

A.V.V.M. Sri Pushpam College (Autonomous), Poondi – 613 503

PG & Research Department of Microbiology M.Sc., Programme in Microbiology OUTCOME BASED EDUCATION - CHOICE BASED CREDITSYSTEM

SCHEME OF PROGRAMME AND SYLLABUS (For the candidates admitted from 2023-2024 onwards)

Vision and Mission of the college

Vision

To provide quality academic programmes and value oriented higher education to the rural community, equip them to encounter current regional, national and global demands upholding moral standards and intellectual competency.

Mission

- To provide conducive environment for quality teaching-learning process and innovative research.
- To bestow substantial educational experience that is intellectually, socially, and personally transformative.
- To strive to bring out the latent potentiality and core competency of the learners
- To foster the culture of research-based learning, independent academic inquiry by encouraging the students to involve in research activities ranging from hands on training, student projects, publications etc.,
- To nurture essential skills, competent minds and compassionate hearts.
- To impart a practical, demanding and overall development of the personality generated by love, consideration and care for the society.
- To serve the society by extending needful outreach programmes to the rural populace.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- Make the learners realise the transformative power of education.
- Acquire profound disciplinary, applied, integrative knowledge and intellectual competency and domain specific and generic skills.
- Pursue lifelong learning and generate innovative solutions for the problems at individual and social level.
- Create a collaborative and inclusive environment, and serve the betterment of the society with moral integrity.
- Motivate to become a committed professional with necessary ethics as a leader as well as a team player.
- **Introduction: PO & PSO**
- **Programme Outcome, Programme Specific Outcome and Course Outcome**
- Students completing this programme will be able to present their core post-graduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises.

- **PROGRAMME OUTCOMES for M.Sc., Microbiology Programme**
- **PO1: Disciplinary Knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form part of Post graduate programmes of study.
- **PO2: Critical Thinking:** Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.
- **PO3: Problem Solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real-life situations.
- **PO4: Analytical & Scientific Reasoning:** Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.
- **PO5: Research related skills:** Ability to analyze, interpret and draw conclusions from quantitative / qualitative data; and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned research perspective; develop sense of inquiry and capability for asking relevant questions / problem arising / synthesizing / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypothesis, Test / analyze / Interpret the results and derive conclusions.
- **PO6: Self-directed & Lifelong Learning:** Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn", through self-placed and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.
- **PROGRAMME SPECIFIC OUTCOMES for M.Sc., Microbiology Programme**
- **PSO1:** Acquire good knowledge and understanding, to solve specific theoretical and applied problems in different areas of the specific discipline of study.
- **PSO2:** Understand, formulate, and develop arguments logically to address issues arising in social sciences, business and other context /fields.
- **PSO3:** To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions. To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.

Curriculum Structure for PG Programmes (OBE - CBCS) - 2023

	Nature of Course	Total No. of Courses	Total marks	Total credit	Total credits for the Programme
Part – A	Core Course	13	1300	51	80 (CGPA)
	Elective Course	05	500	15	
	Extra Disciplinary Course	01	100	3	
	Core Industry Module (CIM)	01	100	3	
Part – B (i)	Skill Enhancement Course(SEC)	04	400	8	
Part – B (ii)	Ability Enhancement Compulsory Course (AECC) – Soft Skill	04	400	8	10 (Non CGPA)
	Internship / Industrial Activity	--	--	2	
	Total	28	2800	90	90
	Value Added Course (VAC)	01	100	--	
	Extra Credit Course - MOOC / Field visit / Hands on Training	--	--	Max: 4	

Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

Course Structure: M.Sc. Microbiology (OBE- CBCS 2023)

