, *Streptococcus pyogenes*, *Pneumococcus*, *Bacillus anthracis*, *Clostridium tetani* and *Clostridium botulinum*.

Unit III:	**Gram Negative Organisms**	**[12 Periods]**

Gram negative organisms Morphology, cultural characteristics, pathogenicity and clinical manifestations of *E. coli, Klebsiella pneumoniae, Salmonella typhi, Shigella dysentriae, Pseudomonas aeroginosa, Vibrio cholerae, Neiserria gonorrhoeae,* and *Neiserria meningitidis*.

Unit IV:	**Mycobacteria, Spirochetes and Intracellular parasites**	**[12 Periods]**

Morphology, cultural characteristics, pathogenicity and clinical manifestations of *Corynebacterium diphteriae, Mycobacterium tuberculosis, Mycobacterium leprae. Spirochaetes – Treponema pallidium,* and *Leptospira icterohaemorrhagiae, Mycoplasma pneumoniae, Rickettsia rickettsii and Chlamydia trachomatis.*

Unit V:	**Lab diagnosis**	**[12 Periods]**

Laboratory diagnosis of common bacterial infections– Process of sample collection, transportation and processing- antibiotics- modes of action-Antibacterial susceptibility testing- drug resistance.

Text Books:

1. Tom Parker, M. Leslie H. Collier. (1990). Topley&Wilson's Principles of Bacteriology, Virology and Immunity,8th Edition. London: Edward Arnold.
2. Greenwood, D., Slack, R.B. and Peutherer, J.F. (2012) Medical Microbiology, 18thEdition. Churchill Livingstone, London.
3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edition. C.V. Mosby Company, St. Louis.
4. Ananthanarayanan, R. and Jayaram Panicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.

Reference Books:

1. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.
2. Kevin Kavanagh, (2018). Fungi Biology and Applications 3rd Edition. Wiley Blackwell publishers.
3. C.J. Alexopoulos, C.W. Mims, M. Blackwell, (2007). Introductory Mycology, 4th edition. Wiley publishers.
4. A.J. Salle (2007). Fundamental principles of bacteriology, fourth edition, Tata McGraw-Hill Publications.
5. Christopher C. Kibbler, Richard Barton, Neil A. R. Gow, Susan Howell, Donna M. MacCallum, Rohini J. Manuel (2017). Oxford Textbook of Medical Mycology. Oxford University Press.ASM.3rd Edition.
6.

Web Resources:

1. http://textbookofbacteriology.net/nd
2. https://microbiologysociety.org/members-outreach-resources/links.html

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	2	1	1	2	3	2	2	1
CO2	3	3	3	3	3	2	2	1	3	2	1	3	3	3	3	2
CO3	3	2	3	2	3	1	2	1	2	1	1	2	3	3	3	2
CO4	3	2	2	2	3	1	2	1	2	1	1	2	3	3	2	2
CO5	3	3	3	3	3	2	2	1	3	2	1	3	3	3	3	2

Semester 5

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core VI – Medical Mycology and Parasitology	4	5	-	-	**Theory**

Course Introduction

This course enables a student to illustrate the medically important fungi and parasite. It also emphasizes on the various laboratory methods for identifying different types of fungi and parasites.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will be able to
CO 1:	Describe the fungal characteristics, classification and mycoses
CO 2:	Compare the susceptibility testing- CLSI, EUCAST methods
CO 3:	Illustrate the life cycle and pathology of parasitic infections
CO 4:	Analyze the medically important helminths
CO 5:	Evaluate the validation of antimicrobial technology

Unit I:	**Superficial mycoses**	**[12 Periods]**

Characteristics of fungi- morphological classification of fungi- classification of fungal infections - superficial mycoses- surface, cutaneous infections- subcutaneous mycoses- Mycetoma, Chromomycoses, Sporotrichosis, Rhinsporidiosis.

Unit II:	**Systemic mycoses**	**[12 Periods]**

Systemic Mycoses –Histoplasmosis, Blastomycosis, Coccidioidomycoses, Opportunistic Mycoses- *Cryptococcosis, Candida allbicans*, Aspergillosis and Penicilliosis. Antifungal agents- Antifungal susceptibility testing- CLSI, EUCAST methods.

Unit III:	**Protozoology**	**[12 Periods]**

Introduction of protozoa- Morphology, life cycle, pathology - *Entamoeba histolytica*, Intestinal flagellates- *Giardia lamblia*, Genital flagellate- *Trichomonas vaginalis*, Hemoflagellates- *Leishmania donovani*, Tissue flagellate- *Toxoplasma gondii* Malarial parasite-*Plasmodium vivax* and Coccidia- *Cryptosporidium parvum*.

Unit IV:	**Helminthology**	**[12 Periods]**

Helminthology- Medically important helminths- Tapeworms- *Taenia solium, Taenia saginata,* Trematodes- *Schistosoma haematobium; Fasciola hepatica;* Nematodes-*Ascaris lumbricoides, Wuchereria bancrofti*

Unit V:	**Laboratory diagnosis of fungi and parasites**	**[12 Periods]**

Collection of specimen - wet mount, KOH and LPCB and fungal culture --Collection of specimen - Preservation and examination of stool- macroscopic and microscopic examination, Concentration methods- floatation-sedimentation techniques, duodenal contents, anal swabs, blood- thin and thick smear- staining and cerebrospinal fluid.

Text Books:

1. Subash Chandra Parija., "Textbook of Medical Parasitology protozology and Helminthology", All India Publishers and Distributors, New Delhi.
2. AroraD.R. and AroraB. (2002). Medical Parasitology, 1stEdition CBS Publishers & Distributors, New Delhi.
3. Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta.
4. Ananthanarayanan, R. and Jayaram Panicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.
5. Jagdish Chander (2018). Textbook of Medical Mycology, 4th edition, Jaypee brothers medical publishers.

Reference Books:

1. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19thEdition. Lange Medical Publications, U.S.A.
2. Ananthanarayan, R. and Jeyaram Paniker, C.K. (2009). Text Book of Microbiology, 8thEdition. Orient Longman, Chennai.
3. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
4. Topley & Wilsons's (1990). Principles of Bacteriology, Virology and Immunity, 8th Edition, Vol. III Bacterial Diseases, Edward Arnold, London.
5. Finegold, S.M. (2000). Diagnostic Microbiology, 10th Edition. C.V. Mosby Company, St. Louis.

Web Resources:

1. https://cmr.asm.org/content/30/3/811
2. https://www.nejm.org/doi/full/10.1056/NEJMoa1811400

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	2	1	1	2	3	2	2	1
CO2	3	2	2	2	3	1	2	1	2	1	1	2	3	2	2	1
CO3	3	2	2	2	3	1	2	1	2	1	1	2	3	2	2	1
CO4	3	2	2	2	3	1	2	1	2	1	1	2	3	2	2	1
CO5	3	3	3	3	3	2	2	1	3	2	1	3	3	3	3	2

Semester 5

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Core VII – Medical Virology	4	5	-	-	**Theory**

Course Introduction

This course describes the replications and life cycle strategies of DNA and RNA Viruses. A candidate undertaking this course shall enumerate the integrated information in viral reproduction and host interaction.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.
CO 2:	Elucidate the role of replication in the sustenance of virus existence
CO 3:	Acquire knowledge of basic and general concepts of causation of disease by virus particles
CO 4:	Delve on to treatment options of viral diseases
CO 5:	Understand the need for various parameters of assessment of their severity and the methods of diagnosis of emerging viral infections.

Unit I:	**General structure and cultivation of viruses**	**[12 Periods]**

General Properties, replication and Classification of viruses (Baltimore classification), Cultivation of viruses- in animals, embryonated eggs and tissue culture, Virus purification assays - collection and transport of clinical specimens for viral infections.

Unit II:	**Viral reproduction**	**[12 Periods]**

DsDNA T4 – lytic cycle adsorption - penetration- synthesis -assembly - release of phage particles - one step growth experiment. ssDNA phage - ØX 174 replication. Temperate bacteriophages – prophage – integration and excision. Defective phages – λ phage - conversion between lytic and lysogeny phases – reproduction of RNA phages.

Unit III:	**Plant Viruses**	**[12 Periods]**

General properties, structure, genome replication of DNA containing virus – CaMV and gemini virus- RNA containing viruses – TMV and BMV- Myco and Phycophages

Unit IV:	**Animal Viruses**	**[12 Periods]**

Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (Flavi virus), Picorna viruses (Polio virus and Rhinovirus), Hepatitis viruses (HAV, HBV, HCV, HDV, HEV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps and Measles virus), Pox viruses (Variola, Vaccinia), Herpes viruses (Herpes simplex, Varicella zoster), Adeno viruses, Rota viruses and HIV viruses. Oncogenic viruses (Human Papilloma virus): Introduction, characteristics of transformed cells, mechanism of viral oncogenesis and clinical manifestations.

Unit V:	**Diagnosis of Emerging Viral infections**	**[12 Periods]**

Emerging and reemerging viral infections (SARS, Swine flu, Ebola, Dengue, Chikungunya- and Corona) – causes, spread and preventive measures. Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections – Antiviral agents, Interferons and Viral Vaccines, Immunization schedules.

Text Books:

1. Prescott L.M, Harley, J.P Klein D.A., 2020 "Microbiology", Wm C Publishers, New Delhi.
2. S., Rajan (2007). Medical microbiology, MJP publisher. Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta.
3. Ananthanarayanan, R. and Jayaram Panicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.
4. Jagdish Chander (2018). Textbook of Medical Mycology, 4th edition, Jaypee brothers medical publishers.

Reference Books:

1. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19thEdition. Lange Medical Publications, U.S.A.
2. Ananthanarayan, R. and Jeyaram Paniker, C.K. (2009). Text Book of Microbiology, 8th Edition. Orient Longman, Chennai.
3. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.

