MARY MATHA COLLEGE OF ARTS AND SCIENCE (CO-EDUCATION)	
Programme :	B.Sc. MICROBIOLOGY
Programme code:	
Duration:	3 years [UG]
Programme Outcomes	**PO1: Disciplinary Knowledge:** Acquire detailed knowledge and expertise in all the disciplines of the subject. **PO2: Communication skills:** Able to communicate scientific information, concepts, experiments and significance. **PO3: Ethical value:** Apply knowledge on ethical and legal based issues **PO4: Analytical reasoning:** Familiarize to collect, analyze and interpret scientific data. **PO5: Contribution to society:** Solve public issues concerned with public health and safety for the welfare of the society. **PO6: Scientific reasoning** Solve problems understanding the issues, and find solutions, in day-to-day life. **PO7: Employability skill** Equip with skills, based on current trends and future expectations for career development and placements. **PO8: Entrepreneurial skill** Equip with skills and competency to become a successful entrepreneur. **PO9:Research related skill** Proficient skills and competence to make a prospective career in Research & Development. **PO10: Life long learning** Identify the need for skills necessary to be successful in future. **PO11: Instrumentation skill** Handle laboratory experiments following safety precautions and standards.

Programme Specific Outcome	**PSO-1: Placement** Prepare the students in all disciplines like agriculture, industry-medical, pharma, dairy, hotel, food and food processing, immunologicals, cosmetics, vermitechnology and water treatment for effective and respectful placement. **PSO-2:Entrepreneur** To create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO-3:Research and Development** Design and implement HR systems that comply with good laboratory practices, following ethical values, leading the organization towards growth and development. . **PSO-4:Contribution to society** To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK

(Those who have joined in the Academic year 2023-24 onwards)

B.Sc Microbiology

Part	Courses	Subject	Code	Cr.	Hrs
		SEMESTER - I			
I	Lang. – I	Tamil - **I**		3	6
II	Lang. - II	General English		3	4
III	CC – 1	Fundamentals of Microbiology and Microbial diversity		4	5
	CC – 2	Lab in Fundamentals of Microbiology and Microbial diversity		4	5
	EC – I [Any One]	1. Basic and Clinical Biochemistry		3	4
		2. Introduction to Microbiology			
IV	SEC –I (NME)	Social and Preventive Medicine		2	2
IV	FC	Good Laboratory Practices		2	2
	AECC- 1	Soft Skill – I (Ancillary Zoology)		2	2
	Total			**23**	**30**
		SEMESTER II			
I	Lang. -I	Tamil - **II**		3	6
II	Lang. -II	General English		3	4
III	CC – 3	Microbial Physiology and metabolism		4	5
	CC - 4	Lab in Microbial Physiology and Metabolism		4	5
	EC – II [Any One]	Bioinstrumentation		3	4
		Applied Microbiology			
IV	SEC –II (NME)	Nutrition and Health Hygiene		2	2
	SEC - III	Sericulture		2	2
	AECC –II	Soft Skill - II		2	2
				23	**30**
		SEMESTER III			
I	Lang. -I	Tamil - **III**		3	6
II	Lang. -II	General English		3	4
III	CC – 5	Molecular Biology and Microbial genetics		4	5
	CC - 6	Lab in Molecular Biology and Microbial Genetics		4	5
	EC –3	Clinical Laboratory Technology		3	4
IV	SEC –IV	Organic farming and bio fertilizer technology		1	2
	SEC – V	Aquaculture		2	2
	AECC – III	Soft Skill – III (General Biology)		2	2
	EVS	Environmental Studies		1	1
				23	**30**

Part	Courses		Code	Cr.	Hrs
SEMESTER IV					
I	Lang. – I	Tamil - **IV**		3	6
II	Lang. - II	General English		3	4
III	CC – 7	Immunology and Immunotechnology		4	5
	CC - 8	Lab in Immunology and Immunotechnology		4	4
	EC – IV	Food processing Technology		2	3
IV	SEC –VI	Vaccine Technology		2	2
IV	SEC –VII	Apiculture		2	2
	AECC- Soft Skill – 4	Medical Coding - II		2	2
	EVS	Environmental Studies		1	1
	Total			**24**	**30**
SEMESTER V					
III	CC – 9	Bacteriology and Mycology		4	5
	CC - 10	Virology and Parasitology		4	5
	CC - 11	Lab in Medical Microbial Technology		4	5
	Core 12	Project with Viva voce		4	5
	EC – V	Recombinant DNA Technology		3	4
	EC – VI	Biosafety and Bioethics		3	4
IV		Value Education		1	1
		Internship/Industrial Training (carried out in II year summer vacation) 30 hrs		2	
				25	**30**
SEMESTER VI					
III	CC – 13	Environmental and Agricultural Microbiology		4	5
	CC – 14	Food, Dairy and Probiotic Microbiology		4	5
	CC – 15	Lab in Food and Agricultural Microbiology		4	5
	EC –7 [Any One]	Pharmaceutical Microbiology		3	5
	EC - 8	Entrepreneurship and Bio business		3	5
IV	Processional competency skill enhancement course	Microbial Quality Control and Testing		2	4
		Value Education		1	1
V		Extension Activity (outside college hrs)		1	
				22	**30**

SEMESTER - 1

Title of the Course		FUNDAMENTALS OF MICROBIOLOGY AND MICROBIAL DIVERSITY						
PART		III						
Category	Core - I	Year	I	Credits	4	Course Code		
		Semester	I					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	--	5	25	75	100

Learning Objectives

Learn the fundamental principles about different aspects of Microbiology including recent developments in the area.
Describe the structural organization, morphology and reproduction of microbes.
Explain the methods of cultivation of microbes and measurement of growth.
Understand the microscopy and other basic laboratory techniques – culturing, disinfection and sterilization in Microbiology.
Compare and contrast the different methods of sterilization.

UNIT	Details	No. of Periods for the Unit
I	History and Evolution of Microbiology, Classification – Three kingdom, five kingdom, six kingdom and eight kingdom. Microbial biodiversity: Introduction to microbial biodiversity- ecological niche. Basic concepts of Eubacteria, Archaebacteria and Eucarya. Conservation of Biodiversity.	
II	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.	
III	Bacterial culture media and pure culture techniques. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques.	
IV	Microscopy – Simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM, Confocal microscopy, and Atomic Force Microscopy. Stains and staining methods.	
V	Sterilization–moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic; Antimicrobial agents.	

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	Study the historical events that led to the discoveries and inventions and understand the Classification of Microorganisms.
CO2	Gain Knowledge of detailed structure and functions of prokaryotic cell organelles.
CO3	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO4	Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.
CO5	Understand the concept of asepsis and modes of sterilization and disinfectants.

Text Books (Latest Editions)	
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 CollegePublishing, 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://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2.	https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4.	https://bio.libretexts.org/@go/page/9188
5.	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1					M	M				M	
CO 2										M	M
CO 3											S
CO 4				M							S
CO 5				M							S

S-Strong M-Medium L-Low

Title of the Course		LAB IN FUNDAMENTALS OF MICROBIOLOGY AND MICROBIAL DIVERSITY						
PART		III						
Category	Core - II	Year	I	Credits	4	Course Code		
		Semester	I					

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
	-	-	5	5	25	75	100

Learning Objectives

Acquire knowledge on Cleaning of glass wares, GLP and sterilization.
Gain knowledge on media preparation and cultural characteristics.
Learn the pure culture technique
Learn the microscopic techniques and staining methods.
Acquire knowledge on stain and staining methods

UNIT	Details	No. of Periods for the Unit
I	Cleaning of glass wares, Microbiological good laboratory practice and safety. Sterilization and assessment of sterility– Autoclave, hot air oven, and membrane filtration.	
II	Media preparation: liquid media, solid media, semi-solid media, agar slants, agar deeps, agar plates.	
III	Preparation of basal, differential, enriched, enrichment, transport, and selective media preparation- quality control of media, growth supporting properties, sterility check of media. Pure culture techniques: streak plate, pour plate, decimal dilution.	
IV	Culture characteristics of microorganisms: growth on different media, growth characteristics, and description. Demonstration of pigment production. Microscopy: light microscopy and bright field microscopy.	
V	Staining techniques: smear preparation, simple staining, Gram's staining and endospore staining. Study on Microbial Diversity using Hay Infusion Broth-Wet mount to show different types of microbes, hanging drop.	

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	Practice sterilization methods; learn to prepare media and their quality control.
CO2	Learn streak plate, pour plate and serial dilution and pigment production of microbes.
CO3	Understand Microscopy methods, different Staining techniques and motility test.
CO4	Observeculture characteristics of microorganisms.
CO5	Study on Microbial Diversity using Hay Infusion Broth-Wet mount

Text Books (Latest Editions)

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.
5.	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
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 with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO 1				M			L	M	L		M
CO 2				S			L	L	L		
CO 3				S			M	M	L		M
CO 4				S			M	L	L		
CO 5				S			M	L	L		

S-Strong M-Medium L-Low

Title of the Course		BASIC AND CLINICAL BIOCHEMISTRY						
PART		III						
Category	EC - I	Year	I	Credits	3	Course Code		
		Semester	I					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		4	-	-	4	25	75	100

Learning Objectives

Attain thorough knowledge on carbohydrates and lipids, their characteristic properties and organization in carrying out all the living functions which constitute the life.
Explain the biological activity of amino acids and proteins.
Identify the metabolic errors in enzymes of carbohydrates and lipids.
Describe the disorders in amino acid metabolism.
Interpret the consequences, biochemical, clinical features, diagnosis and treatment of metabolic diseases of day today life.

UNIT	Details	No. of Periods for the Unit
I	Biomolecules -Carbohydrate – General properties, function, structure, classification– monosaccharides (Glucose, Fructose, Galactose), Oligoaccharides (Sucrose, Maltose, Lactose) and polysaccharides (Starch, Glycogen,) and biological significance. Lipids – General properties, functions, structure, classification (Simple, Derived and Complex), Cholesterol, LDL, HDL – biological significance.	12
II	Biomolecules - Amino acids – General properties, functions, structure, classification and biological significance. Proteins– General structure, Properties, functions, classification and biological significance.	12
III	Disorders of Metabolism: Disorders of carbohydrate metabolism: diabetes mellitus,ketoacidosis, hypoglycemia, glycogen storage diseases, galactosemia and lactose intolerance. Disorders of lipid metabolism: hyperlipidemia, hyperlipoproteinemia, hypercholesterolemia, hypertriglyceridemia,sphingolipidosis.	12
IV	Disorders of Metabolism: Disorders of amino acid metabolism:alkaptonuria, phenylketonuria, phenylalaninemia, homocystineuria, tyrosinemia, aminoacidurias.	12
V	Evaluation of organ function tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase	12

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	Explain the structure, classification , biochemical functions and significance of carbohydrates and lipids
CO2	Differentiate essential and non-essential amino acids, biologically important modified amino acids and their functions, Illustrate the role, classification of Proteins and recognize the structural level organization of proteins, its functions and denaturation.
CO3	Assess defective enzymes and Inborn errors. Recognize diseases related to carbohydrate and lipid metabolism.
CO4	Discuss and evaluate the pathology of aminoacid metabolic disorders.

CO5	Appraise the imbalances of enzymes in organ function and relate the role of Clinical Biochemistry in screening and diagnosis.

Text Books (Latest Editions)	
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.	AmbikaShanmugam'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,LubertStryer, John L. Tymoczko, Gregory J. Gatto (2015). Biochemistry, 8th edition. WH Freeman publisher.