S. No.	Semester	Category	Course Code	Title of the Course	Maximum Marks			Minimum Marks for Pass			Hours/Week	Credits
					CIA	EE	Total	CIA	EE	Total		
1	I	Core I	23P1MBC1	General Microbiology and Microbial Diversity	25	75	100	10	30	50	6	4
2		Core II	23P1MBC2	Immunology Immunomics and Microbial Genetics	25	75	100	10	30	50	5	4
3		Core III	23P1MBCP1	Practical I - General Microbiology and Microbial Diversity, Immunology Immunomics and Microbial Genetics	25	75	100	10	30	50	5	4
4		Elective I	23P1MBEL1A/ 23P1MBEL1B	Health and Hygiene / Micro algal Technology	25	75	100	10	30	50	5	3
5		Elective II	23P1MBEL2A/ 23P1MBEL2B	Herbal technology and Cosmetic Microbiology/ Essential of Laboratory Management and Bio Safety	25	75	100	10	30	50	5	3
6		SEC 1	23P1MBSEC1	Entrepreneurship in Biobusiness	25	75	100	10	30	50	2	2
7		AECC 1	23P1MBAECC1	Communicative Skill and Personality Development	25	75	100	10	30	50	2	2
		Extra Credit	Field visit / Hands on Training			-	-	-	-	-	-	-
8	II	Core IV	23P2MBC3	Medical Bacteriology and Mycology	25	75	100	10	30	50	6	4
9		Core V	23P2MBC4	Medical Virology and Parasitology	25	75	100	10	30	50	5	4
10		Core VI	23P2MBCP2	Practical II - Medical Bacteriology and Mycology, Medical Virology and Parasitology	25	75	100	10	30	50	5	4
11		Elective-III	23P2MBEL3A/ 23P2MBEL3B	Clinical and Diagnostic Microbiology/ Bio remediation	25	75	100	10	30	50	5	3
12		Elective-IV	23P2MBEL4A/ 23P2MBEL4B	Bioinformatics / Nanobiotechnology	25	75	100	10	30	50	5	3
13		SEC 2	23P2MBSEC2	Vermitechnology	25	75	100	10	30	50	2	2
14		AECC 2	23P2MBAECC2	Language Lab	25	75	100	10	30	50	2	2

S. No.	Semester	Category	Course Code	Title of the Course	Maximum Marks			Minimum Marks for Pass			Hours/Week	Credits	
					CIA	EE	Total	CIA	EE	Total			
15	III	Core VII	23P3MBC5	Soil and Environmental Microbiology	25	75	100	10	30	50	6	4	
16		Core VIII	23P3MBC6	Molecular biology & Recombinant DNA technology	25	75	100	10	30	50	6	4	
17		Core IX	23P3MBCP3	Practical III - Soil and Environmental Microbiology, Molecular biology & Recombinant DNA technology	25	75	100	10	30	50	5	4	
18		CIM	23P3MBCIM	Fermentation Technology	25	75	100	10	30	50	4	3	
19		EDC	23P3MBEDC	Mushroom Cultivation Technology	25	75	100	10	30	50	5	3	
20		SEC 3	23P3MBSEC3	Organic forming and Biofertilizer Technology	25	75	100	10	30	50	2	2	
21		AECC 3	23P3MBAEC3	Research Methodology	25	75	100	10	30	50	2	2	
		Internship / Industrial Activity (Carried out in summer vacation at the end of I Year – 30 hours)										-	2
		Extra Credit	MOOC (Massive open online course)			-	-	-	-	-	-	-	-
22	IV	Core X	23P4MBC7	Food and Dairy Microbiology	25	75	100	10	30	50	6	4	
23		Core XI	23P4MBC8	Bioinstrumentation and Biostatistics	25	75	100	10	30	50	5	4	
24		Core XII	23P4MBCP4	Practical IV - Food and Dairy Microbiology, Bioinstrumentation and Biostatistics	25	75	100	10	30	50	5	4	
25		Elective V	23P4MBEL5A/ 23P4MBEL5B	Bio safety, Bioethics and IPR / Water conservation and Water Treatment Technology	25	75	100	10	30	50	5	3	
26		Core XIII	23P4MBC9PR	Project with Viva Voce	25	75	100	10	30	50	5	3	
27		SEC4	23P4MBSEC4	Microbial Quality control and Testing	25	75	100	10	30	50	2	2	
28		AECC4	23P4MBAECC4	Comprehensive Knowledge	-	100	100	-	-	50	2	2	
					Total			2800					90
			Value Add Course	Fruit and vegetable processing		-	100	100	-	50	50	SS	-
		Extra Credit	MOOC (Massive open online course)			-	-	-	-	-	-	-	

Internship/ Industrial Activity:

Students must complete in-plant training in any industry or organization where a programme-related procedure is being used, and this training must be done during the summer vacation at the end of I Year. A minimum of 30 hours should be spent on training. Students must submit a report on their training together with a certificate from the relevant industry or organization authority.