4. Topley & Wilsons's (1990). Principles of Bacteriology, Virology and Immunity, 8th Edition, Vol. III Bacterial Diseases, Edward Arnold, London.
5. Finegold, S.M. (2000). Diagnostic Microbiology, 10th Edition. C.V. Mosby Company, St. Louis.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/
2. https://www.ncbi.nlm.nih.gov/pubmed/21722309

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	2	1	1	2	3	2	2	1
CO2	3	2	2	2	3	1	2	1	2	1	1	2	3	3	2	1
CO3	3	3	3	2	3	1	2	1	3	1	1	3	3	3	3	2
CO4	3	3	2	3	3	2	2	1	3	1	1	3	3	3	3	2
CO5	3	3	3	3	3	2	2	1	3	2	1	3	3	3	3	2

ALLIED COURSES

Semester 1

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Allied - Bioinstrumentation	4	5	-	-	Practical

Course Introduction

This course highlights the basic laboratory skills that are essential for work in clinical, Pharmaceutical, Microbiology, Biochemistry and Biotechnology laboratories. Upon successful completion of this course, students will be able to explain bioinstrumentation techniques, design and application.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the analytical instruments and study the basic principles in the field of sciences.
CO 2:	Gain knowledge about principles of spectroscopy
CO 3:	Understand the analytical techniques of Chromatography and electrophoresis
CO 4:	Understand the principle of different types of scans used in medical diagnosis
CO 5:	Gain information about the principles of radioactivity and its measurements

Unit I:	**Analytical Preparations and Instrumentations:**	**[12 Periods]**

pH meter, Buffer systems, Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave, Hot Air Oven, incubator, incinerator, biosafety cabinets, lyophilizer. Biochemical calculations-preparations of Molar solutions - Buffers- Phosphate, Acetate, TE, TAE- calculation of Normality, PPM- Ammonium sulphate precipitation.

Unit II:	**Spectroscopic Techniques**	**[12 Periods]**

Principles, instrumentation and applications of Colorimeter, Ultraviolet and Visible, Infra-red, Mass Spectrophotometers

Unit III:	**Chromatographic and Electrophoresis Techniques:**	**[12 Periods]**

Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PFGPAGE.

Unit IV:	**Imaging techniques:**	**[12 Periods]**

Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes

Unit V:	**Fluorescence and radiation-based techniques**	**[12 Periods]**

Spectrofluorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.

Text Books:

1. Jayaraman J (2011). Laboratory Manual in Biochemistry, 2nd Edition. Wiley Eastern Ltd., New Delhi.
2. Ponmurugan. P and Gangathara PB (2012). Biotechniques.1st Edition. MJP publishers.
3. Veerakumari, L (2009). Bioinstrumentation- 5th Edition. MJP publishers.
4. Upadhyay, Upadhyay and Nath (2002). Biophysical chemistry – Principles and techniques 3rd Edition. Himalaya publishing home.
5. Chatwal G and Anand (1989). Instrumental Methods of Chemical Analysis. S. Himalaya Publishing House, Mumbai.

Reference Books:

1. Rodney. F. Boyer (2000). Modern Experimental Biochemistry, 3rd Edition. Pearson Publication.
2. SkoogA., WestM (2014). Principles of Instrumental Analysis – 14th Edition W.B. Saunders Co., Philadephia.
3. N. Gurumani. (2006). Research Methodology for biological sciences- 1st Edition – MJP Publishers.
4. Wilson K, and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology.7th Edition. Cambridge University Press.
5. Webster, J.G. (2004). Bioinstrumentation- 4th Edition - John Wiley & Sons (Asia) Pvt. Ltd, Singapore.

Web Resources:

1. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction-

types- uses-and-other-details-with-diagram/12489
2. https://www.watelectrical.com/biosensors-types-its-working-andapplications/
3. http://www.wikiscales.com/articles/electronic-analytical-balance/ Page 24 of 75

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	1	1	1	1	1	1	2	1	2	2	1
CO2	3	3	2	1	3	1	1	1	1	1	1	2	1	2	2	1
CO3	3	3	3	1	3	1	1	1	1	1	1	2	1	3	3	1
CO4	3	3	2	1	3	1	1	1	1	1	1	2	1	2	2	1
CO5	3	2	2	1	3	1	1	1	1	1	1	2	1	2	2	1

Semester 2

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Biomolecules	4	4	-	-	Allied

Course Introduction

Biochemistry is a branch of science which deals with the chemistry of living organisms and that of their biological processes. Biomolecule deals with the ability to comprehend chemical combinations and reactions that occurs due to biological processes such as growth, reproduction, metabolism, heredity.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the knowledge of carbohydrates.
CO 2:	Describe the structure and functions of amino acids.
CO 3:	Comprehend the molecular basis of lipids
CO 4:	Decipher the structure and molecular basics of nucleic acids.
CO 5:	Present the basis of enzymes and its actives.

Unit I:	**Carbohydrates**	**[12 Periods]**

Structure and Classification of Sugars -Monosaccharides, disaccharides and polysaccharides – classification, structure, biological and physiological importance.

Unit II:	**Amino acids**	**[12 Periods]**

Classification of amino acids – essential amino acids – properties – zwitter ion – isoelectric. Proteins: classification and function of proteins– structural level of organization.

Unit III:	**Lipids**	**[12 Periods]**

Classification and properties of lipids. Types of fatty acids – saturated, unsaturated and essential fatty acids. Classification and significance of lipoproteins, glycolipids and phospholipids. Biological significance of steroids and cholesterol.t

Unit IV:	**Nucleic acids**	**[12 Periods]**

Components of DNA and RNA. Double helical structure of DNA, Structure and types of DNA – Structure and types of RNA.

Unit V:	**Enzymes**	**[12 Periods]**

Classification of enzymes with examples, coenzymes and cofactors (structures not needed) – Active site: Lock and key model– induced fit hypothesis. Factors affecting enzyme activity. Enzyme inhibitors. Chemical and industrial applications of enzymes amylase, protease and lipase.

Text Books:

1. Satyanarayana, U. and Chakrapani, U (2014). Biochemistry,4th Edition, Made Simple Publisher.
2. Jain J L, Sunjay Jain and Nitin Jain (2016). Fundamentals of Biochemistry, 7th Edition, S Chand Company.
3. Ambika Shanmugam's (2016). Fundamentals of Biochemistry for Medical Students, 8th Edition. Wolters Kluwer India Pvt Ltd.
4. Vasudevan. D.M. Sreekumari.S, Kannan Vaidyanathan (2019). Textbook Of Biochemistry For Medical Students. Kindle edition, Jaypee Brothers Medical Publishers
5. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto (2015). Biochemistry, 8th edition. WH Freeman publisher.

Reference Books:

1. Amit Kessel& Nir Ben-Tal (2018). Introduction to Proteins: structure, function and motion. 2nd Edition, Chapman and Hall.
2. David L. Nelson and Michael M. Cox (2017). Lehninger Principles of Biochemistry, 7th Edition W.H. Freeman and Co., NY.
3. Lupert Styrer, Jeremy M. Berg, John L. Tymaczko, Gatto Jr., Gregory J (2019). Biochemistry. 9th Edition, W.H. Freeman& Co. New York.
4. Donald Voet, Judith Voet, Charlotte Pratt (2016). Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, Wiley.
5. Joy PP, Surya S. and AswathyC (2015). Laboratory Manual of Biochemistry, Edition 1., Publisher: Kerala agricultural university.

Web Resources:

1. https://metacyc.org
2. https://www.medicalnewstoday.com

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	1	1	1	1	1	1	1	1	2	1	1
CO2	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO3	3	2	3	2	2	1	1	1	1	1	1	1	1	3	3	1
CO4	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	1
CO5	3	2	2	2	2	1	1	1	1	1	1	1	1	2	2	1

Semester 3

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Biostatistics and Computer Application	4	4	-	-	Allied

Course Introduction

This course is designed to enable the students to learn the Application of Statistics in the field of Biology.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Provide the basics of Biostatistics
CO 2:	Describe the Measures of location and dispersion
CO 3:	Apply the concept of probability theory in research
CO 4:	Identify the hardware parts in a computer
CO 5:	Illustrate different utilities available in Microsoft Excel software

Unit I:	**Statistical methods**	**[12 Periods]**

Nature and Scope of Statistical methods and their limitations - Data collection -Classification and Tabulation - Primary and Secondary data and their applications in life sciences - Diagrams - Line diagram, Bar diagram and Pie diagram - Graphical presentation - Histogram and Ogives.

Unit II:	**Measures of Central Tendency**	**[12 Periods]**

Measures of Location and Dispersion - Stem and Leaf plots - Box and Whisker Plots - Co -efficient of variation - Skewness and its measures.

Unit III:	**Probability**	**[12 Periods]**

Probability - Concept and Definition - Addition and Multiplication theorems of Probability (statement only) - simple problems - Binomial, Poisson and Normal distributions (without proof) - simple problems.

Unit IV:	**Basics to Computers**	**[12 Periods]**

Introduction to Computers - Classification - Generations - Low, Medium and High level languages - Software and Hardware - Operating Systems - Compilers and Interpreters - Personal, Mini, Main frame and Super computers - their characteristics and application, BIT, BYTE, WORD computer memory and types; data representation and storage, binary codes, binary system.

Unit V:	**Microsoft Excel**	**[12 Periods]**

Microsoft Excel - Data entry - Graphs - Aggregate functions - formulae and functions (students are expected to be familiar with all operations) - different number systems and conversions, input and output devices, secondary storage media - Numerical problems based on Units I to IV may be worked using Microsoft Excel. AI functions in Excel.