Reference Books	
1.	AmitKessel&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.	LupertStyrer, 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://www.abebooks.com › plp
2.	https://kau.in/document/laboratory-manual-biochemistry
3.	https://metacyc.org
4.	https://www.medicalnewstoday.com
5.	https://journals.indexcopernicus.com

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO 1	M										
CO 2	M										
CO 3				S	S	S					
CO 4				S	S	S					
CO 5	M										

S-Strong M-Medium L-Low

Title of the Course		Social and Preventive Medicine						
PART		III						
Category	EC - I	Year	I	Credits	3	Course Code		
		Semester	I					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		4	-	-	4	25	75	100

Learning Objectives

Describe the concepts of health and disease and their social determinants.
Summarize the health management system.
Know about the various health care services.
Outline the goals of preventive medicine.
Gain knowledge about alternate medicine.

UNIT	Details	No. of Periods for the Unit
I	Introduction to social medicine: History of social medicine-concepts of health and disease-social determinants of health and disease-Health and quality of life-Health information system- measures of population health-health policies.	12
II	Health management: Applications of behavioral sciences and psychology in health management- nutritional programs for health management-water and sanitation in human health-national programs for communicable and non-communicable diseases- environmental and occupational hazards and their control.	12
III	Health care and services: Health care of the community-information, education, communication and training in health-maternal & child health-school health services- Geriatrics-care and welfare of the aged-mental health-health services through general practitioners.	12
IV	Preventive medicine: Introduction- role of preventive medicine- levels of prevention-Risk assessment in communities and vulnerable population surveillance, monitoring and reporting of disease outbreaks forecasting and control measures in	12

	community setting early detection methods.	
V	Prevention through alternate medicine: Unani, Ayurveda, Homeopathy, Naturopalhy systems in epidemic and pandemic outbreaks. Interational health regulations response during SARS and MERS coronavirus, Ebola and novel SARS-COV2 outbreaks.	**12**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Identify the health information system
CO2	Associate various factors with health management system
CO3	Choose the appropriate health care services
CO4	Appraise the role of preventive medicine in community setting
CO5	Recommend the usage of alternate medicine during outbreaks

	Text Books
1.	Park.K (2021). Textbook of preventive and social medicine, 26" edition. Banarsidas Bhanot publishers
2.	Mahajan& Gupta (2013). Text book of preventive and social medicine, 4'edition. Jaypec brothers medical publishers.
3.	Chun-Su Yuan, Eric J. Bieber, Brent Bauer (2006). Textbook of Complementary and Altemative Medicine. Second Edition. Routledge publishers.
4.	Vivek Jain (2020). Review of Preventive and Social Medicine: Including Biostatics.12"edition, Jaypee Brothers Medical Publishers.
5.	Lal Adarsh Pankaj Sunder (2011). Textbook of Community Medicine: Preventive and Social Medicine, CBS publisher.
	Reference Books
	Howard Wairzkin, Alina Pérez, Mait Anderson (2021). Social Medicine and the coming Transformation. First Edition. Routledge publishers.
	GN Prabhakars (2010) Short Textbook of Preventive and Social Medicine. Second Edition Jaypee publishers.
	Jerry M. Suls, Karina W. Davidson, Robert M. Kaplan (2010). Handbook of Health Psychology and Behavioral Medicine. Guillord Press.
	Marie Eloïse Muller, Marie Muller, Marthie Bezuidenhout, Karien Jooste (2006). Health Care Service Management. Juta and Company Lid.
	Geofiey Rose (2008), Rose's Suategy of Prevenive Medicine: The Complete. OUP Oxford.
	Web Resources
	https://www.omicsonline.orglscholarly/social-preventive-medicine-journals articles-ppts list. php

Mapping with Programme Outcomes:

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	1	1
CO2	2	1	1	2	3
CO3	3	3	3	2	2
CO4	3	3	1	2	3
CO5	3	3	1	3	3

3- Strong 2- Medium 1- Low

Title of the Course		Good Laboratory Practices						
PART		IV						
Category	FC	Year	I	Credits	2	Course Code		
		Semester	I					

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
	2	-	-	2	25	75	100

Learning Objectives

Understand the principles, scope, and importance of Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP).
Apply laboratory safety rules and follow standard protocols for handling chemicals, glassware, and laboratory instruments.
Perform basic calibration and maintenance procedures for common laboratory equipment.
Demonstrate awareness of biosafety levels, biohazard management, and laboratory waste disposal practices.
Maintain laboratory records and analyze data using statistical tools and Microsoft Office applications.

UNIT	Details	No. of Periods for the Unit
I	Introduction to GLP, History, Scope and fundamental of GLP, WHO guidelines for GLP & GMP Concept of quality control & assurance.	12
II	General rules, protocols for lab safety measures. Precautions and safety in handling: chemicals, Laboratory tools, Glass wares and Instruments. Calibration of Instruments: weighing scale, microcentrifuge, pH meter, colorimeter. spectrophotometer, water bath.	12
III	Biosafety cabinets - Introduction, Laminar hood and Biosafety levels I, II, III & IV Laboratory associated hazards/infections, disposal of biohazard materials-Methodology and disinfection, Fire triangle and fire prevention methods and safety.	12
IV	Maintenance of data records, its analysis using statistical and mathematical tools. Use of Microsoft word, Excel.	12

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Explain the concepts, history, guidelines, and quality assurance aspects of Good Laboratory Practice (GLP).
CO2	Implement laboratory safety measures and follow standard operating procedures while handling laboratory materials and equipment.
CO3	Calibrate and operate common laboratory instruments such as pH meters, spectrophotometers, centrifuges, and weighing balances.

CO4	Apply biosafety principles, identify laboratory hazards, and perform appropriate biohazard disposal and disinfection procedures.
CO5	Maintain accurate laboratory documentation and utilize Microsoft Word and Excel for data recording, analysis, and reporting.

Text Books (Latest Editions)	
1.	1. Handbook Good Laboratory Practices-World health organization (WHO) 2. Life science protocol manual (2018)-DBT star college scheme 3. Guidelines for good laboratory practices-Indian council of medical research, New Delhi (2008). 4. FDA ORA Laboratory Manual of Quality Policies 5. FDA CFR GMP Regulations for Drug Products 6. ISO 17025 General requirements for the competence of testing and calibration laboratories. 7. Pharmacopoeias (BP/USP/EP/JP) 8. ICH Guidance QB4 Evaluation and Recommendation of Pharmacopoeial Texts for 9. Use in the ICH Regions 10. ICH Q2(R1): Validation of Analytical Procedures: Text and Methodology 11. ICH Q5C: Quality of Biotechnological Products: Stability Testing of 12. Biotechnological/Biological Products 13. WHO Guidelines for Sampling of Pharmaceutical and Related Materials

SEMESTER – 2

Title of the Course		MICROBIAL PHYSIOLOGY AND METABOLISM						
PART		III						
Category	CORE	Year	I	Credits	4	Course Code	233003201	
		Semester	II					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	-	5	25	75	100

Learning Objectives

Study the basic principles of microbial growth.
Understand the basic concepts of aerobic and anaerobic metabolic pathways.
Analyze the role of individual components in overall cell function.
Provide information on sources of energy and its utilization by microorganisms.
Study the different types of metabolic strategies.

UNIT	Details	No. of Periods for the Unit
I	Physiology of microbial growth: Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass,and cell count). Control of microbial growth.	
II	Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth.	
III	An overview of Metabolism - 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	
IV	Photosynthesis - An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.	
V	Bacterial reproduction - Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.	

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Describe microorganisms based on nutrition.
CO2	Know the concept of microbial growth and identify the factors affecting bacterial growth.
CO3	Explain the methods of nutrient uptake.
CO4	Describe anaerobic and aerobic energy production.
CO5	Elaborate on the process of bacterial photosynthesis and reproduction

Text Books (Latest Editions)	
1.	Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridge.
2.	RajapandianK.(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..	BhanuShrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism. Lambert academic Publication.
Web Resources	
1.	https://sites.google.com/site/microbial physiologyoddsem/teaching-contents
2.	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3.	https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4.	http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf
5.	https://www..frontiersin.org.microbial-physiology-and-metabolism

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						2			2	
CO2						2	1		2	
CO3						2			2	
CO4						2			2	
CO5						2			2	

3- Strong 2- Medium 1- Low

Title of the Course		LAB IN MICROBIAL PHYSIOLOGY AND METABOLISM						
PART		III						
Category	CORE	Year	I	Credits	4	Course Code	233003202	
		Semester	II					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	5	5	25	75	100

Learning Objectives

Understand the principles of motility test.
Understand the basic concepts of staining methods.
Learn the bacterial count using different methods and anaerobic culture.
Study the morphological demonstration of microorganisms and identification.
Study the biochemical identification of the bacteria.

UNIT	Details	No. of Periods for the Unit
I	Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining	
II	Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve.	
III	Anaerobic culture methods. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.	
IV	Morphological variations in algae, fungi and protozoa. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa.	
V	Methods of bacterial identification- morphological, physiological, and biochemical methods - IMViC test, H2S, TSI, Oxidase, catalase, urease test, and Carbohydrate fermentation test.Maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.	

Course Outcomes	
Course Outcomes	Oncompletionofthiscourse,studentswill be able;
CO1	Describe hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method.
CO2	Demonstrate Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining.
CO3	Explain antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.
CO4	Describe demonstration of the size of yeast, fungal filaments and protozoa.
CO5	Elaborate on the bacterial identification- morphological, physiological, and biochemical methods.

Text Books	
1.	James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York .
2.	Kannan. N (1996).Laboratory manual in General Microbiology. Palani Publications
3.	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4.	Gunasekaran. P (2007). Laboratory manual in Microbiology. New age international publisher.

Reference Books	
1.	DavidWhite., James Drummond., Clay Fuqua (2012) Physiology and Biochemistry of Prokaryotes. 4th Ed. Oxford University Press, New York.
2.	Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.
3.	Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.
4.	Dawes, I.W and Sutherland L.W (1992). Microbial Physiology (2nd edition), Oxford Blackwell Scientific Publications.
5..	Moat, A.G and J.W Foaster, (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications.
Web Resources	
1.	https://sites.google.com/site/microbial physiologyoddsem/teaching-contents
2.	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3.	https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4.	https://www.studocu.com/microbial-physiology-practicals
5.	https://www.agr.hokudai.ac.jp/microbial-physiology

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
CO1						M	L	M	L		M
CO2						M	M	L	M		L
CO3						L	M	M	L		M
CO4						L	M	M	M		M
CO5						M	M	M	M		M

3- Strong 2- Medium 1- Low

Title of the Course		BIOINSTRUMENTATION						
PART		III						
Category	EC - II	Year	I	Credits	3	Course Code	233003203	
		Semester	II					

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
	4	-	-	4	25	75	100

Learning Objectives

- ✍ Practice, experiment with and apply the basic instruments in the laboratory.
- ✍ Predict the functionality of Beer – Lambert's law in identifying and quantifying a biomolecule.
- ✍ Employ the separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.
- ✍ Understand the clinical important isotopes and detection of isotopes.
- ✍ Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.

UNIT	Details	No. of Periods for the Unit
I	pH – Definition – pH meter. Measurement of pH and calibration of pH meter - Buffers – Preparation of Buffers. Microscopy: Principle and applications of Compound, Bright field, Phase contrast and Fluorescence Microscope.	12
II	Spectra – Absorption and Emission Spectra – Beer Lambert's law – Colorimeter, UV-Visible Spectrophotometer. Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR).	12
III	Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.	12
IV	Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials.	12
V	Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.	12

Course Outcomes

Course Outcomes	Oncompletionofthiscourse,studentswill be able;
CO1	Learn about handling and uses of pH meter and microscope
CO2	Spectroscopy can clarify its principle, types and its benefits
CO3	Learn more about chromatography and electrophoresis techniques
CO4	Understanding about radio isotopes and its applications in medicine
CO5	Get a solution about the types of centrifuge and how to use to sedimentation of mixtures.