Ability Enhancement Compulsory Course (AECC):

(Communicative Skill and Personality Development, Language Lab, Research Methodology and Comprehensive Knowledge)

Mode of Assessment for these courses is Viva-Voce examination.

Components of Evaluation:

Internal Marks : 25

External Marks : 75

Total 100

Field visit / Hands on Training:

In order to achieve experiential learning, these programmes with a minimum of 15 hours of contact time are offered as Extra Credit Courses in the I Semester. Evaluation of visit report will be held at the end of II Semester.

Components of Evaluation:

Internal Marks 25

External Marks : 75

Total 100

MOOC:

Massive Open Online Course is offered in the III and IV Semester as an Extra Credit Course. Students can avail any one or more of the courses available in MOOC to equip their skill and knowledge themselves. To receive the extra credit, students must provide their MOOC course completion certificate at the end of the second year.

Skill Enhancement courses (SEC) offered by the Microbiology Department

1. Entrepreneurship in Biobusiness
2. Vermitechnology
3. Organic farming and Biofertilizer Technology
4. Microbial quality control and Testing.

Extra Disciplinary Course (EDC) offered by the Microbiology Department

Mushroom Cultivation Technology

Value Added Course offered by the Microbiology Department:

Fruit and vegetable processing will be conducted for II PG students as a certificate Course

Bloom's Taxonomy based Assessment pattern

Bloom's category	Section	Choice	Marks	Total
K1 to K6	A	Compulsory	10 x 2 = 20	75
	B	Either / Or	5 x 5 = 25	
	C	3 out of 5	3 x 10 = 30	

SECTION – A (10 x 2 = 20)

Answer All the questions

(Two Questions from each units)

CO	K Level	Q. No.	Questions
		1.	
		2.	
		3.	
		4.	
		5.	
		6.	
		7.	
		8.	
		9.	
		10.	

SECTION – B (5 x 5 = 25)

Answer All the questions

(One Question from each unit)

		11(a).	
(OR)			
		11(b).	
		12(a).	
(OR)			
		12(b).	
		13(a).	
(OR)			
		13(b).	
		14(a).	
(OR)			
		14(b).	
		15(a).	
(OR)			
		15(b).	

SECTION – C (3 x 10 = 30)

Answer ANY THREE questions

(One Question from each unit)

		16.	
		17.	
		18.	
		19.	
		20.	