Text Books:

1. Daniel W.W (1995) Bio statistics: A Foundation for Analysis in Health Science, 6th Edition, John Wiley
2. Camphell R.C (1989) Statistics for Biologist, Cambridge University Press

Reference Books:

1. Snedecor G.W and Cochran W.G (1967) Statistical Methods, Oxford Press
2. R.K Taxali: PC Hardware and Software, Galgotia Publication.

Web Resources:

1. https://www.classcentral.com/subject/biostatisticshttps://www.medicalnewstoday.com

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	1	2	1	1	1	2	2	2	2	2	1
CO2	3	3	2	2	1	1	2	1	1	1	2	2	2	2	2	1
CO3	3	3	3	2	2	2	3	1	2	2	2	2	3	3	3	2
CO4	2	2	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO5	2	2	1	2	3	2	2	1	1	1	2	2	2	2	2	1

Semester 4

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Research Methodology	4	4	-	-	Allied

Course Introduction

Research Methodology introduces students to the nature, scope, and significance of research and research methodologies. Additionally, the course studies primary and secondary research methods with applications to specific problems, using qualitative and quantitative designs for individual investigation on current problems within a student's area of interest. Students will complete an individual research proposal based on a business topic of interest, using the course's textbooks and selected scholarly and peer reviewed sources.

Course Focus on: Skill Development / Entrepreneurship / Employability / **Research**

Course Outcomes	On completion of this course, students will
CO 1:	Grasp the basic of research and formation of problems
CO 2:	Understand and apply the major types of research designs and errors
CO 3:	Formulate clearly defined scaling techniques and report writing
CO 4:	Analyze and summaries the basic terms such as mean, medium and mode
CO 5:	Gain the ability to apply T-Test, Chi Square-Test to research data

Unit I:	**Research Basics**	**[12 Periods]**

Research – Meaning – Scope and Significance – Utility of Business research – Qualities of good researcher – Types of research – Research Process-Research design– Identification, Selection and formulation of research problems- Setting objectives – literature review

Unit II:	**Sampling methods**	**[12 Periods]**

Sampling – Methods and techniques – Sample size – Sampling error – Field work and data collection- Tools of data collection- Secondary data sources and usage- online data sources- Primary data collection methods – Interview schedule- Questionnaire – Observation, interview and mailed questionnaire – online surveys -pilot study and final collection of data.

Unit III:	**Data analysis**	**[12 Periods]**

Measurement and scaling techniques – Processing and analysis of data – Editing and coding – Transcription and Tabulation – Statistical tools used in research – Hypothesis -Measures of Central tendency – Mean – Median - Mode-Standard deviation – Correlation – simple and multiple correlations.

Unit IV:	**Data validation**	**[12 Periods]**

Test of significance – 't' Test - large sample, test of significance for attributes, analysis of variants - Chi-square test and ANOVA test – Ranking Concept & Methods

Unit V:	**Report Preparation**	**[12 Periods]**

Interpretations - Report writing– Types of Reports - contents and style of reports – Usage of Tables and Charts - Steps in drafting reports – Reference - Bibliography

Text Books:

1. N. Gurumani. (2006). Research Methodology for biological sciences- 1st Edition – MJP Publishers.
2. Camphell R.C (1989) Statistics for Biologist, Cambridge University Press
3. Business Research Methods - Kothari - 4th Edition

Reference Books:

1. Business Research Methods - Emory
2. 2. Business Research Methods –Rummel & Ballaine.
3. Snedecor G.W and Cochran W.G (1967) Statistical Methods, Oxford Press

Web Resources:

1. What Is a Research Methodology? | Steps & Tips (scribbr.com)

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	1	1	1	2	3	1	2	1

CO2	3	3	2	2	1	1	1	1	1	1	1	2	3	2	2	1
CO3	3	2	2	1	1	1	1	1	1	1	1	2	2	1	2	1
CO4	3	2	2	1	1	1	1	1	1	1	1	2	2	1	2	1
CO5	3	3	2	1	2	1	1	1	1	1	1	2	2	2	2	1

SKILL ENHANCEMENT COURSES

Semester 1

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	SEC-1-Clinical Laboratory Technology	4	4	-	-	Theory

Course Introduction

This course was intended to create a skill set among the candidates on the clinical lab techniques. Students would be imparted with knowledge on the various methodologies involved in clinical analysis of samples.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand different types of microbial diseases.
CO 2:	Describe the process of collection of samples in labs.
CO 3:	Understand the methods of processing clinical samples.
CO 4:	Analyze and perform clinical serology.
CO 5:	Study the antibiogram analysis of different clinical pathogens

Unit I:	**Laboratory principles**	**[12 Periods]**

Basic laboratory principles - Code of conduct of medical laboratory personnel -Understanding the organogram of clinical lab – Job responsibilities of lab technician - Medical laboratory professional and professionalism in laboratory workers - clinic borne infection - personal and safety measures.

Unit II:	**Specimen collection and processing**	**[12 Periods]**

Blood, urine, stool, sputum CSF, amniotic fluid and bile. Separation of serum and plasma, Handling of specimens for testing, preservation of specimens, transport of specimens and factors affecting the clinical results. Pre analytical factors affecting the clinical results.

Unit III:	**Introduction to histopathology**	**[12 Periods]**

Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing - Collection of specimens, Labelling and fixation, Dehydration, Clearing, Impregnation, Embedding - Paraffin block making, Section Cutting, Microtomes – types and mounting of sections.

Unit IV:	**Introduction to Haematology**	**[12 Periods]**

Laboratory methods – Enumeration of complete blood, ESR and Retic count used in the investigation of coagulation disorders - coagulation tests, Routine coagulation tests, (prothrombin time, plasma recalcification time, partial thromboplastin time, activated partial thromboplastin time, thrombin time), Laboratory diagnosis of bleeding disorders. Estimation of fibrinogen, Assay of coagulation factors.

Unit V:	**Quality Standards in Health Laboratories**	**[12 Periods]**

Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment - pre-analytical, analytical and post-analytical requirements as per NABL 15189: 2022 quality standards.

Text Books:

1. Mukharji, K.L. (2000). Medical Laboratory Techniques, Vol - I, II & III, 5th Edition. Tata McGraw-Hill, Delhi.
2. Ochei, A., Kolhatkar.A. (2000). Medical Laboratory Science: Theory and Practice, McGraw Hill Education.
3. Ramnik Sood (2015). Concise Book of Medical Laboratory Technology: Methods and Interpretation, 2nd Edition, Jaypee Brothers Medical Publishers, NewDelhi.
4. S. Ramakrishnan, KN Sulochana(2012). Manual of Medical Laboratory Techniques,Jaypee Brothers Medical Publishers Pvt. Ltd
5. Talib V.H. (2019).Handbook Medical Laboratory Technology, 2nd Edition, Directorate of health services, Government of India.

Reference Books:

1. Rutherford, B.H. Gradwohl , A.C. Sonnenwirth L. Jarett. Gradwohls. (2000). Clinical Laboratory Methods and Diagnosis, Vol-I, 8th edition, Mosby.

2. Baker, F.J., Silverton, R.E., and Pallister, J. (1998). An Introduction to Medical Laboratory Technology, 7th Edition, CBS Publishers and Distributors Pvt. Ltd.
3. Godkar (2021). Textbook of Medical Laboratory Technology, 3rd Edition, Bhalani Publishing House.
4. M.N. Chatterjee and Rana Shinde. (2008). Textbook of Medical Biochemistry, 7th Edition, Jaypee Brothers Medical Publishers Pvt. Limited.
5. James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5th Edition). The Benjamin publishing company. New York. Pillai, K. (Ed.). (2017). Textbook of Medical Laboratory Technology. New Delhi, India: Jaypee Brothers Medical Publishers.
6. Mukhopadhyay, M. (Ed.). (2016). Practical Clinical Biochemistry Methods

Web Resources:

1. https://www.pdfdrive.com › wintrobes-clinical-hematology
2. https://nptel.ac.in/courses/102105087
3. https://vlab.amrita.edu/index.php?sub=3&brch=272

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	2	2	1	1	2	2	1	1
CO2	3	3	2	2	2	1	1	1	2	2	1	1	2	2	2	1
CO3	3	3	3	2	2	1	1	1	2	2	1	1	2	2	3	1
CO4	3	3	3	2	2	1	2	1	2	2	1	1	2	2	3	1
CO5	3	3	3	2	2	1	2	1	2	2	1	1	2	3	3	1

Semester 3

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	SEC-2-Vaccine Technology	4	4	-	-	Theory

Course Introduction

This course, delve into various aspects of vaccine technology, including the principles of immunology, the different types of vaccines, vaccine production methods, and the latest advancements in vaccine research and development.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines
CO 2:	Understand the types of vaccines
CO 3:	Construct vaccine applying rDNA technology
CO 4:	Formulate the strategies for developing an innovative vaccine technology with different mode of vaccine delivery.
CO 5:	Evaluate the regulatory issues and guidelines for the management of vaccine production.

Unit I:	**Vaccination and Immunity**	**[12 Periods]**

History of vaccination, Active and passive immunization; requirements for induction of immunity, Epitopes, linear and conformational epitopes, characterization and location of APC, MHC and immunogenicity,

Unit II:	**Types of Vaccines**	**[12 Periods]**

Viral/bacterial/parasite vaccine differences, methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines; Licensed vaccines, Viral Vaccine - Poliovirus vaccine-inactivated & Live, Rabies vaccines, Hepatitis A & B vaccines, Bacterial Vaccine - Anthrax vaccines, Cholera vaccines, Diphtheria toxoid, Parasitic vaccine - Malaria Vaccine.

Unit III:	**Vaccine Technology**	**[12 Periods]**

Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines. Recent advances in Malaria, Tuberculosis, HIV.

Unit IV:	**Vaccine Research**	**[12 Periods]**

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Rationale vaccine design based on clinical requirements: Scope of future vaccine strategies.