TextBooks	
1.	Upadhyay and UpadhyayNath. (2009). "Biophysical Chemistry", Principles and Techniques. Himalaya Publishing House.
2.	L.Veerakumari, (2006) "Bioinstrumentation" MJP publishers , Kindle Edition.
3.	SkoogD.A.F.James Holler and Stanky,R.Crouch, (2007) "Instrumental Methods of Analysis" Cengage Learning.
4.	Palanivelu P, 2000. Analytical Biochemistry & Separation Techniques, 4th edition, Twenty first century publications.
5.	Prakash M, 2009. Understanding Bioinstrumentation, 1st edition, Discovery Publishing House Pvt Ltd

Reference Books	
1.	Keith Wilson,John Walker,(2010).Principles and techniques of Biochemistry and Molecular Biology"(7th edition).Cambridge University Press.
2.	David L.Nelson, Michael M Cox.Lehninger(2008)."Principles of Biochemistry",Fifth edition W.H.Freeman,Newyork.
3.	Khandpur R S, 2014. Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India).
4.	L.A Geddes and L.E.Baker (2008) "Principles of Applied Biomedical Instrumentation"WileyIndia Third Edition.
5..	Sharma B K, 2005. Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.

Web Resources	
Unit-I	https://microbeonline.com/ph-meter-parts-principle-and-applications/ https://www.britannica.com/technology/microscope
Unit-II	https://www.vedantu.com/physics/spectroscopy#:~:text=be%20updated%20soon)-,Principle%20of%20Spectroscopy,by%20the%20sample%20or%20object.
Unit-III	https://microbenotes.com/chromatography-principle-types-and-applications/ https://microbeonline.com/electrophoresis-principles-types-and-uses/
Unit-IV	https://www.britannica.com/story/how-radioactive-isotopes-are-used-in-medicine
Unit-V	https://microbenotes.com/centrifugation-principle-types-and-applications/

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CLO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
TOTAL	**15**	**15**	**15**	**14**	**14**	**14**	**15**	**14**	**14**

3- Strong 2- Medium 1- Low

Title of the Course		Nutrition & Health Hygiene						
PART		SEC II						
Category	SEC – II NME	Year	I	Credits	2	Course Code	234603230	
		Semester	II					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Learning Objectives

Learn about nutrition and their importance
Make student understand the nutritional facts for a better life.
Learn information to optimize our diet
Impart knowledge on different health care programs taken up by India
Learn knowledge on different health indicators and types of hygiene methods

UNIT	Details	No. of Periods for the Unit
I	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	6
II	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.	6
III	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.	6
IV	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.	6
V	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.	6

Course Outcomes

Course Outcomes	Oncompletionofthiscourse,studentswill be able to;
CO1	Learn the importance of nutrition for a healthy life
CO2	Study the nutrition for life cycle
CO3	Know the health care programmes of India
CO4	Learn the importance of community and personal health & hygiene measures
CO5	Create awareness on community health and hygiene

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

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

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1					3	2	2	2		3
CO2					3	2	2	2		3
CO3					3	2	2	2		3
CO4					3	3	1			3
CO5					3	3	2			3

3- Strong 2- Medium 1- Low

Title of the Course		SERICULTURE						
PART		IV						
Category	SEC III	Year	I	Credits	2	Course Code	234403230	
		Semester	I					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Learning Objectives

Acquire knowledge on the concepts of origin, growth and study of Sericulture as science and scientific approach of mulberry plant.
Describe the morphology and physiology of silkworm.
Discuss effective management of silkworm diseases.
Demonstrate field skills in mulberry cultivation and silkworm rearing with an emphasis on technological aspects.
Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises.

UNIT	Details	No. of Periods for the Unit
I	General introduction to Sericulture, its distribution in India. Botanical distribution and taxonomical characters of mulberry varieties and species.Biology of Mulberry plant and Mulberry crop cultivation and protection.	6
II	Silkworm- biology-morphology of silkworm. Life cycle of silkworm- egg, larva, pupa, and moth.	6
III	Silkworm pathology: Introduction to Parasitism, Commensalism, Symbiosis and Parasite relationship - Mulberry Silkworm Diseases: Introduction, types, Pebrine, Grasserie, Muscardine, Flacherie, Symptoms and Pathogens, Mode of Infection, Prevention and Control -Non – mulberry silkworm diseases: Pebrine, Bacterial and viral diseases. Brief Account of Pests and Predators of Silkworms, Nature of damage and control measures.	6
IV	Rearing of silkworm. Cocoon assessment and processing technologies. Value added products of mulberry and silkworms.	6
V	Entrepreneurship and rural development in sericulture:Planning for EDP, Project formulation, Marketing, Insectary facilities and equipments: Location, building specification, air conditioning and environmental control, furnishings and equipment, sanitation and equipment, subsidiary facilities.	6

Course Outcomes

Course Outcomes	On completion of this course, students will be able to;
CO1	Discuss the overall aspects of Sericulture and the biology and varieties of mulberry plant.Creates awareness among students about the economic importance and suitability of Sericulture in Indian conditions.
CO2	Familiarize with the lifecycle of silk worm.
CO3	Explain common diseases of silkworm encountered during rearing, sources of infection, disease symptoms, pre-disposing factors and their management practices.

CO4	Attain thorough knowledge about the cultivation of mulberry, maintenance of the farm, seed technology, silkworm rearing, post cocoon techniques like stifling, reeling, and utilization of by-products.
CO5	Plan the facilities required for establishment of insectary. Competent to transfer the knowledge and technical skills to the Seri-farmers.Analyze the importance of sericulture in entrepreneurship development and emerge as potential entrepreneur.

TextBooks	
1.	Ganga, G. and Sulochana Chetty (2010). Introduction to Sericulture,, J., Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
2.	Dr. R. K. Rajan&Dr. M. T. Himantharaj(2005). Silkworm Rearing Technology, Central Silk Board, Bangalore.
3.	Dandin S B, Jayant Jayaswal and Giridhar K (2010). Handbook of Sericulture technologies,Central Silk Board, Bangalore.
4.	M. C. Devaiah, K. C. Narayanaswamy and V. G. Maribashetty(2010). Advances in Mulberry Sericulture,,CVG Publications, Bangalore
5.	T.V.SatheandJadhav.A.D.(2021). Sericulture and Pest Management, Daya Publishing House.
Reference Books	
1.	S. Morohoshi (2001). Development Physiology of Silkworms 2nd Edition, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi
2.	Hamamura, Y (2001). Silkworm rearing on Artificial Diet. Oxford & IBH publishing Co., Pvt. Ltd. NewDelhi.
3.	M.Johnson, M.Kesary (2019). Sericulture, 5th. Edition. Saras Publications.
4.	Manisha Bhattacharyya (2019). Economics of Sericulture, Rajesh Publications.
5.	Muzafar Ahmad Bhat, Suraksha Chanotra, Zafar Iqbal Buhroo, Abdul Aziz and Mohd. Azam (2020). A Textbook on Entrepreneurship Development Programme in Sericulture, IP Innovative Publication.
Web Resources	
1	https://egyankosh.ac.in › bitstream
2	https://archive.org › details › SericultureHandbook
3	https://www.academic.oup.com
4	https://www.sericulture.karnataka.gov.in
5	https://www.silks.csb.gov.in

MappingwithProgrammeOutcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3				3		3				
CO2	2				3						
CO3	3				3						
CO4							3	3		3	
CO5					3		3	3			

3- Strong 2- Medium 1- Low

SEMESTER – 3

Title of the Course		**MOLECULAR BIOLOGY AND MICROBIAL GENETICS**						
PART		**III**						
Category	Core – 5	**Year**	II	**Credits**	4	**Course Code**	**233003301**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	--	5	25	75	100

Learning Objectives	
LO1	Provide knowledge on structure and replication of DNA.
LO2	Illustrate the significance and functions of RNA in protein synthesis.
LO3	Explain the cause and types of DNA mutation and DNA repair mechanisms.
LO4	Outline the role of plasmids and phages in genetics.
LO5	Examine mechanisms of gene transfer and recombination.

UNIT	**Details**	**No. of Periods for the Unit**
I	DNA Structure - 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 - 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.	**15**
II	Transcription in Prokaryotes - Concept of transcription - RNA Polymerases - prokaryotic. General transcription factors in eukaryotes. Distinction between transcription processes in prokaryotes. Translation in prokaryotes - Translational machinery - ribosome structure in prokaryotes, tRNA structure and processing. Inhibitors of protein synthesis in prokaryotes. Overview of regulation of gene expression – *lac* and *trp* operons as examples. Regulation of gene expression by DNA methylation.	**15**
III	Mutation - 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 - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.	**15**
IV	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.	**15**
V	Gene Transfer Mechanisms- 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.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will;
CO1	Analyze the significance of DNA and elucidate the replication mechanism.
CO2	Illustrate the types of RNA and protein synthesis machinery.
CO3	Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms.
CO4	Evaluate the importance of plasmids and phages in genetics.
CO5	Analyze gene transfer and recombination methods.

Text Books (Latest Editions)	
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 SnustedD.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). iGenetics - 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
2.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
3.	https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/
4.	Molecular Biology Notes - Microbe Notes
5.	Molecular Biology Lecture Notes & Study Materials | Easy Biology Class

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1				3	3	2	3	2	3	2	
CO 2				3	2	2	3	2	3	1	
CO 3				2	3	2	3	2	3	1	
CO 4				2	2	2	3	2	3	1	
CO 5				2	3	3	3	2	3	1	

S-Strong M-Medium L-Low

Title of the Course		LAB IN MOLECULAR BIOLOGY AND MICROBIAL GENETICS						
PART		III						
Category	Core – 6	Year	II	Credits	4	Course Code	233003302	
		Semester	III					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	5	5	25	75	100

Learning Objectives

- ✍ Provide knowledge on structure and replication of DNA.
- ✍ Elucidate the methods of Genomic and Plasmid DNA isolation.
- ✍ Explain methods of protein separation.
- ✍ Explain artificial transformation method.
- ✍ Outline the role of phages in genetics.

Experiments

- Study of different types of DNA and RNA using micrographs and model / schematic representations.
- Study of semi-conservative replication of DNA through micrographs / schematic representations.
- Isolation of Genomic and Plasmid DNA from *E. coli* and Analysis by Agarose gel electrophoresis.
- Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).
- Resolution and visualization of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) – Demonstration.
- UV induced auxotrophic mutant production and isolation of mutants by replica plating technique – Demonstration.
- Perform artificial Transformation in *E. coli.*
- Isolation of antibiotic resistant mutants by gradient plate method. - Demonstration
- Screening and isolation of phages from sewage.
- Perform RNA isolation.
- Estimate RNA.

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	Illustrate different types of DNA and RNA.
CO2	Utilize hands-on training in isolation of genomic and plasmid DNA.
CO3	Analyze importance of experimental microbial genetics.
CO4	Apply the knowledge of molecular techniques in various fields.
CO5	Investigate the significance of Phages.

Text Books (Latest Editions)

1.	Crichton. M. (2014). Essentials of Biotechnology. Scientific International Pvt Ltd.New Delhi.
2.	Sambrook J. and Russell D.W. (2001). Molecular Cloning - A Laboratory Manual – 7th Edition. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
3.	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.
4.	Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
5.	James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5th Edition). The Benjamin publishing company. New York.