OBE QUESTION PATTERN

Total Marks: 75

Bloom's Taxonomy Action Verbs

K1 Remember	K2 Understand	K3 Apply	K4 Analyze	K5 Evaluate	K6 Create
<ul style="list-style-type: none"> • Choose • Copy • Define • Describe • Discover • Duplicate • Enumerate • Examine • Find • How • Identify • Label • List • Locate • Match • Memorize • Name • Omit • Recall • Recognize • Relate • Select • Show • Spell • State • Tabulate • Tell • What • When • Where • Which • Who • Why 	<ul style="list-style-type: none"> • Associate • Classify • Compare • Contrast • Convert • Demonstrate • Describe • Differentiate • Discuss • Distinguish • Estimate • Explain • Express • Extend • Identify • Illustrate • Indicate • Infer • Interpret • Outline • Paraphrase • Predict • Relate • Rephrase • Show • Summarize • Translate 	<ul style="list-style-type: none"> • Apply • Build • Calculate • Change • Choose • Complete • Construct • Demonstrate • Develop • Discover • Dramatize • Experiment • Identify • Interview • Interpret • Illustrate • Make use of • Manipulate • Model • Modify • Organize • Paint • Plan • Prepare • Produce • Relate • Select • Show • Sketch • Solve • Use • Utilize 	<ul style="list-style-type: none"> • Advertise • Appraise • Analyze • Assume • Break down • Categorize • Classify • Compare • Conclusion • Connect • Contrast • Differentiate • Discover • Dissect • Distinguish • Discriminate • Divide • Examine • Explain • Function • Inference • Inspect • List • Motive • Order • Point out • Prioritize • Relationships • Select • Separate • Simplify • Subdivide • Survey • Take part in • Test for • Theme 	<ul style="list-style-type: none"> • Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Convince • Criteria • Criticize • Decide • Deduct • Defend • Determine • Discriminate • Estimate • Evaluate • Explain • Find errors • Grade • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Order • Predict • Prioritize • Prove • Rank • Rate • Recommend • Reframe • Select • Summarize • Support • Value 	<ul style="list-style-type: none"> • Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Generalize • Hypothesize • Imagine • Improve • Integrate • Invent • Make up • Maximize • Minimize • Modify • Originate • Organize • Plan • Predict • Prepare • Produce • Propose • Rearrange • Rewrite • Role-play • Solution • Solve • Substitute • Write

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
I	23P1MBC1	General Microbiology and Microbial Diversity	6	4
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability		√	Addresses Professional Ethics	
Addresses Human Values				
Course Objectives				
1	Acquire knowledge on the principles of different types of microscopes and their applications.			
2	Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.			
3	Exemplify, isolate and cultivate microalgae from diverse environmental sources.			
4	Explain various pure culture techniques and discuss sterilization methods.			
5	Discuss the importance and conservation of microbial diversity.			
SYLLABUS				
UNIT	Content			No. of Hours
I	History and Scope of Microbiology. Microscopy – Principles and applications. Types of Microscopes - Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry – Stage, Ocular and its applications.			18
II	Bacterial Structure, properties and biosynthesis of cellular components – Cell wall, cell membrane, flagella, pili, structure of spore - endospore structure and types. Bacterial photosynthetic pigments. Growth and nutrition - Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.			18
III	Actinomycetes and Fungi - Distribution, morphology, classification, reproduction and economic importance, -life cycle <i>Saccharomyces-Aspergillus</i> Algae - Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Life cycle - <i>Chlamydomonas</i> , (Green algae), <i>Nostoc</i> (Cyanobacteria) <i>Ectocarpus</i> , (Brown algae), <i>Polysiphonia</i> , (Red algae).			18
IV	Microbial techniques - Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems - Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres - National and International.			18
V	Biodiversity - Introduction to microbial biodiversity, Conservation of Biodiversity. Extremophiles – Thermophiles - Thermophilic Archaeobacteria, Methanogens, Alkaliphiles and Acidophiles - Barophiles - Halophiles - Classification, cell walls and membranes – purple membrane and physiological adaptations and molecular applications, compatible solutes, Osmoadaptation / halotolerance .			18

Text Books	
1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd.
2.	Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5 th Edition). Mc.Graw Hill. Inc, New York.
3.	Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6 th Edition). McGraw - Hill company, New York.
4.	White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5.	Dubey R.C. and Maheshwari D. K. (2009). Textbook of Microbiology. S. Chand, Limited.
REFERENCES BOOKS	
1.	Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12 th Edition). Pearson, London, United Kingdom
2.	Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3 rd Edition). Cambridge University Press, Cambridge.
3.	Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California.
4.	Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2 nd Edition). Books / Cole Thomson Learning, UK.
5.	Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15 th Edition). Pearson.
Web Resources	
1.	http://sciencenetlinks.com/tools/microbeworld
2.	https://www.microbes.info/
3.	https://www.asmscience.org/VisualLibrary
4.	https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5.	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Pedagogy: Teaching / Learning methods

(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcome

Course Outcomes	On completion of this course, students will;	
CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	K1, K2
CO2	Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different Environmental conditions.	K2
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.	K3, K4
CO4	Create aseptic conditions by following good laboratory practices.	K4, K6
CO5	Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.	K5 & K6
Cognitive Level: K1-Remember; K2-Understanding; K3-Apply; K4 -Analyze; K5-Evaluate; K6-Create.		