Unit V:	**Regulations and ethical compliance**	**[12 Periods]**

Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Regulation of vaccines in developing countries, Quality control and regulations in vaccine research, Animal testing, Rational design to clinical trials, Large scale production, Commercialization. Vaccine safety ethics and Legal issues.

Text Books:

1. Ronald W. Ellis. (2001). New Vaccine Technologies. Landes Bioscience.
2. Cheryl Barton. (2009). Advances in Vaccine Technology and Delivery. Espicom Business Intelligence.
3. Male, David. Ed. (2007). Immunology. 7th Edition. Mosby Publication.
4. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne. (2002). Immunology. 6th Edition, Freeman.
5. Brostoff J, Seaddin JK, Male D, Roitt IM. (2002). Clinical Immunology. 6th Edition, Gower Medical Publishing.

Reference Books:

1. Stanley A. Plotkin, Walter Orenstein& Paul A. Offit. (2013). Vaccines, 6th Edition. BMA Medical Book Awards Highly Commended in Public Health. Elsevier Publication.
2. Coico, R. *et al*. (2003). Immunology: A Short Course. 5th Edition, Wiley – Liss.
3. Parham, Peter. (2005). The Immune System. 2nd Edition, Garland Science.
4. Abbas, A.K. *et al*. (2007). The Cellular and Molecular Immunology. 6th Edition, Sanders / Elsevier.
5. Weir, D.M. and Stewart, John (2000). Immunology. 8th Edition, Churchill Pvt. Ltd. Technology. New Delhi, India: Jaypee Brothers Medical Publishers.

Web Resources:

1. https://www.slideshare.net/adammbbs/pathogenesis-3-rd-internal-updated-43458567

2. https://www.bio.fiocruz.br/en/images/stories/pdfs/mpti/2013/selecao/vaccine-processtechnology.pdf
3. https://www.dcvmn.org/IMG/pdf/ge_healthcare_dcvmn_introduction_to_pd_for_vaccine_production_29256323aa_10mar2017.pdf

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	2	2	1	2	1	1	3	2	2	2
CO2	3	2	2	1	2	1	2	1	1	2	1	1	2	2	2	2
CO3	3	3	3	3	3	1	2	1	2	2	1	1	3	3	3	3
CO4	3	3	3	3	3	1	2	2	2	3	2	2	3	3	3	3
CO5	3	3	2	2	3	2	3	3	2	3	3	2	3	3	3	3

Semester 5

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	SEC-3-Bioethics IPR and Biosafety	4	4	-	-	Theory

Course Introduction

This course aids to explore ethical considerations, intellectual property rights (IPR), and biosafety in biotechnology. Delve into the intersection of science, ethics, and policy. Analyze case studies, regulations, and emerging trends. Essential for biotech professionals and policymakers.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment
CO 2:	Develop stratagems for the use of genetically modified organisms and Hazardous materials
CO 3:	Develop critical ethical analysis skills and analyse contemporary moral problems in medicine and health care.
CO 4:	Analyze and respond to the comments of other students regarding philosophical issues.
CO 5:	Pave the way for the students to catch up Intellectual Property (IP) as a career option.

Unit I:	**Basics of Biosafety**	**[12 Periods]**

Basics of Biosafety - Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. Biological Risk Groups. Need and application of biosafety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).

Unit II:	**Hazardous materials**	**[12 Periods]**

Hazardous materials in Microbiology - Categories of Waste in the Microbiology Laboratories, Biohazardous waste and their disposal and treatments- issues in use of GMO's, risk for animal/human/ agriculture and environment owing to GMO. Hazardous materials, Emergency response/ first aids in Laboratories.

Unit III:	**Biosafety**	**[12 Periods]**

Biological Safety Containment in Laboratory - Primary and secondary containments - Physical and biological containment. Types of biosafety containments (level I, II, III), PPE, Biosafety guidelines in India - Roles of Institutional Biosafety Committee, RCGM, GEAC.

Unit IV:	**Bioethics**	**[12 Periods]**

Introduction and need of Bioethics - its relationship with other branches, Ethical implications of bioscience products and techniques. Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.

Unit V:	**IPR and Patent laws**	**[12 Periods]**

IPR, Patents and Patent laws - Intellectual property rights-TRIP- GATT International conventions patents, Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law, Microbiological inventions, and patent law. Legal Development-Patentable subjects and protection in Microbiology. The patenting of living organisms.

Text Books:

1. Usharani. B, S Anbazhagi, C K Vidya, (2019). Biosafety in Microbiological Laboratories- 1st Edition, Notion Press, ISBN-101645878856
2. Satheesh. M.K., (2009). Bioethics and Biosafety- 1st Edition, J. K International Publishing House Pvt. Ltd: Delhi, ISBN :9788190675703
3. Deepa Goel and Shomini Parashar, (2013). IPR, Biosafety and Bioethics- 1st Edition, Pearson education: Chennai, ISBN-13: 978-8131774700
4. Raj Mohan Joshi (2006). Biosafety and Bioethics. Gyan Books publisher.
5. Sateesh. M.K. (2013). Bioethics and Biosafety. I.K. International pvt, Ltd.

Reference Books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited, ISBN-10: 9386668572
2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited, ISBN: 9788120349896
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis, ISBN-10:

8131251659.
4. Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, Ezebuiro Nwagbo Christpeace, Charles Oluwaseun Adetunji, Abdulrazak B. Ibrahim, Benjamin Ewa Ubi (2022). Biosafety and Bioethics in Biotechnology-Policy, Advocacy, and Capacity Building,1st edition. CRC Press
5. Sree Krishna. V (2007). Bioethics and Biosafety in Biotechnology. New age international publishers.

Web Resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. World Intellectual Property Organization. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf.
3. https://www.niehs.nih.gov/bioethics
4. https://www.sist.sathyabama.ac.in
5. https://www.longdom.org/bioethics-and-biosafety

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	1	1	2	3	3	1	2	3	2	2	2
CO2	3	3	2	3	3	1	1	2	3	3	1	2	3	3	2	2
CO3	2	2	3	2	1	2	2	3	2	3	1	2	3	2	3	2
CO4	1	2	1	1	1	3	3	2	1	2	1	2	2	1	1	3
CO5	2	2	2	2	1	2	2	2	2	2	3	2	3	2	2	2

Semester 6

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	SEC-4-Project Control System – QC and Testing	4	4	-	-	Theory

Course Introduction

This course focuses into the essential principles and practices of quality control and testing within project management. Explore strategies to ensure projects meet standards and achieve success through testing methodologies used in Microbiological labs.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.
CO 1:	Describe the microbiological aspects of quality control of food and pharmaceutical products.
CO 2:	Explain the identification of pathogenic microorganisms and good laboratory practices.
CO 3:	Acquire the knowledge of different sterility test for the pharmaceutical products.
CO 4:	Illustrate the safety concern management and regulations of food and pharmaceutical industry and learn the basic standard methods and procedures for the microbiological analysis of food.
CO 5:	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.

Unit I:	**Quality Control methods**	**[12 Periods]**

Microbial quality control: definition, history and introduction. Standard Methods involved in assessment of microbial quality control. Q.A and Q.C definitions and importance. Traditional Microbiological Quality Controlling methods: Sampling methods, TVC, APC and serial dilution techniques. Good laboratory practices, Good microbiological practices.

Unit II:	**Instrumentations in QC**	**[12 Periods]**

Instruments associated in QC & QA: Principle involved, working conditions, uses and precautions of Laminar Air Flow (LAF), Autoclave, Incubator, pH meter, Colony counter, Hot air oven, Centrifuges, colorimeter/ spectrophotometer, ELISA and storage devices. Methodology of Disinfection, Autoclaving & Incineration.

Unit III:	**Media and Formulations**	**[12 Periods]**

Culture media used in QC and QA: Design of specialized media for identification of pathogens. Good laboratory practices in culture media preparation: raw material, water, pH. Uses of media. Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.

Unit IV:	**Sterility**	**[12 Periods]**

Determining Microbes in Pharmaceutical Samples: Sterility testing for pharmaceutical products, Bioburden, pyrogen test, in process and final process control, safety and sterility test.

Unit V:	**Safety and Microbial Standard**	**[12 Periods]**

HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers.

Text Books:

1. W.B. Hugo & A.D. Russell. (1998). Pharmaceutical Microbiology.6thEdition. Blackwell scientific Publications.
2. Kulkarni A. K. Bewoor V. A. () Quality Control, Wiley India Pvt. Ltd,
3. Chandrakant Kokare (2016). Pharmaceutical Microbiology, 1st Edition, Nirali Publication.
4. Brown.M.R.W. (2017). Microbiological Quality Assurance
5. A Guide Towards Relevance and Reproducibility of Inocula,1st Edition. CRC press.
6. Dev Raj Rakesh Sharma And V K Joshi (2011).Quality Control For Value Addition In Food Processing, New India Publishing Agency.

Reference Books:

1. Rosamund M. Baird, Norman A. Hodges, Stephen P. Denyer. (2000). Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices. 1st Edition, CRC Press.

2. Konieczka, (2012). Quality Assurance and Quality Control in the Analytical Chemical Laboratory a Practical Approach (Hb), Routledge, Taylor and Francis group.
3. Singh Gajjar, Budhrani, Usman. (2021). Quality Control and Quality Assurance (M. Pharm) S Vikas And Company.
4. David Roesti, Marcel Goverde (2019). Pharmaceutical Microbiological Quality Assurance and Control: Practical Guide for Non-Sterile Manufacturing, Wiley publication.
5. Amihud Kramer Bernard A. Twigg (2017). Quality Control For The Food Industry Fundamentals & Applications (Vol.1) 3rd Edition, MEDTEC publication..