Reference Books	
1.	Glick B. R. and Patten C.L. Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press. 2018.
2.	Russell P.J. (2010). iGenetics - 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.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
Web Resources	
1.	https://www.molbiotools.com/usefullinks.html
2.	(PDF) Molecular Biology Laboratory manual (researchgate.net)
3.	https://www.molbiotools.com/usefullinks.html
4.	https://geneticgenie.org3.
5.	https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1				3	1	2	3	2	3	2	3
CO 2				3	1	2	3	2	3	2	3
CO 3				3	1	2	3	2	3	2	3
CO 4				3	1	2	3	2	3	2	3
CO 5				3	1	2	3	2	3	2	3

S-Strong M-Medium L-Low

Title of the Course		CLINICAL LABORATORY TECHNOLOGY						
PART		III						
Category	EC - 3	Year	II	Credits	2	Course Code	233003303	
		Semester	III					

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
	3	-	-	3	25	75	100

Learning Objectives

LO1	Demonstrate ethical and professional conduct with patients, laboratory personnel, health-care professionals, and the public.
LO2	Explain how accurate and reliable information might be obtained about proper procurement, storage, and *handling* of laboratory *specimens*.
LO3	Develop a sound scientific knowledge foundation that prepares them to interpret, analyze and evaluate scientific knowledge in clinical practice.
LO4	Perform a full range of laboratory tests with accuracy and precision.
LO5	Establish quality assurance principles and practices to ensure the accuracy and reliability of laboratory information.

UNIT	Details	No. of Periods for the Unit
I	**Introduction to Clinical Laboratory Science**: Basic laboratory principles - Code of conduct for medical laboratory personnel - Organization of clinical laboratory and role of medical laboratory technician - Safety measures. Assessment of a patient and brief history of collection. Maintenance of Hygiene & Infection Control Practices.	**9**
II	**Specimen collection and processing** - 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.	**9**
III	**Introduction to histopathology**-Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing - Collection of specimens, Labeling and fixation, Dehydration, Clearing, Impregnation, Embedding - Paraffin block making, Section Cutting, Microtomes – types and mounting of sections.	**9**
IV	**Introduction to Haematology**- Laboratory methods 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.	**9**
V	**Quality Standards in Health Laboratories** – Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment - pre-analytical, analytical, and post-analytical phases of testing.	**9**

Course Outcomes

Course Outcomes	On completion of this course, students will;
CO1	Describe characteristics of laboratory organizations and demonstrate professionalism by displaying professional conduct, model ethical behavior and operate as a vital member of the medical lab team. Practice safety or infection control procedures in the clinical laboratory, properly use safety equipment and maintain a clean, safe work environment.

CO2	Accurately collect specimens for various purposes. Determine appropriate tests based on test request, Maintain standard and transmission-based precautions, Engage in the scientific process by understanding the principles and practices of clinical study design, implementation, and dissemination of results.
CO3	Identify the basic structure of cells, tissues and organs and describe their contribution to normal function. Interpret light and electron microscopic histological images and identify the tissue source and structures. Relate and recognize the histological appearance of affected tissues to the underlying pathology.
CO4	Recognize the pathologies behind benign and malignant disorders of erythrocytes, leucocytes, thrombocytes and familiar with the diagnosis, evaluation, and management of hematologic malignancies.
CO5	Interpret, implement, and complying with laws, regulations and accrediting standards and guidelines of relevant governmental and non-governmental agencies.

Text Books (Latest Editions)	
1.	Mukharji,K.L. (2000).Medical Laboratory Techniques, Vol - I, II & III, 5th Edition. Tata McGrawHill, Delhi.
2.	Ochei,A., Kolhatkar.A. (2000).Medical Laboratory Science: Theory and Practice, McGraw Hill Education.
3.	RamnikSood (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 RanaShinde.(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.
Web Resources	
1.	https://www.jaypeedigital.com › book
2.	https://www.pdfdrive.com › wintrobes-clinical-hematology
3.	https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4.	https://vlab.amrita.edu/index.php?sub=3&brch=272
5.	https://nptel.ac.in/courses/102105087

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO 1			2								3
CO 2					2	3					3
CO 3						3		S		3	3
CO 4					2	3			3		3
CO 5	2									2	

S-Strong M-Medium L-Low

Title of the Course		ORGANIC FARMING AND BIO FERTILIZER TECHNOLOGY						
PART		III						
Category	SEC - IV	Year	II	Credits	2	Course Code	234403330/ 234403329	
		Semester	III					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Learning Objectives	
LO1	Impart knowledge about the significance of organic farming and strategies to increase the yield to conserve environment.
LO2	To encourage organic farming in urban areas.
LO3	Comprehensive knowledge about bacterial biofertilizers, its advantages and future perspective.
LO4	Structure and characteristic features of Cyanobacterial and fungal biofertilizer
LO5	Develop the knowledge and skill to produce, analyze the quality of packaging, storage and assess the shelf life and bioefficacy of biofertilizers.

UNIT	Details	No. of Periods for the Unit
I	Principle of organic farming: principles of health, fairness, ecological balance, and care.Environmental benefits of organic farming: sustainability- reduces non-renewable energy by decreasing agrochemical need. Biodiversity-crop rotation, inter-cropping. Ecological services – biological control, soil formation and nutrient cycling.	6
II	Organic farming for urban space; Create a sustainable organic garden (Backyard- Square Foot Gardening, Small Space Gardening, Mini Farming) Composting, Vermicomposting	6
III	Biofertilizers: Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*	6
IV	Structure and characteristic features of Cyanobacterial biofertilizers- *Anabaena, Nostoc ;*Structure and characteristic features of fungal biofertilizers- AM mycorrhiza	6
V	Production of *Rhizobium, Azotobacter, Anabena*; Biofertilizers - Storage, shelf life, quality control and marketing	6

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Become an Entrepreneur with wide knowledge about farming and sustainable resources.
CO2	Implement organic farming in urban areas with knowledge on compost.
CO3	Gain knowledge about the bacterial biofertilizers and its advantages
CO4	Understand the significance about Cyanobacterial and fungal biofertilizers
CO5	Understand and implement the use of bio fertilizers.

Text Books (Latest Editions)	
1.	A.K. Sharma (2006). Hand book of Organic Farming
2.	A.C.Gaur (2017). Hand book of Organic Farming and Biofertilizers
3.	N.S. Subbarao (2017). Bio-fertilizers in Agriculture and Forestry (4th Edition) Med tech publisher
4	SubbaRao, N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5	Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
Reference Books	
1.	Masanobu Fukuoka, Frances Moore Lappe Wendell Berry (2009). The One-Straw Revolution: An Introduction to Natural Farming, 1st edition, YRB Classics.
2.	SujitChakrabarty(2018). Organic Home Gardening Made Easy, 1st Edition,
3	Singh and Purohit (2008). Biofertilizer technology. Agrobios, India.
4	Bansal M (2019). Basics of Organic Farming CBS Publisher.
5	Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3rd Edition). American Society for Microbiology.
Web Resources	
1.	https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2.	https://www.fao.org/organicag/oa-faq/oa-faq6/en/
3.	https://www.india.gov.in/topics/agriculture/organic-farming
4.	https://agriculture.nagaland.gov.in/bio-fertilizer/
5.	https://vlab.amrita.edu/index.php?sub=3&brch=272

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
CO 1	3	2	1	2	2
CO 2	2	3	2	2	1
CO 3	3	3	2	3	1
CO 4	3	3	1	2	1
CO 5	3	3	2	2	3

S-Strong M-Medium L-Low

Title of the Course		AQUACULTURE						
Part		IV (Common for Biotechnology and Microbiology)						
Category	SEC - 5	Year	II	Credits	2	Course Code	238203330/ 238203329	
		Semester	III					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Learning Objectives

- Students will be able to understand aquaculture systems, conditioning factors, fish feeding behaviour and breeding and rearing techniques.

UNIT	Details	No. of Periods for the Unit
I	Aquaculture-Global scenario, Origins and growth of aquaculture, Present status in India and Tamil Nadu; Fish pond construction- site selection; types of ponds, water quality analyses, liming and fertilization, morphology and commercial characteristics of cultivable fishes, culture practice, predator fishes, weed fishes control, Sources of pollution, Environmental impacts.	6
II	Fin fish culture - Composite fish culture (Indian Major Carps and Murrels); Sewage fed fish culture and integrated fish culture, Marine water fish culture. Shellfish and seaweed culture - Culture of marine prawns, edible and pearl oysters, adaptive management; Seaweeds- types and their culture practices.	6
III	Live feed organisms – Artemia and rotifers culture; Fish feed - types, formulation and preparation, techniques, Consequences of artificial feeding; Natural, supplementary and artificial breeding; Breeding – Bundh breeding and induced breeding; rearing of hatchlings, fry and fingerlings.	6
IV	Fungus infections. Protozoan diseases. Worm diseases. Non parasitic diseases. Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics.	6
V	Applied aquaculture: Identification of cultivable fish species; Morphometry of pond (Enclosed rectangular method/Shore length/ shore area and shore line development).Fishing technology (crafts and gears). Home aquarium and agency involved in aquaculture.	6

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	To perform the lab analyses for water quality and basics in aquaculture
CO2	To develop as entrepreneur in the aquaculture
CO3	To develop variety of fish feed formulation and production of fish feed
CO4	To perform the diagnostic analyses for fish diseases
CO5	Expertise in identification of fishes and design the aquarium

Text Books	
1	Biswas, K. P. 2000. Prevention and control of fish and prawn diseases. Narendra publishing house, New Delhi.
2	Hute, M. And Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3	Ninawe, A. S and Khadkar, G. D. 2009. Nutrition in Aquaculture, First Edition, Narendra publishing House, New Delhi.
References Books	
1	Biswas, K. P. 2000. Prevention and control of fish and prawn diseases. Narendra publishing house, New Delhi.
2	Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3	Ninawe, A. S and Khadkar, G. D. 2009. Nutrition in Aquaculture, First Edition, Narendra publishing House, New Delhi.
4	Jameson, J.D. and Santhanam. R. 1996, Manual of ornamental fishes and farming, Technologies Peejay, Thoothukkudi.
5	Jhingran, V.G. 1997. Fish and Fisheries of India. Hindustan Publishers, New Delhi.
6	Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	3
CO2	2	3	3	2	2	2
CO3	2	3	3	2	2	3
CO4	2	3	2	2	2	2
CO5	2	3	2	2	2	2

3 – Strong, 2 – Medium – Low

Title of the Course		GENERAL BIOLOGY						
Part		Soft Skill – III						
Category	AECC – III	Year	II	Credits	2	Course Code		
		Semester	III					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		3	-	-	2	25	75	100

Learning Objectives

✍ Students will be able to understand general biological systems.

UNIT	Details	No. of Periods for the Unit
I	Basics of classification: species, genus, family-Nomenclature-binomial system. Systems of classification-artificial, natural and phylogenetic; Bentham and Hooker system of classification of plants (Cohort level only). General classification of animals up to class level with examples as mentioned in practical syllabus-description for example is not required.	6
II	General characters and classification up to class level for the plant groups algae, fungi and Bryophytes. Type study (Development of sex organs need not be discussed). Algae: Sargassum, Fungi: Yeast, Bryophytes: Funaria	6
III	General characters and classification up to class level for the plant groups Pteridophytes and Gymnosperms. Type study (Development of sex organs and anatomical aspects need not be discussed). Pteridophytes: Selaginella, Gymnosperms: Pinus economic importance of gymnosperms. Angiosperms: description of a typical monocot and dicot flowers.	6
IV	Digestive, respiratory, excretory and reproductive systems in cockroach and frog.	6
V	Digestive, respiratory, excretory and reproductive systems in pigeon and man.	6

Reference Books

1. A.C. Dutta: Botany for Degree Students, Oxford University Press.
2. G.M. Smith: Cryptogamic Botany, Vol. I & II, Tata McGraw Hill.
3. W.T. Tailor and R.J. Wehe: General Biology, East West Press Pvt. Ltd.
4. E.L. Jordon and P.S. Verma (1995) Invertebrate Zoology, S. Chandra & Co., New Delhi

SEMESTER – 4

Title of the Course		**IMMUNOLOGY AND IMMUNOTECHNOLOGY**						
PART		**IV**						
Category	**Core – 7**	**Year**	II	**Credits**	4	**Course Code**	**233003401**	
		Semester	IV					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	-	5	25	75	100

Learning Objectives

- ✍ To gain knowledge about immune system, organs of immunity and cells involved.
- ✍ To distinguish the types of antigens and antibodies; their properties.
- ✍ To provide in-depth knowledge on immuno-techniques.
- ✍ To discuss the role of MHC system in transplantation; functions of Tumor specific antigens.
- ✍ To impart knowledge on immunological disorders.