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13	PO14
CO1	M			M							S			
CO2	L			S										
CO3							S	S	M					
CO4			S	S			S							
CO5					S		S	S	S					

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1MBC2	Immunology, Immunomics and Microbial Genetics	5	4
Nature of the course				
	Employability Oriented	√	Relevant to Local need	√
	Entrepreneurship Oriented	√	Relevant to regional need	√
	Skill development Oriented	√	Relevant to national need	√
	Addresses Gender Sensitization	√	Relevant to Global development need	
	Addresses Environment and Sustainability		Addresses Professional Ethics	
	Addresses Human Values	√		
Course Objectives				
1.	Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.			
2.	Describe immunoglobulin and its types. Categorize MHC and understand its significance.			
3.	Elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.			
4.	Acquire knowledge the structure DNA in prokaryotes and eukaryotes.			
5.	Explain out gene transfer studies in microbes.			
SYLLABUS				
Units	Content			No. of Hours
I	Introduction to biology of the immune system – Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Antigen processing and presentation to T- lymphocytes.			15
II	Immunoglobulins. Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, Diversity of TCR, T cell surface alloantigens, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.			15
III	Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO, Rh System and genetic basis of D- antigens. Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labelled Assay-Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry. Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants. Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology.			15

IV	Structural properties of prokaryotic and eukaryotic genome Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications- methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, gene mapping.	15
V	Gene Transfer Mechanisms- Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of <i>E. coli</i> , Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.	15
Text Books		
1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5 th Edition). Wiley-Blackwell, New York.		
2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7 th Edition). W. H. Freeman and Company, New York.		
3. Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10 th Edition). Elsevier.		
4. Malacinski G.M. (2008). Freifelder’s Essentials of Molecular Biology. (4 th Edition). Narosa Publishing House, New Delhi.		
5. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8 th Edition). Wiley India Pvt. Ltd.		
References Books		
1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3 rd Edition). Current Biology Ltd. New York.		
2. Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt’s Essential Immunology. (11 th Edition). Wiley-Blackwell.		
3. Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4 th Edition). Wiley-Blackwell.		
4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.		
5. Russell P.J. (2010). Genetics - A Molecular Approach. (3 rd Edition). Pearson New International 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. [PDF] Lehninger Principles of Biochemistry (8 th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in		
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/		

Pedagogy:Teaching / Learning methods
 (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

CO Number	On completion of this course, students will; be able to	
CO1	Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity.	K1 &K2
CO2	Justify the significance of MHC molecules in immune response and antibody production.	K2&K5
CO3	Design antibodies and evaluate immunological assays in patient samples.	K4&K5
CO4	Analyze genomic DNA of prokaryotes and eukaryotes.	K4
CO5	Summarize gene transfer mechanisms for experimental study.	K1&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze; K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S			M		M	S		S					
CO2	S			S	M	S			S					
CO3				S		S	S	S	S	M				
CO4				S	M	S	M		S	M				
CO5				S	M	S	M		S	S				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching /Cycle	No. of Credits
I	23P1MBCP1	Practical I - General Microbiology and Microbial Diversity, Immunology Immunomics and Microbial Genetics	5	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need		
Addresses Environment and Sustainability		Addresses Professional Ethics	√	
Addresses Human Values	√			
Course Objectives				
1	Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.			
2	Prepare media for bacterial growth. Discuss plating and growth measurement techniques.			
3	Acquire adequate skills to perform blood grouping and serological reactions.			
4	Provide fundamental skills in preparation, separation and purification of immunoglobulin.			
5	Apply the knowledge of molecular biology skills in clinical diagnosis.			
UNIT	Contents			No. of Hours
I	Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy – Motility of Spirochetes. Washing and cleaning of glasswares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method. Staining techniques - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.			15
II	Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities. Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.			15
III	Hematological reactions - Blood Grouping – forward and reverse, Rh Typing Identification of various immune cells by morphology – Leishman staining, Giemsa staining. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP. Detection of HBs Ag by ELISA. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID) Immunoelectrophoresis and staining of precipitin lines- Rocket immunoelectrophoresis and counter current immunoelectrophoresis.			15
IV	Demonstration -Preparation of lymphocytes from peripheral blood by density gradient centrifugation. Purification of immunoglobulin– Ammonium Sulphate Precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex.			15
V	Western Blotting – Demonstration. Isolation of genomic DNA from <i>E. coli</i> and analysis by agarose gel electrophoresis Estimation of DNA using colorimeter (Diphenylamine reagent) Separation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) UV induced mutation and isolation of mutants by replica plating technique. Plasmid DNA isolation from <i>E.coli</i> . RNA isolation from yeast. RNA estimation by Orcinol method.			15