Web Resources:

1. https://www.study.com/microbiology-quality-control-testing-definition-procedures.
2. https://www.sigmaaldrich.com
3. https://www.coursera.org
4. https://www.atcc.org
5. https://www.fao.org

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	3	2	2	2	2	2	2	2	1	3	1	2
CO2	3	3	3	3	3	2	2	2	2	2	2	2	1	3	1	2
CO3	2	2	3	3	3	2	2	2	2	2	2	2	1	1	1	2
CO4	2	2	2	3	3	3	3	3	3	3	3	3	1	2	1	2
CO5	2	2	2	2	3	2	2	2	2	2	2	2	1	2	1	2

ELECTIVE COURSES

Semester 2

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 1 – Bio Entrepreneurship (DSE)	4	4	-	-	Theory

Course Introduction

Microbiology has played a central role in all aspects of Biological sciences, including morphogenesis, Genetics, developmental biology, Physiology, Biochemistry and Cell biology. Entrepreneurial Microbiology introduces the candidates in the various opportunities and modalities in the field of Microbiology and train them to take up versatile avenues matching with Global business market.

Course Focus on: Skill Development / **Entrepreneurship** / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Describe and apply several entrepreneurial ideas and business theories in practical framework.
CO 2:	Analyse the business environment in order to identify business opportunities
CO 3:	Express the mass production of microbial inoculants used as Bio fertilizers and Bio insecticides
CO 4:	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits
CO 5:	Integrate and apply knowledge of the regulation of industries, utilize effective team work skills within an effective management team

Unit I:	**Bio Entrepreneurship**	**[12 Periods]**

Introduction to bio-business, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Government schemes and funding. Small scale industries: Definition; Characteristics; Need and rationale.

Unit II:	**Entrepreneurship Opportunity in Agricultural Microbiology**	**[12 Periods]**

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agricultural waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agriculture management.

Unit III:	**Entrepreneurship Opportunity in Industrial Microbiology**	**[12 Periods]**

Entrepreneurship Opportunity in Industrial Biotechnology: Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope- Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production- microbe enriched compost. Bio pesticide/ insecticide production. Bio fertilizer. Single cell protein.

Unit IV:	**Therapeutic and Fermented products**	**[12 Periods]**

Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.

Unit V:	**Project Management, Technology Management and Start-up Schemes**	**[12 Periods]**

Building Bio-start-up business challenges in Indian context-industry partners (BIRAC, DBT, Incubation centers. etc.,), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Project proposal preparation, Successful start-ups-case study.

Text Books:

1. Craig Shimasaki. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press.
2. Ashton Acton, O. (2012). Biological Pigments– Advances in Research and Application Scholarly Editions: Atlanta, Georgia.
3. Jennifer Merritt, Jason Feifer (2018). Start Your Own Business, 7th edition, Entrepreneur Press publisher.

4. Peter F. Drucker (2006). Innovation and Entrepreneurship. Harper Business publisher.
5. Leah Cannon (2017). How to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs? International Kindle paper white.

Reference Books:

1. Crueger, W, and Crueger. A. (2000). Biotechnology: A Text Book of Industrial microbiology, 2nd Edition, Sinauer Associates: Sunderland. Mass.
2. Paul S Teng. (2008). Bioscience Entrepreneurship in Asia World Scientific Publishing Company.
3. Charles E. Bamford, Garry D. Bruton (2015). ENTREPRENEURSHIP: The Art, Science, and Process for Success, 2nd Edition, McGraw Hill publisher.
4. Yali Friedman (2014). Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science 4th Edition, Logos press publication.
5. Stephanie A. Wisner (2022). Building Backwards to Biotech: The Power of Entrepreneurship to Drive Cutting-Edge Science to Market, International Kindle paper white.

Web Resources:

1. https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
2. https://www.crg.eu/biobusiness-entrepreneurship
3. https://www.entrepreneur.com
4. https://www.birac.nic.in

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	3	2	2	1	3	2	2	3	1	2
CO2	2	3	2	3	2	1	2	2	3	1	3	3	2	2	2	2
CO3	3	3	2	3	3	1	2	1	2	1	2	2	1	3	2	2
CO4	3	3	3	3	3	1	2	1	2	1	2	2	2	3	3	2
CO5	3	3	2	3	3	3	3	3	2	2	2	3	3	2	2	3

Semester 2

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 1 – Applied Microbiology (NME)	4	4	-	-	Theory

Course Introduction

Candidates studying this paper would be familiar with techniques involved in production of different types of products related to microbiology and other life science sectors. They would be sensitized on successful marketing strategies of the products.

Course Focus on: Skill Development / **Entrepreneurship** / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Identify the possibilities of manufacturing Microbiological products
CO 2:	Interpret different production methods of microbiological products
CO 3:	Develop and strengthen the entrepreneurial quality in Microbiology
CO 4:	Produce the products of economic value
CO 5:	Infer the role of patent in defining a product

Unit I:	**Mushroom cultivation**	**[12 Periods]**

Types of Mushroom - Cultivation of *Agaricus campestris*, *Agaricus bisporous*, *Valvarellia volvaciae*, Nutritional value, cultivation method, control of pathogen and pest, Medicinal value of Mushroom, Advantages of mushroom- Drawbacks, Disadvantages and Potential risk associated with mushroom cultivation- Single Cell Protein (SCP)

Unit II:	**Bio fertilizers**	**[12 Periods]**

Composting – Microbiology of composting, preparation of compost, types of composting, advantages of composting, vermicomposting. Bio-fertilizer – chemical fertilizer versus bio-fertilizer, organic farming, Rhizobium, Azospirillium, Azotobacter and phosphate solubilizers as bio fertilizer.

Unit III:	**Microbial Diagnostics**	**[12 Periods]**

Production of kits –Microbes in diagnostics - plasmid DNA isolation, serum electrophoresis and diagnostic kits -WIDAL, ASO, RPR.

Unit IV:	**Commercial product production**	**[12 Periods]**

Commercial product production - Beer, Wine, Antibiotics- Penicillin, enzymes- lipase, amylase and protease. Amino acids - lysine, glutamic acid, Media formulation.

Unit V:	**Business prospects of Microbiology:**	**[12 Periods]**

Entrepreneurial development – activity, institute involved, process of entrepreneurship -socio-economic gain, schemes and programme for entrepreneurship. History of patent, characteristics of patent, inventor-cost of patent, patent in India and other Countries – HACCP regulation

Text Books:

1. R.C Dubey., "Textbook of Biotechnology" New age Publishers, New Delhi.
2. Craig Shimasaki. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press.
3. Ashton Acton, O. (2012). Biological Pigments– Advances in Research and Application Scholarly Editions: Atlanta, Georgia.
4. Jennifer Merritt, Jason Feifer (2018). Start Your Own Business, 7th edition, Entrepreneur Press publisher.
5. Peter F. Drucker (2006). Innovation and Entrepreneurship. Harper Business publisher.
6. Leah Cannon (2017). How to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs? International Kindle paper white.

Reference Books:

1. Ronald M Atlas and Richard Bartha., "Microbial Ecology", Pearson publication, Germany.
2. Greene., "Entrepreneurship ideas inaction", Thomson learning, New York.
3. Anil Kumar S.," Entrepreneurship Development", New Age International, India.
4. Satyanarayana U ., "Biotechnology", Books and Allied P Ltd, Kolkata, India.

Web Resources:

1. https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
2. https://www.crg.eu/biobusiness-entrepreneurship
3. https://www.entrepreneur.com
4. https://www.birac.nic.in

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	1	1	1	1	1	2	3	3	2	2
CO2	3	3	3	2	3	2	2	1	1	1	1	2	3	3	3	3
CO3	2	3	2	3	2	3	3	3	2	2	3	3	2	3	3	3
CO4	2	3	3	3	3	2	2	2	2	2	3	2	2	3	3	3
CO5	2	2	2	1	1	1	1	3	2	3	2	2	3	2	2	1

Semester 4

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 2 – Pharmaceutical Microbiology (NME)	4	4	-	-	Theory

Course Introduction

This course explores the vital intersection of microbiology and pharmaceuticals, covering topics such as microbial contamination control, sterility assurance, and regulatory compliance. Gain essential insights into ensuring product safety and efficacy in pharmaceutical manufacturing.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Learn the basics of chemotherapy and action of antibiotics
CO 2:	Carry out the microbiological assay of antibiotics
CO 3:	Analyse Microbiological standardization of Pharmaceuticals, sterility testing of pharmaceutical products and apply sterilization in pharmaceutical industry
CO 4:	Evaluate the process and develop new strategies for rational drug design
CO 5:	Learn the Regulatory guidelines in pharmaceuticals product.

Unit I:	**Pharmaceutical Microbiology**	**[12 Periods]**

Introduction to Pharmaceutical microbiology: Ecology of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipment and their control measures; Design and layout of sterile manufacturing.

Unit II:	**Microbial spoilage**	**[12 Periods]**

Microbial contamination and spoilage of pharmaceutical products: Microbial aspects of pharmaceutical products; Sterilization of pharmaceutical products: Heat, gaseous, radiation and filtration; Contamination and Spoilage of Pharmaceutical products: sterile injectable and non-injectable, ophthalmologic preparation, implants.

Unit III:	**Antibiotics**	**[12 Periods]**

Production of antibiotics: Production of antibacterial – Penicillin, Tetracycline; antifungal – Griseofulvin, Amphotericin; antiparasitic agents – Artemesin, Metronidazole; Semi-synthetic antibiotics and anticancerous agents; Additional application of microorganisms in pharmaceutical sciences: Enzymes- Streptokinase, Streptodornase, L-asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes); Biosensors in pharmaceuticals.

Unit IV:	**Immunological products**	**[12 Periods]**

Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; Immunodiagnostics - immuno sera and immunoglobulin; Quality control in Pharmaceutical: In – Process and Final Product Control; Sterility tests.

Unit V:	**QC and GMP**	**[12 Periods]**

Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals – BIS (IS), ISI, ISO, WHO and US certification.