UNIT	**Details**	**No. of Periods for the Unit**
I	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.	**15**
II	Antigen and Antibody: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.	**15**
III	Immunoassay and Immunotechniques - Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immuno fluorescence techniques and Flow cytometry	**15**
IV	Transplantation and TumorImmunology - 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.	**15**
V	Immunological disorders and diseases - Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and non-organ specific – RA, Graves.	**15**

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses.
CO2	Investigate the structures of Ag and Ab; Immunization.
CO3	Justify the Immunoassay and Immunotechniques.
CO4	Explain about the immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation
CO5	Analyze the overreaction by our immune system leading to hypersensitive conditions and its consequences.
Text Books (Latest Editions)	
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://www.ncbi.nlm.nih.gov/books/NBK279395/
2	https://med.stanford.edu/immunol/phd-program/ebook.html
3	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview | ScienceDirect Topics

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S			M		S			M	
CO2	S			M	M				M	
CO3	S			S	S		S			
CO4	S		M	S	S				M	
CO5	S			S	M	M				

3- Strong 2- Medium 1- Low

Title of the Course		LAB IN IMMUNOLOGY AND IMMUNOTECHNOLOGY						
PART		III						
Category	Core – 8	Year	II	Credits	4	Course Code	233003402	
		Semester	IV					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	4	4	25	75	100

Learning Objectives

- ✍ To gain hands-on knowledge to identify Blood group and typing.
- ✍ To acquire adequate skill to perform latex agglutination reactions.
- ✍ To analyze precipitation reactions in gels.
- ✍ To investigate the antigen & antibody reactions in electrophoresis.
- ✍ To familiarize with Separation of Lymphocytes.

Experiments

- Identification of blood group and typing.
- Coomb's test. TPHA
- T cell identification (Demonstration)
- Latex Agglutination reactions- RF, ASO, CRP
- Ouchterlony's Double Diffusion Method (antigen pattern).
- Single Radial Immuno Diffusion Method.
- Electrophoresis - Serum, Counter and Immuno.
- Separation of Lymphocytes by gradient centrifugation method.
- ELISA: Hepatitis/ HIV

Course Outcomes

Course Outcomes	On completion of this course, students will be able;
CO1	Assess the blood groups and types
CO2	Competently perform serological diagnostic tests such as RF, ASO, CRP
CO3	Illustrate the antigen antibody reactions in gel.
CO4	Compare & contrast antigens and antibodies in electrophoresis
CO5	Examine the concept of ELISA.

Text Books (Latest Editions)

1.	Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd edition, CBS.
2.	Asim Kumar Roy. (2019). Immunology Theory and Practical, Kalyani Publications.
3	Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5th Edition., Wiley-Blackwell, New York.
4	Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7th Edition., W. H. Freeman and Company, New York.
5	Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.

Reference Books	
1.	Frank C. Hay, Olwyn M. R. Westwood. (2008).Practical Immunology, 4th Edition, Wiley-Blackwell.
2.	Wilmore Webley. (2016). Immunology Lab Manual, LAD Custom Publishing.
3.	Rose. (1992). Manual of Clinical Lab Immunology, ASM.
4.	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
5.	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition., Wiley-Blackwell.
Web Resources	
1.	https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual
2.	https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf
3.	https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf
4.	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5.	Immunology - an overview | ScienceDirect Topics

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3
CO2	2	2	3	2	2
CO3	3	2	2	2	2
CO4	3	2	3	2	2
CO5	2	1	3	1	2

3- Strong 2- Medium 1- Low

Title of the Course		FOOD PROCESSING TECHNOLOGY						
PART		III						
Category	EC – 4	Year	II	Credits	3	Course Code	233003403	
		Semester	IV					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		4	-	-	4	25	75	100

Learning Objectives

- ✍ To provide knowledge on objectives of food preservation.
- ✍ To explain the freshness criteria and quality assessment of meat and fish.
- ✍ To outline the methods of milk processing and fermented milk products.
- ✍ To explain the importance of fat and oil processing.
- ✍ To discuss the methods of microbiological examination of foods.

UNIT	Details	No. of Periods for the Unit
I	Introduction to food preservation –objectives and techniques of food preservation. Preservation: principles of high temperature, low temperature, radiation, chemical preservatives and bio preservatives.	12
II	Freshness criteria and quality assessment of meat and fish –spoilage and methods of preservation. Production of byproducts after processing waste and their utilization. Role of packaging material, types of packaging material.	12
III	Composition of milk; assessment of milk, thermal processing of fluid milk-pasteurization (LTH, HTST&UHT techniques). Fermented milk products-cheese, Butter milk, Yogurt, Kumis, Kefir and Acidophilus milk. Hygiene and sanitation requirement in food processing and fermentation industries.	12
IV	Importance of fats and oils in Food-Extraction of fats and Oils-Rendering, pressing, solvent extraction, pressing of oil- degumming, refining, bleaching, deodorization, fractionation, pyrolysis of fats, toxicity of frying oil.	12
V	Methods for the microbiological examination of foods. Food borne illness and diseases (typhoid, Cholera, Mycotoxin, Ofotoxin, malaria & Amoebiasis). Microbial cultures for food fermentation. Indian Factories Act on safety, HACCP, Safety from adulteration of food.	12

Course Outcomes

Course Outcomes	On completion of this course, students will be able;
CO1	Assess the fundamental concepts of food preservation.
CO2	Investigate the quality assessment of meat and fish.
CO3	Design the processing of milk and milk quality assessment.
CO4	Explain about the importance of fats and oils.
CO5	Plan the food safety and adulteration detection.

Text Books (Latest Editions)	
1.	Avantina Sharma. (2006). Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP.
2.	Sivasankar. (2005). Food Processing and Preservation, 3rd Edition.,Prentice hall of India Pvt Ltd, NewDelhi.
3.	Ramaswamy H & Marcotte M. (2006). Food Processing: Principles & Applications. Taylor & Francis.
4.	NIIR Board of Food and Technologist. (2005). Modern Technology of Food Processing and Agrobased industries, National Institute of Industrial Research, Delhi.
5..	Adams M.R. and Moss M. O (2007). Food Microbiology. New Age International.
Reference Books	
1.	Fellos PJ. (2005). Food Processing Technology: Principle &Practice 2nd Edition. CRC.
2.	Peter Zeuthen and Leif Bogh-Sorenson. (2005). Food Preservation Techniques, WoodlandPublishing Ltd, Cambridge, England.
3.	Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Pilar Cano. (2004). Novel Food Processing Technologies, CRC.
4.	Suman Bhatti, Uma Varma. (1995). Fruit and vegetable processing organizations and institutions, 1st Edition., CBS Publishing, New Delhi.
5..	MirdulaMirajkar, Sreelatha Menon. (2002). Food Science and Processing Technology Vol-2,Commercial processing and packaging, Kanishka publishers, New Delhi.
Web Resources	
1.	https://sites.google.com/a/uasd.in/ecourse/food-processing-technology
2.	https://nptel.ac.in/courses/126105015
3.	https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/
4.	food processing | Definition, Purpose, Examples, & Facts | Britannica
5.	Food Processing Technology | Food News & Views Updated Daily (foodprocessing-technology.com)

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	1	3
CO2	2	1	2	2	3
CO3	2	2	3	2	3
CO4	2	1	3	3	1
CO5	1	1	2	2	2

3- Strong 2- Medium 1- Low

Title of the Course		VACCINE TECHNOLOGY						
PART		III						
Category	SEC – VI	Year	II	Credits	2	Course Code	234403430/ 234403429	
		Semester	IV					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Learning Objectives

To provide knowledge on the basics of immunization and induction of immunity.
To learn the types of vaccines, its immunological effects and regulatory guidelines.
To learn the role of rDNA in vaccine technology.
To provide the knowledge on conventional to recent technology of vaccine production
To learn about ethical issues and regulations in vaccine production and clinical trials

UNIT	Details	No. of Periods for the Unit
I	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,	6
II	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.	6
III	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.	6
IV	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.	6
V	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.	6

Course Outcomes	
Course Outcomes	On completion of this course, students will be able;
CO1	Explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines.
CO2	Understand the types of vaccines.
CO3	Construct vaccine applying rDNA technology.
CO4	Formulate the strategies for developing an innovative vaccine technology with different mode of vaccine delivery.
CO5	Evaluate the regulatory issues and guidelines for the management of vaccine production.

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. etal. (2003). Immunology: A Short Course. 5th Edition, Wiley – Liss.
3.	Parham, Peter.(2005). The Immune System. 2nd Edition, Garland Science.
4.	Abbas, A.K. etal. (2007). The Cellular and Molecular Immunology. 6th Edition, Sanders / Elsevier.
5.	Weir, D.M. and Stewart, John (2000). Immunology. 8th Edition, Churchill Pvt. Ltd.
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
4.	https://www.sciencedirect.com/science/article/pii/B9780128021743000059
5.	https://www.researchgate.net/publication/313470959_Vaccine_Scaleup_and_Manufacturing

Mapping with Programme Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M									M
CO2					S					
CO3							M			M
CO4									L	M
CO5			L		M					

3- Strong 2- Medium 1- Low

Title of the Course		APICULTURE						
PART		III						
Category	SEC – VII	Year	II	Credits	2	Course Code	238203430/ 238203429	
		Semester	IV					

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
	2	-	-	2	25	75	100

Learning Objectives

- ✍ To understand the biology of honey bees.
- ✍ To study on honey bee colony establishment.
- ✍ To develop knowledge on honey extraction.
- ✍ To understand the diseases of honey bees and their control.
- ✍ To gain information on financial assistance and funding agencies for bee keeping industry.

UNIT	Details	No. of Periods for the Unit
I	Biology of Bees: Honeybee – Systematic position – Species of Honey bees – Life history of Honey bee – behaviour – swarming – Pheromone.	6
II	Social life in Bees:Bee colony – Castes – natural colonies and their yield – Types of bee hives – Structure – location, care and management.	6
III	Bee Rearing:Apiary – Care and Management – Artificial bee hives – types – construction of spaceframes – Selection of sites – Handling – Maintenance – Instruments employed in Apiary – Extraction instruments.	6
IV	Bee Economy: Honey – Composition – uses – Bee wax and its uses – yield in national and international market – Diseases of honey bees and their control methods. Economics of bee culture.	6
V	Entrepreneurship: venture – Preparing proposals for financial assistance and funding agencies – Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens.	6

Course Outcomes

Course Outcomes	On completion of this course ,students will be able;
CO1	Understand the systematic position and life history of honey bee.
CO2	Reveal the different stages and types of bees and discuss about the care and management of apiculture.
CO3	Describe the practice of bee rearing process and analyze instruments employed in apiary.
CO4	Compare and contrast the composition of honey and bee wax and interpret the yield in National and International markets.
CO5	Clarify the proposal for financial assistance and funding agencies and reveal the modern methods employed in artificial bee hives.