Text Books	
1.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2.	Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.
3.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2 nd Edition). -Taylor & Francis.
4.	Rich R. R., Fleisher T. A., Shearer W. T., Schroeder H, Frew A. J. and Weyand C. M. (2018). Clinical Immunology: Principles and Practice. (5 th Edition). Elsevier.
5.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.
References Books	
1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi.
2.	Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
3.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7 th Edition). John Wiley and Jones, Ltd.
4.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd. 2012.
5.	Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2 nd Edition). Narosa Publishing Home Pvt Ltd.
Web Resources	
1.	http://textbookofbacteriology.net/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4.	[PDF] Lehninger Principles of Biochemistry (8 th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Demonstration, Experimentation, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion.)

Course Outcomes

Course outcomes	On completion of this course, students will; be able to	
CO1	Apply microscopic techniques and staining methods in the identification and differentiation of microbes.	K1,K3&K4
CO2	Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	K3&K2
CO3	Perform and evaluate immunological reactions to aid diagnosis.	K3&K5
CO4	Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	K4&K5
CO5	Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	K4&K5

Cognitive Level: K1-Remember; K2-Understanding; K3-Apply; K4 -Analyze; K5-Evaluate; K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M					S	M	M	S		M			
CO2	M					S	M	M	S		M			
CO3					S		S	M	S		M			
CO4						S	S	M	S		S			
CO5						S	S	M	S		S			

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
I	23P1MBEL1A	Elective I – Health and Hygiene	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability		Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Acquire knowledge on hygiene and live healthy.			
2	Provide insights on health laws for food safety and hygiene.			
3	Explain health, physical exercises and their importance.			
4	Illustrate mental hygiene and involved in mental hygiene.			
5	Describe the various health and health education programmes by the government.			
UNIT	Contents			No. of Hours
I	Introduction to hygiene and healthful live. Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.			15
II	Nutrition and Health – Balanced diet, Food surveillance, food fortification, adulteration and preventive measures. Health laws for food safety. Environmental and housing hygiene. Ventilation and lighting.			15
III	Physical health, physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief. International control of health, WHO. Personal hygiene, Sun bathing, Colon Hygiene. Health destroying habits and addictions - Pan, supari, ganja, drinking, smoking, tea and coffee.			15
IV	Mental hygiene - factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adulthood and old age. Mental health occupational hazards.			15
V	Health programme and health education – Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive and Child health programmes (RCH).			15
Text Books				
1.	Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4 th Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi			
2.	Swaminathan (1995) Food& Nutrition (Vol I) (2 nd Edition). The Bangalore Printing &Publishing Co Ltd., Bangalore.			
3.	Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd			
4.	Lindsay Dingwall.(2010). Personal Hygiene Care Print ISBN:9781405163071 Online ISBN:9781444318708 DOI:10.1002/9781444318708			
5.	Walter C. C. Pakes(1900). The Science of Hygiene: a Text-book of Laboratory Practice. (London: Methuen and Co.,).			
References Books				
1.	Khader V. (2000) Food, Nutrition and Health, Kalyan Publishers, New Delhi.			
2.	Srilakshmi, B. (2010) Food Science, (5 th Edition) New Age International Ltd., New Delhi.			