Text Books:

1. Chand Pasha Kedernath. (2021). Text book of Pharmaceutical Microbiology. Ramnath Publisher.
2. Hugo WB and Russell AD. (2004). Pharmaceutical Microbiology VII edition. Blackwell Scientific Publication, Oxford.
3. Franklin, DJ. and Snow, GA. (2013). Biochemistry of antimicrobial action. Chapman& Hall.
4. Kuntal Das (2019). Pharmaceutical Microbiology, second edition, Nirali Prakashan.
5. Priyatama Powar, Shital Nimbargi, Vaijayanti Sapre (2020). Pharmaceutical Microbiology, I edition, Technical publications.

Reference Books:

1. Handa, S.S. and Kapoor, V.K. (2022). Pharmacognosy. 4thEdition. Vallabh Prakashan Publishers, New Delhi.
2. Kokate, C.K., Durohit, A.P. and Gokhale, S.R., (2002). Pharmacognosy. 12th edition Nirali Prakasham

Publishers, Pune.
3. S. P. Vyas & V. K. Dixit. (2003). Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi.
4. Wallis, T.E. (2005). Text book of Pharmacognosy. 5th edition. CBS publishers and distributors, New Delhi.
5. Garrod, L.P., Lambert, HP. And C'Grady, F. (1973). Antibiotics and Chemotherapy. (eds). Churchill Livingstone..

Web Resources:

1. https://www.pharmapproach.com/introduction-to-pharmaceutical-microbiology/
2. https://www.iptsalipur.org/wp-content/uploads/2020/08/BP303T_PMB_UNIT_I.pdf
3. https://www.pharmanotes.org/2021/11/pharmaceutical-microbiology-b-pharma.html
4. https://snscourseware.org/snscphs/notes.php?cw=CW_604b15c6313c5
5. https://www.thermofisher.com

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	1	1	1	1	1	2	2	2	2	2
CO2	3	3	3	2	3	2	2	1	1	1	1	2	3	3	3	3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3	3
CO5	2	2	2	1	2	1	1	3	2	3	2	2	3	3	2	1

Semester 4

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 2 – rDNA Technology (DSE)	4	4	-	-	Theory

Course Introduction

This course shall describe the cloning and expression strategies used in various field of Life science. It also deals with the pros and cons of using in vitro modification of nucleic acids.

Course Focus on: Skill Development / **Entrepreneurship** / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.
CO 2:	Discuss the various cloning vectors and their applications.
CO 3:	Assess the usage and advantages of molecular tools.
CO 4:	Explain plant and animal tissue culture protocols and gene transfer mechanism.
CO 5:	Elucidate and understand the application of genetic engineering and gene therapy.

Unit I: **[12 Periods]**

MilestonesinrDNATechnology-GeneManipulation-StepsinvolvedinGeneCloning.Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease - Discovery, Types, Mode of Action-Application of Ligase, DNA Polymerase, DNA Modifying enzymes and Topoisomerases. Use of L inkers and Adapters.

Unit II: **[12 Periods]**

Artificial Gene Transfer methods- Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 and pMB1.Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage. Hybrid Vectors, Phagemid, Cosmid, BAC and YAC. Screening of Recombinants. Genomic DNA and cDNA library-Construction and Screening.

Unit III: **[12 Periods]**

Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western & Northern. DNA sequencing Methods-Sanger's and Automated method. Recent Trends in Genetic Engineering-Targeted Genome Editing- ZFNs, TALENs, CRISPRs. Gene Targeting-Knock-in &Knock-outs. DNA Finger Printing,

Unit IV: **[12 Periods]**

Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture-Micro propagation- Callus and Protoplast Culture-Production of Bio-Active Secondary Metabolites by Plant Tissue Culture -Agrobacterium and Crown Gall Tumors, Ti Plasmid and Ri Plasmid-Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines- Types, Establishment and Maintenance of Cell Lines.

Unit V: **[12 Periods]**

Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy-Germline and Somatic Cell Therapy -Ex-vivo Gene Therapy-SCID (Severe Combined Immuno Deficiency) – In-vivo Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) –Vectors in Gene Therapy-Viral and Non-Viral Vectors. Transgenic Plants– Bt Cotton, Bt Corn, Round Ready soybean, Flavr Savr Tomato and Golden Rice

Text Books:

1. Brown T.A. (2016). Gene Cloning and DNA Analysis. 7th Edition. John Wiley and Jones, Ltd.
2. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. 3rd Edition. John Wileys and Sons Ltd.
3. Keya Chaudhuri (2013). Recombinant DNA technology. The Energy and Resources Institute
4. Siddra Ijaz, Imran UlHaq (2019). Recombinant DNA Technology. Cambridge Scholars Publishing.
5. Monika Jain (2012). Recombinant DNA Techniques: A Textbook, I Edition, Alpha Science International Ltd

Reference Books:

1. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. 2nd Edition. Narosa Publishing Home Pvt Ltd.
2. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of

Recombinant DNA. 5th Edition. ASM Press.
3. Russell P.J. (2010). Genetics - A Molecular Approach, 3rd Edition. Pearson New International Edition.
4. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria,4th Edition. ASM Press Washington-D.C. ASM Press.
5. James D. Watson, Michael Gilman, Jan Witkowski, Mark Zoller (1992). Recombinant DNA. Scientific American Books

Web Resources:

1. https://www.britannica.com/recombinant-DNA-technology
2. https://www.byjus.com/recombinant-dna-technology
3. https://www.rpi.edu
4. https://www.ncbi.nlm.nih.gov
5. https://www.le.ac.uk/recombinant-dna-and-genetic-techniques

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	1	2	1	1	2	1	2	3	3	3	2
CO2	3	3	2	2	3	1	2	1	1	1	1	2	3	3	3	2
CO3	3	3	2	2	3	2	2	1	1	1	1	2	3	3	3	2
CO4	3	3	3	2	3	2	2	1	2	1	1	2	3	3	3	3
CO5	3	3	2	2	3	1	2	2	2	2	1	2	3	3	3	3

Semester 5

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 3 – Bioinformatics (NME)	4	4	-	-	Theory

Course Introduction

This course explores the intersection of biology and computer science, focusing on the analysis and interpretation of biological data.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Demonstrate a comprehensive understanding of fundamental biological concepts
CO 2:	Proficient in using computational techniques and tools commonly employed in bioinformatics
CO 3:	Analyze biological data sets using appropriate statistical methods and bioinformatics algorithms, and interpret the results effectively
CO 4:	Possess programming skills in languages commonly used in bioinformatics
CO 5:	Aware of ethical considerations related to the use of bioinformatics techniques and data

Unit I:	**Instrumentation**	**[12 Periods]**

Fundamentals of X-ray diffraction, NMR spectroscopy of macromolecules, Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Ramachandran plot.

Unit II:	**Structure prediction**	**[12 Periods]**

Protein secondary structure classification databases: HSSP, FSSP, CATH, Ectoprotein secondary structure prediction methods: GOR, Chou-Fasman, PHD, PSI- PRED, J-Pred.

Unit III:	**Homology modelling**	**[12 Periods]**

Protein Tertiary structure prediction methods: Homology Modelling, Fold Recognition, Ab- intio Method, Protein folding, Molecular Dynamics of Protein, Molecular Docking of Protein, Small molecule and Nucleotide, Concepts of Force Field

Unit IV:	**Database and software**	**[12 Periods]**

Motif and Domain: Motif databases and analysis tools, Domain databases (CDD, SMART, ProDom) and Analysis tools. HMM (Hidden Markov Model): Introduction to HMM, its application in Sequence alignment and Structure prediction, HMM based Software's (HMMER and HMMSTR) – Microbial database

Unit V:	**Nucleic acid structure prediction**	**[12 Periods]**

Structural features of RNA: Primary, Secondary, Tertiary. Introduction to RNA Secondary structure prediction, Methods for RNA Secondary structure prediction, Limitation of RNA Secondary structure prediction

Text Books:

1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
2. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
3. Lesk, A. M. (2008). Introduction to Bioinformatics (3rd ed.). Oxford University Press.

Reference Books:

1. Zvelebil, M., & Baum, J. O. (2008). Understanding Bioinformatics. Garland Science.
2. Compeau, P., & Pevzner, P. (2014). Bioinformatics Algorithms: An Active Learning Approach. Active Learning Publishers.
3. Nilsson, R. H., & Olsson, M. J. (2016). Biological Data Analysis: A Practical Approach. Wiley.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/
2. https://www.ensembl.org/
3. https://www.uniprot.org/

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

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CO2	3	3	2	2	3	1	2	1	1	1	1	2	3	3	3	2
CO3	3	3	2	2	3	2	2	1	1	1	1	2	3	3	3	2
CO4	3	3	3	2	3	2	2	1	2	1	1	2	3	3	3	3
CO5	3	3	2	2	3	1	2	2	2	2	1	2	3	3	3	3

Semester 5

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 3 – Marine Microbiology (DSE)	4	4	-	-	Theory

Course Introduction

This course is designed to make the students get an idea about isolation, Identification and preservation of the marine microbes and its application in various fields. It also imparts knowledge about the origin and maintenance of microbial diversity and its role in the structure and function of marine ecosystems.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Extend knowledge on Microbiology to the marine ecosystem
CO 2:	Illustrate different marine organisms based on the ecology of growth
CO 3:	Understand the different marine ecosystem and their role in natural balance
CO 4:	Elaborate on the positive and negative aspects of microbes in marine environment
CO 5:	Attribute to the methods used for exploring marine organism and their classification

Unit I:	**Collection and preservation of marine samples**	**[12 Periods]**

Marine microorganisms: collection, preservation, enumeration (total and viable counts), isolation of culture and identification based on morphological, physiological and biochemical characteristics. International and national collection centres.