Text Books	
1.	Dewey M. Caron. (2013). Honey Bee Biology and Beekeeping. Revised Edition. Wicwas Press, Kalamazoo. ISBN 10: 1878075292
2.	R. A. Morse. (1993). Rearing queen honey bees. Wicwas press, NY. ISBN-10 : 1878075055
3.	Ted Hooper. (2010). Guide to Bees & Honey: The World's Best Selling Guide to Beekeeping. Northern Bee Books. Oxford. ISBN 10: 1904846513
4.	Jayashree K. V., Tharadevi C.S. and Arumugam N. (2014) Apiculture. Saras Publication
5.	Raj H. (2020). Vinesh Text Book of Apiculture. S. Vinesh and Co.
Reference Books	
1.	Dewey M. Caron. (2020). The Complete Bee Handbook: History, Recipes, Beekeeping Basics, and More,Rockridge Press. ISBN-10 : **1646119878**
2.	Joachim Petterson. (2016). Beekeeping: A Handbook on Honey, Hives & Helping the Bees, Weldon Owen.
3.	Eva Crane. (1999). The World History of Beekeeping and Honey Hunting. Routledge. India.ISBN-10 : 0415924677
4.	Pagar B. S. (2016). Textbook Of Apiculture. Sahitya Sagar.
5..	Sehgal P.K. (2018). Text Book of Sericulture, Apiculture and Entomology. Kalayani
Web Resources	
1	Bee Keeping Basics. Retrieved from:https://denton.agrilife.org/files/2013/08/beekeeping-basics.pdf
2	Beekeeping as an Entrepreneurship, Retrieved from: https://lupinepublishers.com/agriculture-journal/pdf/CIACR.MS.ID.000270.pdf
3	Raising Bumble Bees at Home: A Guide to Getting Started. Retrieved from: https://www.ars.usda.gov/ARSUserFiles/20800500/BumbleBeeRearingGuide.pdf
4	Apiculture – Biology for Everybody (homeomagnet.com)
5	Apiculture: Introduction to Apiculture (iasri.res.in)

Mapping with Programme Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	S	S							
CLO2	S	S		S	S				
CLO3		S		S	M				
CLO4				S	M				
CLO5					S				
TOTAL									

3- Strong 2- Medium 1- Low

SEMESTER – 5

Title of the Course		**BACTERIOLOGY AND MYCOLOGY**						
PART		**III**						
Category	Core – 9	**Year**	III	**Credits**	4	**Course Code**		
		Semester	V					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	--	5	25	75	100

Learning Objectives	
LO1	Understand the role of normal flora and pathogenic microbes of various diseases and clinical microbiological techniques.
LO2	Basic knowledge about Gram positive pathogenic bacteria and their epidemiology
LO3	Acquire knowledge about Gram negative pathogenic bacteria and nosocomial infections
LO4	Comprehensive knowledge about medically important, its classification and its significance
LO5	Gain knowledge about the general characteristics and mode of action of various antibacterial agents

UNIT	**Details**	**No. of Periods for the Unit**
I	History, Classification of Medically Important Microbes, Koch's, and River's postulates-A brief account on the normal microbial flora of the healthy human body – Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases and epidemiology. Collection and transport of clinical specimens for bacterial and fungal infections.	**15**
II	Medically important Gram Positive infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases (a) Streptococcal infections (*Streptococcus pyogenes*), (b) Staphylococcal infections (*Staphylococcus aureus*), (c) Tetanus (*Clostridium tetani*)(d) Diphtheria (*Corynebacteriumdiphtheriae*) (e) Anthrax (*Bacillus anthracis*) (f) Tuberculosis (*Mycobacterium tuberculosis*), (g) Leprosy (*Mycobacterium leprae*).	**15**
III	Medically important Gram-Negative infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases (a) Meningitis (*Streptococcus pneumoniae*) (b) typhoid (*Salmonella typhi*) (c) cholera (*Vibrio cholerae*) (d) bacillary dysentery (*Shigella dysenteriae*); Sexually Transmitted disease (syphilis–*Treponemapallidum.*Gonorrhoea - *Neisseria gonorrhoeae*); Nosocomial infections – definition, importance, and their control (*Pseudomonas aeruginosa*).	**15**
IV	Medically important Fungi - Classification of medically important fungi; Superficial mycoses: PityriasisVersicolor; TineaNigra; Cutaneous mycoses: *Microsporum* spps., *Trichophyton* spps., and *Epidermo phytonfloccosum*. Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses - Blastomycosis; Histoplasmosis; Opportunistic Infections -Candidiasis; Cryptococcosis; Mycotoxins: Aflatoxin	**15**

V	Antimicrobial agents -General characteristics and mode of action of Antibacterial agents. Modes of action with an example for each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.	**15**

COs	**Course Outcomes** On completion of this course, students will;
CO1	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.
CO2	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.
CO3	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.
CO4	Comprehend human-fungal interaction, which can be applied to obtain in-depth knowledge on fungal diseases and the mechanism behind the disease process.
CO5	Explain the types of mycoses caused in humans and categorize the modes of infection, pathogenesis, and treatment with introduction to mycotoxins.

Text Books (Latest Editions)	
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 JayaramPanicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.
5.	JagdishChander (2018). Textbook of Medical Mycology, 4th edition, Jaypeebrothers medical publishers.
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.
Web Resources	
1.	http://textbookofbacteriology.net/nd
2.	https://microbiologysociety.org/members-outreach-resources/links.html
3.	http://mycology.cornell.edu/fteach.html
4.	https://www.adelaide.edu.au/mycology/
5.	https://www.isham.org/mycology-resources/mycological-links

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1	3		3		3		3			2	3
CO 2	3		3		3		3			2	3
CO 3	3		3		3		3			2	3
CO 4	3		3		3		3			2	3
CO 5	3		3	2	3	2	3		3	2	

3-Strong 2-Medium 1-Low

Title of the Course		VIROLOGY AND PARASITOLOGY						
PART		III						
Category	Core – 10	Year	III	Credits	4	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	-	5	25	75	100

Learning Objectives	
LO1	To learn the methods of classification, cultivation and purification of viruses
LO2	To explain the Viruses life cycle, pathogenesis and symptoms
LO3	To outline the emerging viral infection, diagnosis and its vaccines
LO4	To understand the structure and life cycle of parasites
LO5	To provide the knowledge on collection and analysis of specimens

UNIT	Details	No. of Periods for the Unit
I	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.	15
II	Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (Flavi virus), Picorna viruses (Polio virus and Rhinovirus), Hepatitis viruses (HAV, HBV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Measles virus), Pox viruses (Variola), Herpes viruses (Herpes simplex), Adeno viruses, Rota viruses and HIV viruses. Oncogenic viruses (Human Papilloma virus): Introduction, characteristics of transformed cells, mechanism of viral oncogenesis and clinical manifestations.	15
III	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.	15
IV	General introduction to Medical Parasitology, Classification of medically important parasites. Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases caused by the following organisms: *Entameobahistolytica*, flagellates (*Giardia lamblia, Leishmaniadonovani*), Sporozoa-*Plasmodium*spps.	15
V	Introduction to Helminthes, Platyhelminthes – *Taenia* – *Fasciola* – Nemathelminthes – Ascaris— *Enterobius* – *Wuchereria* – *Dracanculus.* Collection, transport and examination of specimen Laboratory techniques in parasitology Examination of faeces for ova and cyst by direct wet mount and iodine wet mount, Concentration methods (Floatation and Sedimentation techniques), Examination of blood for parasites. Cultivation of parasites.	15

COs	Course Outcomes On completion of this course, students will;
CO1	Understand the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.
CO2	Knowledge of basic and general concepts of causation of disease by the pathogenic microorganisms and various parameters of assessment of their severity and the methods of diagnosis.
CO3	Insights to treatment options of viral diseases.
CO4	Knowledge about the importance of protozoans in the intestine.
CO5	Knowledge of Nematodes as infectious agent

	Text Books
1.	S., Rajan(2007). Medical microbiology, MJP publisher.
2.	JeyaramPaniker, C.K. (2006). Text Book of Parasitology Jay Pee Brothers,NewDelhi.
3.	AroraD.R. and AroraB. (2002). Medical Parasitology, 1st Edition CBS Publishers & Distributors, New Delhi.
4.	Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta.
5.	Parija S. C. (1996). Text Book of Medical Parasitology.4th edition, Orient Longman, AllIndia Publishers & Distributors.
	Reference Books
1.	Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19th Edition. Lange Medical Publications, U.S.A.
2.	Ananthanarayan, R. and JeyaramPaniker, 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
3.	https://www.sciencedirect.com/science/article/pii/S2211753919300193
4.	https://cmr.asm.org/content/30/3/811
5.	https://www.nejm.org/doi/full/10.1056/NEJMoa1811400

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO 1					2					2	
CO 2					2					2	
CO 3					2					2	
CO 4					2					2	
CO 5					2					2	

3-Strong 2-Medium 1-Low

Title of the Course		LAB IN MEDICAL MICROBIAL TECHNOLOGY						
PART		III						
Category	Core - 11	Year	III	Credits	4	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	5	5	25	75	100

Learning Objectives

LO1	To familiarize students with medical microbiology techniques and technical knowledge on collection and processing of clinical samples.
LO2	To learn the techniques for isolation and identification of bacterial pathogens.
LO3	To gain expertise in various techniques of clinically important viral pathogens and their identification.
LO4	To get acquainted with medically important fungi and their metabolism.
LO5	To categorize parasites and understand their role in infections.

Exercise

1. Collection and Transport of Clinical specimens.
2. Simple, Differential and Special staining of Clinical materials.
3. Culture techniques used to isolate microorganisms.
4. Identification of bacterial pathogens by their biochemical reactions.
5. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.
6. Isolation of Bacteriophages from Sewage and other natural sources.
7. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining).
8. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining.
9. Slide culture techniques for fungal Identification
10. Identification of Dermatophytes.
11. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.
12. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs.
13. Concentration techniques of stool specimen – Floatation and Sedimentation methods.
14. Examination of blood for Malarial parasites – thin and thick smear preparations.
15. Identification of Medically important parasites in slides / specimens as spotters.

COs	Course Outcomes On completion of this course, students will;
CO1	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques
CO2	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.
CO3	Understand experimental tools used to cultivate and characterize clinically important viruses and bacteriophages
CO4	Elucidate clinically important fungi.
CO5	Investigate Parasites of medical importance and identify them from clinical specimens.