Unit II:	**Classification of marine micro-organism**	**[12 Periods]**

Extremophiles: Thermopiles, basophiles, halophiles, psychrophiles, acid – alkalinophiles, oligotroph, toxitolerant, xerotolerant, endolith – Extremophiles and their environment, biodiversity. Genomics of extremophiles, phylogeny of extremophiles, 16S RNA classification in mitochondrial DNA genome, RAPD, RFLP studies.

Unit III:	**Bioremediation**	**[12 Periods]**

Microbiology of degradation of xenobiotic environment: Ecological considerations, decay behaviour, degradative plasmids, hydrocarbons, oil pollution, surfactants, pesticides, Bioremediation:- Factors affecting bioremediation – role of microbes in the marine nutrient cycles – diseases of marine organisms and its impact on marine biodiversity.

Unit IV:	**Autotrophic marine microbes**	**[12 Periods]**

Brief account of photosynthetic and accessory pigments. Phytoplanktons and Zooplanktons, Red tides, Zones, Bioluminescence and Biopigment, Marine micro and macro-organisms, Coral reefs, Mangroves, Hydrothermal vents and water currents.

Unit V:	**Cataloguing of Marine microbes**	**[12 Periods]**

Bar coding of marine organisms: Genome sequencing and physical mapping of genome. Marine exploration, Aquaculture-inland and freshwater, Isolation of marine bioactive compounds-separation, purification (Example: Plinabulin) and identification techniques, cryopreservation.

Text Books:

1. Se-Kwon Kim. (2013). Bioactive compounds and biotechnological applications. CLS Publishers

Reference Books:

1. Dube, H.C. (1994). A text book of fungi, bacteria and viruses. Vikas Publishing House, New Delhi.
2. Dale, J.W. (1994). Molecular genetics of Bacteria. John Wiley and Stones.

Web Resources:

1. https://www.mbl.edu/microbialdiversity/research-areas/marine-microbiology/
2. https://www.whoi.edu/what-we-do/understand/departments-centers-labs/mmi/

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	1	1	2	2	1	2	2	2	2	2
CO2	3	2	2	2	2	1	1	1	2	1	1	2	1	2	2	2

CO3	3	2	2	2	2	1	1	2	3	2	1	3	2	2	2	2
CO4	3	2	2	1	2	1	1	1	2	2	1	2	2	2	2	2
CO5	3	3	3	3	3	2	2	1	2	2	1	2	2	3	3	2

Semester 6

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 4– Nutrition and Hygiene Practices (NME)	4	4	-	-	Theory

Course Introduction

This course focuses into the essential principles of nutrition and hygiene practices crucial for promoting overall health. Topics include dietary guidelines, food safety, disease prevention, and strategies for maintaining optimal well-being.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Learn the importance of nutrition for a healthy life
CO 2:	Study the nutrition for life cycle
CO 3:	Know the health care programmes of India
CO 4:	Learn the importance of community and personal health & hygiene measures
CO 5:	Create awareness on community health and hygiene

Unit I:	**Nutrition**	**[12 Periods]**

Nutrition – definition, importance, Good nutrition, and mal nutrition; Balanced Diet: Basics of Meal Planning. Carbohydrates, Lipids, Proteins and Vitamins –functions, dietary sources, effects of deficiency. Macro and micro minerals –functions, effects of deficiency; food sources of Calcium, Potassium, and Sodium; food sources of Iron, Iodine, and Zinc. Importance of water– functions, sources, requirements and effects of deficiency

Unit II:	**Diet**	**[12 Periods]**

Nutrition for Life Cycle: Balanced diet - Normal, Pregnant, lactating women, Infancy, young children Adolescents, Adults, and the Elderly; Diet Chart; Nutritive value of Indian foods.

Unit III:	**Nutritional disorders**	**[12 Periods]**

Improper diets: Definition, Identification, Signs and Symptoms - malnutrition, under-nutrition, over-nutrition, Protein Energy Malnutrition, obesity; Nutritional Disease and Disorder - hypertension, diabetes, anemia, osteomalacia, cardiovascular disease.

Unit IV:	**Health**	**[12 Periods]**

Health - Determinants of health, Key Health Indicators, Environment health & Public health; Health-Education: Principles and Strategies. Health Policy & Health Organizations: Health Indicators and National Health Policy of Govt. of India; Functioning of various nutrition and health organizations in India.

Unit V:	**Hygiene**	**[12 Periods]**

Hygiene – Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme. Rural Community Health: Village health sanitation & Nutritional committee. Community & Personal Hygiene: Environmental Sanitation and Sanitation in Public places.

Text Books:

1. Bamji, M.S., K. Krishnaswamy & G.N.V. Brahmam (2009) Textbook of Human
2. Nutrition (3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
3. Swaminathan (1995) Food & Nutrition (Vol I, Second Edition) The Bangalore Printing
4. &Publishing Co Ltd., Bangalore
5. SK. Haldar (2022). Occupational Health and Hygiene in Industry. CBS Publishers.
6. Acharya, Sankar Kr, Rama Das, Minati Sen (2021). Health Hygiene and Nutrition Perception and Practices. Satish Serial Publishing House
7. Dass (2021).Public Health and Hygiene, Notion Press

Reference Books:

1. VijayaKhader (2000) Food, nutrition & health, Kalyan Publishers, New Delhi
2. Srilakshmi, B., (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi
3. Arvind Kumar Goel (2005). A College Textbook of Health & Hygiene, ABD Publishers
4. Sharma D. (2015). Textbook on Food Science and Human Nutrition. Daya Publishing House.
5. Revilla M. K. F., Titchenal A. and Draper J. (2020). Human Nutrition.
6. University of Hawaii, Mānoa.

Web Resources:

1. National Rural Health Scheme:
2. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=969&lid=49
3. National Urban Health Scheme:
4. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=970&lid=137
5. Village health sanitation & Nutritional committee
6. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=149&lid=225
7. Health Impact Assessment - https://www.who.int/hia/about/faq/en/
8. Healthy Living https://www.nhp.gov.in/healthylivingViewall

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	1	2	3	2	3	2	2	3	2	1	2
CO2	3	2	2	2	3	1	2	2	2	2	2	2	3	3	3	2
CO3	3	2	2	3	2	2	2	2	3	3	2	2	3	2	3	2
CO4	3	2	1	2	2	2	3	2	3	3	2	2	2	2	2	3
CO5	3	2	1	2	2	3	3	3	3	3	2	2	2	2	2	3

Semester 6

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Elective 4– Food Dairy and probiotics Microbiology (DSE)	4	4	-	-	Theory

Course Introduction

This course explores the microbial dynamics in food production, focusing on dairy products and probiotics. Topics include fermentation processes, microbial safety, and the role of probiotics in promoting gut health and overall well-being.

Course Focus on: Skill Development / Entrepreneurship / **Employability** / Research

Course Outcomes	On completion of this course, students will
CO 1:	Gain knowledge about food as a substrate for various microbes, Understand about the principles and application of different types of food spoilage and preservation technique,
CO 2:	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique
CO 3:	Gain information about spoilage of milk and its products and its antimicrobial properties
CO 4:	Learn about the various fermented product and its various stage spoilage
CO 5:	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits

Unit I:	**Food and Microorganisms**	**[12 Periods]**

Food as a substrate for microorganisms- Micro-organisms important in food microbiology; Molds, yeasts and bacteria -General Characteristics - Classification and importance. Principles of food preservation - Asepsis - Removal of microorganisms, - High temperature - Low temperature - Drying - Food additives. Nanoscience in food preservation; microencapsulation.

Unit II:	**Contamination and spoilage of food**	**[12 Periods]**

Contamination and spoilage of food products -Food borne infections (Bacillus cereus, Salmonellosis, Shigellosis, Listeria monocytogenes and Campylobacter jejuni) and intoxications – (Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens and mycotoxins) Food borne disease outbreaks - newly emerging pathogens. Conventional and Novel technology in control of food borne pathogens and preventive measures - Food sanitation - plant sanitation - Employees' health standards. Regulatory Agencies &criteria for food safety.

Unit III:	**Dairy Microbiology**	**[12 Periods]**

Microflora of raw milk - sources of contamination. Spoilage and preservation of milk and milk products. - antimicrobial systems in raw milk. Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.

Unit IV:	**Fermentation technology**	**[12 Periods]**

Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, Acidophilus Milk, Kefir, Koumiss). Oriental fermented Foods-Miso –Tempeh Ontjom. Natto, Idli Spoilage and defects of fermented dairy products -. Functional fermented foods and nutraceuticals, bioactive proteins and bioactive peptides, genetically modified foods.

Unit V:	**Probiotics**	**[12 Periods]**

Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. Role of probiotics in health and disease: Mechanism of probiotics. Application of bacteriocins in foods. Bio-preservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.

Text Books:

1. Frazier WC and West off DC. (2017). Food microbiology. 5th Edition TATA McGraw Hill Publishing Company Ltd. New Delhi.
2. Adams, M.R., Moss, M.O. (2018). Food Microbiology 1stedition. New Age Publishers by New Age International (P) Ltd., Publishers.

3. R.C. Dubey. (2014). Advanced Biotechnology. S. Chand publishers.
4. Banwart GJ. (1989). Basic food microbiology, Chapman & Hall, New York.
5. Sugumar D. (1997). Outlines of dairy technology, Oxford University press. 1997.

Reference Books:

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th Edition
2. CBS Publishers and Distributors, Delhi, India.
3. Prescott, Harley and Klein Wim. (2008). Microbiology, 7th Edition McGraw Hill Publications.
4. Robinson, R. K. (2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products (Third Edition), A John Wiley & Sons, Inc., New York.
5. Yuankunlee, Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.
6. Dharumaurai Dhansekaran, Alwarappan Sankaranarayanan. (2021). Advances in Probiotics Microorganisms in Food and Health 1st Edition. eBook ISBN:9780128230916.