Text Books	
1.	Dubey, R.C. and Maheswari, D.K. (2020). S. Chand Publishers. ISBN-13: 978-8121921534, ISBN-10: 8121921538.
2.	K.R. Aneja (2017). Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. 5th Edition. New Age International Publishers. ISBN-10: 9386418304, ISBN-13: 978-9386418302.
3.	Collee, J.G., Fraser, A.G., Marnion, B.P. and Simmons, A. (1996). Mackie & McCartney Practical Medical Microbiology. 14th Edition. Elsevier. ISBN-10: 813120393X, ISBN-13: 978-8131203934.
4.	Prince CP (2009). Practical Manual of Medical Microbiology, Ist edition, Jaypee digital publishing.
5.	James H. Jorgensen, Karen C. Carroll, Guido Funke, Michael A. Pfaller, Marie Louise Landry, Sandra S. Richter, David W. Warnock (2015). Manual of Clinical Microbiology, 11th Edition, ASM press
Reference Books	
1.	Patricia M. Tille (2021). Bailey & Scott's Diagnostic Microbiology, 15th Edition. Elsevier. ISBN-10: 0323681050, ISBN-13: 978-0323681056.
2.	Monica Cheesbrough (2006). District Laboratory Practice in Tropical Countries. Part 1. 2nd Edition. Cambridge University Press. ISBN-10: 0521171571, ISBN-13: 978-0521171571.
3.	Michael A. Pfaller (ed.) (2015). Manual of Clinical Microbiology. Vol. 1 and 2. 11th Edition. ASM Press. ISBN-10: 9781555817374, ISBN-13: 978-1555817374.
4.	Josephine A. Morello, Paul A. Granato and Helen EckelMizer (2002). Laboratory Manual and Workbook in Microbiology. 7th Edition. The McGraw Hill Company. ISBN: 0-07-246354-6.
5.	Rowland, S.S., Walsh, S.R., Teel, L.D. and Carnahan, A.M. ((1994). Pathogenic and Clinical Microbiology: A Laboratory Manual. Lippincott Williams & Wilkins. ISBN-10: 0316760498, ISBN-13: 9780316760492.
Web Resources	
1.	https://www.microcarelab.in/media/microcarelab.in/files/Sample-Collection-Manual.pdf
2.	http://ssu.ac.ir/cms/fileadmin/user_upload/Daneshkadaha/pezeshki/microb/file_amuzeshi/Lab_QA_Microbiology_QA.pdf
3.	https://www.academia.edu/11977315/Basic_Laboratory_Procedures_in_Clinical_Bacteriology
4.	https://cmr.asm.org/content/31/3/e00062-17.full.pdf
5.	https://microbiologyinfo.com/techniques-of-virus-cultivation/

Title of the Course		RECOMBINANT DNA TECHNOLOGY						
Part		III						
Category	EC – 5.1	Year	III	Credits	3	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	-	5	25	75	100

Learning Objectives	
LO1	Understand the principles of rDNA technology.
LO2	Illustrate the molecular tools employed in gene cloning.
LO3	Discuss the importance of various molecular techniques and their importance in Biotechnology.
LO4	Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
LO5	Examine recent trends in genetic engineering and its application in human welfare.

UNIT	Details	No. of Periods for the Unit
I	Milestones in rDNA Technology-Gene Manipulation-Steps involved in Gene Cloning. 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 Linkers and Adapters.	15
II	Artificial Gene Transfer methods- Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications - Plasmid Based Vectors. Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Phagemid, Cosmid, BAC and YAC and SV40. Screening of Recombinants. Genomic DNA and cDNA library-Construction and Screening.	15
III	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, CRISPRs. Gene Targeting-Knock-in &Knock-outs. DNA Finger Printing,	15
IV	Plant Biotechnology – Media, Growth Regulators -Explant Culture-Micro propagation- Callus and Protoplast Culture-Production of Bio-Active Secondary Metabolites by Plant Tissue Culture - Agrobacterium and Crown Gall Tumors, TiPlasmid and RiPlasmid. Transgenic Plants– BtCotton and Golden Rice.	15
V	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. Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy-Human Gene Therapy- Germline (Cystic Fibrosis) and Somatic Cell (Adenosine deaminase) Therapy– Vectors in Gene Therapy-Viral and Non-Viral Vectors.	15

COs	Course Outcomes On completion of this course, students will be able;
CO1	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.
CO2	Discuss the various cloning vectors and their applications.
CO3	Assess the usage and advantages of molecular tools.
CO4	Explain plant and animal tissue culture protocols and gene transfer mechanism.
CO5	Elucidate and understand the application of genetic engineering and gene therapy.

Text Books	
1	Brown T.A.(2016). Gene Cloning and DNA Analysis. 7thEdition . 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
References Books	
1	Maloy S. R., Cronan J.E. Jr. and FreifelderD.(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). iGenetics - 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 with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				3	1	3	3	2	3		
CO2				3	1	3	3	2	3		
CO3				3	1	3	3	2	3		
CO4				3	1	3	3	2	3		
CO5				3	1	3	3	2	3		

3-Strong 2-Medium 1-Low

Title of the Course		Group Project with Viva - Voce						
Part		III						
Category	CC - XII	Year	III	Credits	4	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	5	5	40	60	100
Learning Objectives								

Group projects enable students to get hands-on training in microbiological techniques needed for research. Thus the students can share diverse perspectives resulting in pooling of knowledge and skills. Group work may approach tasks and solve problems in novel, interesting ways, thereby converting established theoretical concepts to practical skills. If structured properly, it will promote team work and collaboration. Group projects also will help students to choose a research design, solve real life problems and benefit the society at large. Thus group project facilitates the students to convert ideas to practice thereby creating a research culture among students.

Guidelines for group project:

A research problem need to be selected based on creative ability and scientific thought.

A brief description of the problem needs to be given.

Hypothesis statement should be framed.

Objectives by which the project work is to be carried out should be clearly stated.

Methodology has to be designed to test the hypothesis.

Results obtained need to be replicable.

Documented report has to be submitted on completion of the project.

Evaluation

	Internal	External	Total
Report	15	50	65
Viva	10	25	35
Total	25	75	100

Title of the Course		BIOSAFETY AND BIOETHICS						
Part		III						
Category	EC – 6.1	Year	III	Credits	3	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	-	5	25	75	100

Learning Objectives	
LO1	To create a research environment - encourage investigation, analysis and studying the bioethical principles, values, concepts, and social and juridical implications contained in the Universal Declaration on Bioethics and Human
LO2	Rights in order to assist their application and promotion in the areas of science, biotechnology and medicine.
LO3	To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.
LO4	To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
LO5	To understand the importance of IPR, Patents and Patent laws.

UNIT	Details	No. of Periods for the Unit
I	Basics of Biosafety - Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).	15
II	Hazardous materials in Biotechnology - Categories of Waste in the Biotechnology 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.	15
III	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.	15
IV	Introduction and need of Bioethics - its relationship with other branches, Ethical implications of biotechnological products and techniques. Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.	15
V	IPR, Patents and Patent laws - Intellectual property rights-TRIP-Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law. Legal development-Patentable subjects and protection in biotechnology. The patenting of living organisms.	15

COs	Course Outcomes On completion of this course, students will be able;
CO1	Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment
CO2	Develop stratagems for the use of genetically modified organisms and Hazardous materials
CO3	Develop skills of critical ethical analysis of contemporary moral problems in medicine and health care.
CO4	Analyze and respond to the comments of other students regarding philosophical issues.
CO5	Pave the way for the students to catch up Intellectual Property (IP) as a career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur

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	DeepaGoel and ShominiParashar, (2013). IPR, Biosaftey and Bioethics- 1st Edition, Pearson education: Chennai, ISBN-13: 978-8131774700
4	Rajmohan Joshi (2006). Biosafety and Bioethics. Gyan Books publisher.
5	Sateesh. M.K. (2013). Bioethics and Biosafety. i.K. International pvt,Ltd.
References 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, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, 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 Organisation. (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 with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3				2			2
CO2	3		3	3						
CO3	3					3				
CO4			3	3						
CO5	3						2			3

3-Strong 2-Medium 1-Low

Title of the Course		Internship / Industrial Training						
Part		IV						
Category		Year	III	Credits	2	Course Code		
		Semester	V					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		--	-	--	--	25	75	100

The Students will undergo minimum 7 days of summer internship/industrial activity training in subject related organization after their Fourth semester for UG examinations (Summer Vacation).

The student will be allotted a faculty for guiding the internship/industrial activity. After the completion of the internship/industrial activity, he/she has to document the work, and submit the report along with the Certificate from the concern organization (2 copies – one to the Controller's Office, one to the Department Library)

The External viva voce examination will be conducted on or before last working day of the Third semester for PG and Fifth semester for UG.

Evaluation of internship/industrial Training

	Internal	External	Total
Internship Report	15	50	65
Viva	10	25	35
Total	25	75	100

SEMESTER – 6

Title of the Course		**ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**						
PART		**III**						
Category	**Core – 12**	**Year**	III	**Credits**	4	**Course Code**		
		Semester	VI					
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	**CIA**	**External**	**Total**
		5	-	-	5	25	75	100

Learning Objectives	
LO1	To discuss the distribution and association of microorganism in various ecosystems and to know about the role of microorganism in water pollution and water quality.
LO2	To acquire knowledge about the role of microorganism in water pollution and water quality
LO3	Gain knowledge about microbes as bio fertilizers and the aspects of application.
LO4	To learn about the process of solid waste management and sewage water treatment.
LO5	Gain knowledge on various plant diseases and pathogens

UNIT	**Details**	**No. of Periods for the Unit**
I	Microorganisms and their Habitats: Structure and function of ecosystems **Terrestrial Environment:** Soil profile and soil microflora, Microbial succession in decomposition of soil organic matter. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. **Aquatic Environment:** Microflora of fresh water and marine habitats, factors influencing microbial growth in the aquatic environments. **Atmosphere:** Aeromicroflora and dispersal of microbes, Assessment of air quality, Enumeration of microorganism in air, Air sanitation.	**15**
II	Water potability: Sources and types of water surface, ground, stored, distilled, mineral and de-mineralized water and their pollution, biological indicators of water Pollution, Eutrophication. Conventional Bacteriological standards of Water Quality, MPN index, coliform test, Membrane filtration. BOD, COD. Advanced molecular methods for water analysis. Water borne diseases. Central Pollution Control Board (CPCB) standards**.**	**15**
III	Microbial Interactions: Rhizosphere microflora. Nitrogen fixation (Symbiosis, non Symbiosis) Brief account of microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. General account and Significance of Biofertilizers – Rhizobium Mass production and biocontrol agents – Bacterial (BGA) ,VAM. Biocontrol agents – Bacterial (Bt) , viral (Baculo), fungal(Trichoderma)	**15**
IV	Waste treatment and bioremediation**:** Solid waste management: Sources and types of solid waste, composting, vermin composting, production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and scope of bioremediation. Degradation of hydrocarbons, oil spills, heavy metals – Chromium and xenobiotics – PCB.	**15**

V	Plant pathology: Mode of entry of pathogens, suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterial diseases –Blight of paddy. Viral disease – TMV. Fungal disease- red rot of sugarcane. Plant disease management.	**15**

COs	**Course Outcomes** On completion of this course, students will be able;
CO1	Describe about the structure and function of ecosystems and understand the role of microbes in various environments
CO2	Identify the cause of water pollution, and perform methods to assess the quality of water.
CO3	Explain the production of biofertilizers and biopesticides.
CO4	Explain about waste treatment process and microbial decomposition and bio-remediation process.
CO5	Describe about plant diseases caused by microbes and acquire a clear idea on plant pathogenic interaction

	Text Books (Latest Editions)
1.	Joseph C. Daniel. (2006). Environmental aspects of Microbiology 2nd Edition. BrightSun Publications.
2	Pradipta. K.M. (2008). Textbook of Environmental Microbiology.I.K.Publishing. House.
3	Ramanathan, and Muthukaruppan SM. (2005). Environmental Microbiology. OmSakthi Pathipagam, Annamalai Nagar.
4	K. Vijaya Ramesh.(2004).Environmental Microbiology. 1st Edition. MJP Publishers.
5	SubbaRao.N.S.(2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt.Ltd.
	Reference Books
1.	Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.
2.	EcEldowney S, Hardman D.J., Waite D.J., Waite S.(1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.
3.	Mitchel, R.(1992). Environmental Microbiology. Wiley –John Wiley and Sons. Inc. Publications, New York.
4.	Clescri, L.S., Greenberg, A.E. and Eaton, A.D.(1998). Standard Methods for Examination of Water and Wastewater, 20thEdition. American Public Health Association.
5.	Atlas, R.M. and Bartha, R.(1992). Microbial Ecology: Fundamentals andApplications, 2nd Edition. The Benjamin / Cummings Publishing Co., Redwood City, CA.
	Web Resources
1.	https://nptel.ac.in/courses/126105016
2	https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236
3	https://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal.htm
4	https://plantpath.cornell.edu/labs/enelson/PDFs/Hill_et_al_2000.pdf
5	https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2389.2005.00781.x

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2				2	3	3	3	3		
CO3	3						3	3		
CO4						3				
CO5	2				2					

3- Strong 2- Medium 1- Low

Title of the Course		FOOD, DAIRY AND PROBIOTIC MICROBIOLOGY						
PART		III						
Category	Core – 13	Year	III	Credits	4	Course Code		
		Semester	VI					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		5	-	-	5	25	75	100

Learning Objectives

LO1	To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.
LO2	To gain information about microflora of milk, give an insight into various types of food borne diseases and their prevention.
LO3	To study about the production of fermented dairy products
LO4	To impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits
LO5	To create a sustainable environmentally and technologically advanced dairy farm

UNIT	Details	No. of Periods for the Unit
I	Food as a substrate for Micro Organisms - 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.	**15**
II	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 sanitation - plant sanitation - Employees' health standards. Regulatory Agencies &criteria for food safety - FASSI and BIS.	**15**
III	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.	**15**
IV	Food fermentations: Indian Pickles, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese). Oriental fermented foods - Miso. Idli Spoilage and defects of fermented dairy products - genetically modified foods (Corn, Pappaya)	**15**
V	Probiotic microorganisms, concept, definition safety of probiotic microorganisms and its legal status of probiotics. Screening methods, health benefits of Probiotics. Application of bacteriocins in foods. Biopreservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention.	**15**

COs	Course Outcomes On completion of this course, students will be able;
CO1	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,
CO2	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique
CO3	Gain information about spoilage of milk and its products and its antimicrobial properties
CO4	Learn about the various fermented product and its various stage spoilage
CO5	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits

	Text Books (Latest Editions)
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 CBS Publishers and Distributors, Delhi, India.
2.	Prescott, Harley and Klein Wim.(2008). Microbiology, 7th Edition McGraw Hill Publications.
3.	Robinson, R. K.(2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products (Third Edition), A John Wiley & Sons, Inc., New York.
4.	Yuankunlee,Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.
5.	DharumauraiDhansekaran, AlwarappanSankaranarayanan. (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 with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3	3		2
CO2					3					2
CO3					3		2			
CO4							3	3		2
CO5					2	2				

3- Strong 2- Medium 1- Low

Title of the Course		LAB IN FOOD AND AGRICULTURAL MICROBIOLOGY						
PART		III						
Category	Core – 14	Year	III	Credits	4	Course Code		
		Semester	VI					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		-	-	5	5	25	75	100

Learning Objectives	
LO1	Toassess the water quality and potability.
LO2	To acquire knowledge on enumeration of bacteria from milk and milk quality analysis
LO3	To investigate various extracellular enzyme producers in soil and to gain knowledge on preparation of biofertilizers
LO4	Improve knowledge on plant pathogens
LO5	To acquire knowledge on preparation of probiotics and prebiotics

Details

1. Physical, chemical, and microbiological assessment of water and potability test forwater.
   - o Physical a – Color, pH,
   - o Chemical - alkalinity, acidity, DO, BOD, COD
   - o Microbiological – MPN index (Presumptive, Completed and Confirmatorytest)
2. Study of air microflora by settle plate method.
3. Isolation and identification of bacteria and fungi from fruits and vegetables.
4. Direct microscopic count of milk.
5. Methylene blue reductase test and Resazurin test.
6. Microbiological examination of milk by SPC.
7. Isolation of extracellular enzyme producers –Amylase, protease, lipase
8. Microbiological assay of antibiotics by cup plate method and other methods
9. Isolation of *Rhizobium*/ *Azotobacter*/ phosphate solubilizing organisms
10. Preparation of biofertilizers – Demonstration
11. Study of plant pathogens- Tikka Disease, Red rot of sugarcane, Citrus canker, Blight of paddy.
12. Study of fungi - *Mucor,Curvularia, Alternaria, Rhizopus, Aspergillus*
13. Isolation of constituent flora of fermented milk.
14. Growth of probiotic LAB in broth, milk and whey.
15. Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink.
16. Effect of prebiotics on the growth of LAB in milk and broth.
17. Survivability of probiotic organisms in fermented milks.
18. Antimicrobial potential of the functional dairy products.

COs	Course Outcomes On completion of this course, students will be able;
CO1	Assess the microbial quality of water and relate the experimental results to the prescribed standards by the statutory bodies
CO2	Evaluate the quality of milk and enumerate bacteria in milk by standard plate count method
CO3	Identify extracellular enzyme producing and nitrogen fixing microorganism form soil and to prepare a biofertilizer.
CO4	Identify various plant pathogenic bacteria
CO5	Synthesize probiotic fermented milks using microorganisms

	Text Books
1.	Cappucino J and Sherman N.(2010). Microbiology: A Laboratory Manual. 9th Edition. Pearson Education Limited.
2.	Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Publications.
3.	R C Dubey and D K Maheswari.(2002). Practical Microbiology. S. Chand Publishing.
4.	Neelima Garg, K.L. Garg, K.G. Mukerji (2010).Laboratory Manual of Food Microbiology, Wiley publication
5.	Aneja, KR.(2010). Experiments in Microbiology, Plant pathology and Biotechnology. New Age International (P) Limited.
	Reference Books
1.	Christon J. Hurst Editor in Chief, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach (2007). Manual of Environmental Microbiology, Third Edition,Wiley publication.
2.	James G Cappucino and Natalie Sherman.(2016). Microbiology – A laboratory manual. 4th Edition. The Benjamin publishing company, New York.
3.	Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai 2016). Manual of Environmental Microbiology, 4th Edition,ASM press.
4.	Burns, Richard G (2005). Environmental MicrobiologyA Laboratory Manual, 2nd Edition .Lippincott Williams & Wilkins, Inc.
5.	Ian Pepper, Charles Gerba, Jeffrey Brendecke (2004). Environmental Microbiology-A laboratory manual, Elsevier.
	Web Resources
1.	https://micobenotes.com/fields-of-microbiology/
2.	https://bio.libretexts.org
3.	https://www.google.com
4.	https://www.sfamjournals.onlinelibrary.wiley.com
5.	https://www.degruyter.com

Title of the Course		PHARMACEUTICAL MICROBIOLOGY						
PART		III						
Category	EC – 7.1	Year	III	Credits	3	Course Code		
		Semester	VI					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		4	-	-	4	25	75	100

Learning Objectives	
LO1	To provide the knowledge on basics of chemotherapy
LO2	To learn the assays and testing methods of antibiotics.
LO3	To gain information about spoilage of pharmaceutical products
LO4	To provide the knowledge on drug discovery and clinical trials
LO5	To learn about regulations in pharmaceutical industry

UNIT	Details	No. of Periods for the Unit
I	Introduction to Pharmaceutical microbiology: Ecology of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipments and their control measures; Design and layout of sterile manufacturing.	12
II	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.	12
III	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.	12
IV	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.	12
V	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.	12

COs	Course Outcomes On completion of this course, students will be able;
CO1	Learn the basics of chemotherapy and action of antibiotics
CO2	Carry out the microbiological assay of antibiotics
CO3	Analyse Microbiological standardization of Pharmaceuticals ,sterility testing of pharmaceutical products Apply sterilization in pharmaceutical industry
CO4	Evaluate the process and develop new strategies for rational drug design
CO5	Learn the Regulatory guidelines in pharmaceuticals product.

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, NiraliPrakashan.
5..	Priyatama Powar, Shital Nimbargi, VaijayantiSapre (2020). Pharmaceutical Microbiology, I edition, Technical publications.
Reference Books	
1.	Handa, S.S. and Kapoor, V.K. (2022). Pharamcognosy. 4thEdition.VallabhPrakashanPublishers,New Delhi.
2.	Kokate, C.K., Durohit, A.P. and Gokhale, S.R, (2002). Pharmacognosy. 12thedition NiraliPrakasham 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 with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2									2
CO2							2			
CO3					3			2		2
CO4									1	2
CO5			1		2					

3- Strong 2- Medium 1- Low

Title of the Course		ENTREPRENEURSHIP AND BIO-BUSINESS						
PART		III						
Category	EC – 8.1	Year	III	Credits	3	Course Code		
		Semester	VI					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		4	-	-	4	25	75	100

Learning Objectives	
LO1	Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development
LO2	Developing personal creativity and entrepreneurial initiative, adopting the key steps in the elaboration of business idea.
LO3	Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.
LO4	Explain the central components of successful business strategies in biotechnology, and create a business plan.
LO5	Understand the various funding resources and develop as Entrepreneur

UNIT	Details	No. of Periods for the Unit
I	Bio Entrepreneurship: 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.	12
II	Entrepreneurship Opportunity in Agricultural Biotechnology: 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.	12
III	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. Biofertilizer. Single cell protein.	12
IV	Therapeutic and Fermented products: Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.	12
V	Project Management, Technology Management and Startup Schemes: Building Biotech business challenges in Indian context-biotech 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.	12

COs	Course Outcomes On completion of this course, students will be able;
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.
CO2	Analyse the business environment in order to identify business opportunities, identify the elements of success of entrepreneurial ventures, evaluate the effectiveness of different entrepreneurial strategies and interpret their own business plan.
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.
CO5	Integrate and apply knowledge of the regulation of biotechnology industries, utilize effective team work skills within an effective management team with a common objective, and gain effective team work skills, with an awareness of cultural diversity and social inclusiveness.

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 Scholorly 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 paperwhite.
Reference Books	
1.	Crueger, W, and Crueger. A.(2000). Biotechnology: A Text Book of Industrialmicrobiology, 2nd Edition, Sinauer Associates: Sunderland.Mass.
2.	Paul S Teng. (2008). Bioscience Entrepreneurship in AsiaWorld 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.
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
5.	https://www.springer.com

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2		3			2		3	3		2
CO3										
CO4				3		3			3	
CO5		3					3	3		

3- Strong 2- Medium 1- Low

Title of the Course		MICROBIAL QUALITY CONTROL AND TESTING						
PART		III						
Category	EC – 8.1	Year	III	Credits	2	Course Code		
		Semester	VI					
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	CIA	External	Total
		2	-	-	2	25	75	100

Course Outcome	
CO1	To understand the use of various advanced techniques for application in the field of quality control and quality assurance.
CO2	To cultivate skills involved execution of microbiological techniques and to develop the good laboratory practices.
CO3	To ensure the food safety regulations and its standards.
CO4	To acquire knowledge on laboratory testing, Control & safety process.
CO5	To analyze microbial standards to establish the quality of food products.

UNIT	Details	No. of Periods for the Unit
I	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.	12
II	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.	12
III	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.	12
IV	Determining Microbes in Pharmaceutical Samples: Sterility testing for pharmaceutical products, Bioburden, pyrogen test, inprocess and final process control, safety and sterility test.	12
V	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.	12

COs	Course Outcomes On completion of this course, students will be able;
CO1	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.
CO2	Describe the microbiological aspects of quality control of food and pharmaceutical products.
CO3	Explain the identification of pathogenic microorganisms and good laboratory practices.

CO4	Acquire the knowledge of different sterility test for the pharmaceutical products.
CO5	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.

Text Books	
1.	W.B.Hugo&A.D.Russell. (1998). Pharmaceutical Microbiology.6th Edition. Blackwell scientific Publications.
2.	Kulkarni A. K. Bewoor V. A. ()Quality Control, Wiley India Pvt. Ltd,
3.	ChandrakantKokare (2016). Pharmaceutical Microbiology, 1st Edition, Nirali Publication.
4.	Brown.M.R.W. (2017). Microbiological Quality Assurance A Guide Towards Relevance and Reproducibility of Inocula, 1st Edition. CRC press.
5	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. 1ª 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)SVikas 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.
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