Web Resources:

1. https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_BacterialGrowth_in_Food/link/5a1d2e02aca2726120 b28eba/download
2. https://www.fda.gov/food/laboratory-methods-food/bam-foodsamplingpreparation-sample-homogenate
3. https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-_A_review
4. https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download
5. https://www.fda.gov/food

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	2	1	2	2	1	2	2	2	2	2
CO2	3	3	3	2	2	1	2	1	3	3	1	2	3	3	3	2
CO3	3	2	2	2	2	1	2	1	2	2	1	2	2	2	2	2
CO4	3	3	3	2	2	1	2	1	2	2	1	2	2	3	3	2
CO5	3	3	2	2	2	2	3	2	3	3	2	3	3	3	3	3

PRACTICAL COURSES

Semester 2

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Fundamentals of Microbiology, Microbial Taxonomy and Diversity, Microbial Physiology and Metabolism Practical	4	4	-	-	Practical

Course Introduction

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Demonstrate an understanding of the fundamental principles of microbiology, including the structure, function, and classification of microorganisms.
CO 2:	Evaluate the diversity of microorganisms in different environments and ecosystems, considering their ecological roles
CO 3:	Explain the physiological processes and metabolic pathways of microorganisms, including energy generation, growth, and interactions with their environment
CO 4:	Analyze and apply knowledge of microbial taxonomy to identify and classify various microorganisms based on their morphological, biochemical, and genetic characteristics
CO 5:	Apply laboratory techniques and methodologies to investigate microbial physiology and metabolism

List of Experiments **[30 Periods]**

Fundamentals of Microbiology

1. Lab Safety Procedures.
2. Preparation of cleaning solutions, methods of sterilization and Fumigation
3. Culture media preparation – Liquid and Solid medium
4. Selective and differential media: Mac Conkey and Blood agar
5. Pure culture techniques – Serial Dilution, pour plate, Spread plate and Looping method
6. Streaking techniques: Simple, Quadrant, Continuous and T-Streak Methods.
7. Enumeration of Bacteria, Fungi and Actinomycetes from soil using serial dilution technique
8. Determination of Motility – Hanging drop & SIM agar.
9. Cultural characteristics of Microorganisms – Colony morphology on Nutrient agar and Slants, Nutrient broth
10. Staining techniques–
    - Simple Staining
    - Negative Staining
    - Gram Staining
    - Endospore staining
    - Acid Fast Staining (Demo)
11. Observation of Fungi
    - Fungal We Mount-Lacto Phenol Cotton Blue Staining (LPCB)
    - Slide Culture Technique

Microbial Physiology and Metabolism

1. Micrometry – determination of size of bacteria.
2. Determination of bacterial Growth curve by turbidometric method.
3. Effect of temperature and pH on growth of microorganism
4. Biochemical characterization of microbes
    - Indole Test
    - Methyl Red Test

- Voges Proskauer Test
- Citrate Utilization Test
- Catalase test
- Oxidase test
- Urease test
- Nitrate Reduction test
- Triple sugar iron agar test
- Carbohydrate fermentation test

5. Hydrolysis test
    - Starch hydrolysis
    - Gelatin hydrolysis
    - Casein hydrolysis
6. Cultivation of anaerobes – Wrights tube method, Mc Intosh fildes jar

Microbial Taxonomy and Diversity

1. Isolation and characterization of thermophiles, halophiles and alkalophiles from water
2. Isolation of *Thiobacillus* sps. from metal sulfides/ rock coal/ acid mine waters.
3. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
4. Studying isolation and propagation of animal viruses by chick embryo technique(Demonstration)
5. Identification of cytopathic effects of plant viruses using photographs(Demonstration)

Text Books:

1. James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York 1996.
2. Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3. Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4. Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.

Reference Books:

1. Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm. C. Brown publishers.
2. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India
3. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS
4. Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5. Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications.

Web Resources:

1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.
2. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
3. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
4. https://microbiologyinfo.com/top-and-best-microbiology-books/
5. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1
CO2	3	3	2	2	2	2	3	2	3	2	1	2	3	2	2	3
CO3	3	3	3	2	2	1	3	2	2	2	1	2	2	2	3	2
CO4	3	2	3	2	2	2	3	2	2	2	1	2	2	3	3	3
CO5	3	3	3	3	3	2	3	2	2	2	1	3	2	3	3	2

Semester 4

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Microbial Genetics, Immunology and Medical Microbiology Practical	4	4	-	-	Practical

Course Introduction

This course aims to train the candidate to learn and experiment various important experiments in Molecular biology, Immunology and Medical Microbiology. Student will get a hands on exposure in doing the experiments and obtain skills to execute experiments independently.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Ability to isolate resolve and annotate the DNA and protein molecules from the given sample
CO 2:	Apply the knowledge of molecular techniques in various fields.
CO 3:	Competently perform serological diagnostic tests such as RF, ASO, CRP, immuno electrophoresis
CO 4:	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques
CO 5:	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.

List of Experiments **[30 Periods]**

Microbial Genetics

1. Study of different types of DNA and RNA using micrographs and models/schematic representation.
2. Study of semi conservative replications of DNA through micrographs / schematic representation.
3. Isolation of genomic and plasmid DNA from *E. coli* and separation by Agarose gel electrophoresis.
4. Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).
5. Extraction and separation of proteins by SDS- PAGE.
6. Isolation of UV induced mutant and auxotrophic mutants by replica plating method.
7. Artificial transformation in *E. coli*.
8. Isolation of antibiotic resistant mutants by gradient plate method.

Immunology

1. Separation of serum and plasma from blood.
2. Agglutination reactions
   - Blood Grouping
   - WIDAL test
   - RPR test
   - ASO test
3. ELISA – Hepatitis or HIV (any one)
4. Precipitation reactions
   - Immunodiffusion – Radial and Ouchterlony's Double immunodiffusion
   - Immunoelectrophoresis – Rocket and Counter current immunoelectrophoresis.
   - ELISA
5. Hematology
   - Erythrocyte count
   - Leukocyte count
   - Differential count
   - ESR Test

Medical Microbiology

1. Identification of clinically important bacteria using morphological, biochemical characterization (any three).
   - *Staphylococcus aureus,*
   - *Streptococcus pyogenes*

- *E. coli*
- *Salmonella sp.*
- *Klebsiella sp.*
- *Pseudomonas sp.*
- *Proteus sp.*

2. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.
3. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane
4. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining).
5. Identification of Dermatophytes.
6. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.
7. Direct Examination of Feces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs.
8. Concentration techniques of stool specimen – Floatation and Sedimentation methods.

Text Books:

1. James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York 1996.
2. Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3. Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4. Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.

Reference Books:

1. Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C. Brown publishers.
2. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India
3. Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS
4. Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5. Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications.

Web Resources:

1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.
2. https://www.molbiotools.com/usefullinks.html
3. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
4. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
5. https://microbiologyinfo.com/top-and-best-microbiology-books/
6. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	3	1	1	1	1	2	1	2	2	2	3	1
CO2	3	3	2	2	3	2	1	2	2	3	2	3	2	3	2	3
CO3	3	2	2	1	3	2	1	2	2	3	1	2	1	1	2	1
CO4	3	3	3	1	3	2	1	1	1	2	1	2	2	2	3	1
CO5	3	3	3	2	3	2	2	2	2	3	2	3	2	3	3	3

Semester 6

Course Code	Couse Title	Credit	Lecture	Tutorial	Practical	Type
	Environmental and Agricultural Microbiology Practical	4	4	-	-	Practical

Course Introduction

This course shall develop the practical knowledge on techniques involved in assessing the various environmental factors affecting the growth of the microorganism.

Course Focus on: Skill Development / Entrepreneurship / Employability / Research

Course Outcomes	On completion of this course, students will
CO 1:	Illustrate isolation of different types of nitrogen fixing bacteria.
CO 2:	Able to explain the water quality analysis.
CO 3:	Develop the practical skill on cultivation of Single Cell Proteins (SCP).
CO 4:	Demonstrate the techniques for air quality assessment.
CO 5:	Validate the parameters required for *in vitro* cultivation of cyanobacteria.

List of Experiments **[30 Periods]**

Environmental and Agricultural Microbiology

1. Isolation of free-living nitrogen fixers –*Azotobacter, Azospirillum*.
2. Isolation of symbiotic nitrogen fixer -*Rhizobium*.
3. Isolation of ammonifiers, nitrifiers and denitrifies.
4. Isolation of Phosphate solubilizers.
5. Isolation of Cyanobacteria from water.
6. Cultivation of SCP- *Azolla*.
7. Water analysis: Physicochemical parameters- pH, Turbidity, TDS, TSS, BOD, COD and DO.
8. MPN Technique – Detection of potability of water.
9. Testing of efficacy of disinfectants - Phenol Coefficient test.
10. Microbial assessment of air quality.

Text Books:

1. James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York 1996.
2. Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3. Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
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1. Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C. Brown publishers.
2. Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India
3. Coyne, M.S. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
4. Okafor, N. (2011). Environmental Microbiology of Aquatic & Waste systems. 1st Edition, Springer, New York.
5. Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.

Web Resources:

1. https://www.researchgate.net/publication/43451458_Environmental_microbiology_A_laboratory_manual/link/56b1120508ae56d7b069dbc2/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:

Course Outcome	Programme Outcomes												Programme Specific Outcome			
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CO1	3	3	3	2	2	1	2	1	2	1	1	2	2	2	3	2
CO2	3	3	2	2	2	1	3	1	3	1	1	2	2	2	2	2
CO3	3	3	3	2	3	2	2	2	2	1	1	2	2	3	3	2
CO4	3	3	2	2	2	2	3	2	3	1	1	2	2	2	2	2

CO5	3	3	3	2	3	1	2	2	2	1	1	2	2	3	3	2