3.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4.	Park K. 2007, Park's text book of Preventive and Social Medicine, Banarsidas Bhanot publishers, India.
5.	Srilakshmi, 2002, Dietetics, New Age Publications, India
Web Resources	
1.	Health and Hygiene - Personal Hygiene, Community Hygiene and Diseases (vedantu.com)
2.	Chapter-32.pdf (nios.ac.in)
3.	Menstrual Health and Hygiene Guide Student Health and Counseling Services (ucdavis.edu)
4.	https://nap.nationalacademies.org/read/11756/chapter/13
5.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.) Course Outcomes	

Course Number	Course Outcomes	
	On completion of this course, students will	
CO1	Identify factors affecting health and health habits.	K1&K2
CO2	Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.	K2&K3
CO3	Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.	K4&K5
CO4	Explore Mental hygiene and maintain emotional stability.	K5
CO5	Participate in health education programmes	K3&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	L				S					M				
CO2					S					M				
CO3					S					L				
CO4					S					M				
CO5	L				S					M				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching/ Hours	No. of Credits
I	23P1MBEL1B	Elective I - Micro algal Technology	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need		
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
CO1	Characterize the different groups of algae.			
CO2	Describe the cultivation and harvesting of algae.			
CO3	Identify the commercial applications of various algal products.			
CO4	Apply microalgae for environmental applications.			
CO5	Employ microalgae as alternate fuels.			
UNIT	Details			No. of Hours
I	Introduction to Algae - General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution - Freshwater, brackish water and marine algae. Identification methods. An overview of applied Phycology. Economically important microalgae.			15
II	Cultivation of freshwater and marine microalgae - Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting of microalgae biomass.			15
III	Microalgae in food and nutraceutical applications - Algal single cell proteins. Cultivation of <i>Spirulina</i> and <i>Dunaliella</i> . Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Phycobiliproteins - production and commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications.			15
IV	Microalgae in environmental applications. Phycoremediation - Domestic and industrial waste water treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.			15
V	Microalgae as feed stock for production of biofuels - Carbon-neutral fuels. Lipid-rich algal strains - <i>Botryococcus braunii</i> . Drop-in fuels from algae - hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Biocrude synthesis from microalgae. Integrated biorefinery concept. Life cycle analysis of algae biofuels.			15
Text Books				
1.	Lee R.E. (2008). Phycology. Cambridge University Press.			
2.	Sharma O.P. (2011). Algae. Tata McGraw-Hill Education.			
3.	Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.			
4.	Lele. S.S., Jyothi Kishen Kumar (2008). Algal bio process technology. New Age International P(Ltd)			
5.	Das., Mihirkumar. Algal Biotechnology. Daya Publishing House, New Delhi.			
References Books				
1	Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.			
2	Bux F. (2013). Biotechnological Applications of Microalgae: Biodiesel and Value-added Products. CRC Press.			
3	Singh B., Baudhdh K., Bux, F. (2015). Algae and Environmental Sustainability. Springer.			

4	Das D. (2015). An algal biorefinery: An integrated approach. Springer.
5	Bux F. and Chisti Y. (2016). Algae Biotechnology: Products and Processes. Springer.
Web Resources	
1	https://www.classcentral.com/course/algae-10442
2	https://onlinecourses.nptel.ac.in/noc19_bt16/preview
3	https://freevidelectures.com/course/4678/nptel-industrial-biotechnology/46
4	https://nptel.ac.in/courses/103103207
5.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae

Pedagogy:Teaching / Learning methods
(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Acquire knowledge in the field of microalgal technology and their characteristics.	K1&K2
CO2	Identify the methods of algal cultivation and harvesting.	K3&K3
CO3	Recognize and recommend the use of microalgae as food, feed and fodder.	K3&K5
CO4	Promote microalgae in phycoremediation.	K4&K5
CO5	Compare and critically evaluate recent applied research in these microalgal applications.	K5

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S													
CO2	S					M								
CO3							S	S	S					
CO4							S		S		M			M
CO5							M	S	S					

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching /Cycle	No. of Credits
I	23P1MBLE2A	Elective II - Herbal Technology and Cosmetic Microbiology	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values				
Course Objectives				
CO1	Impart knowledge of Indian Medicinal Plants and their applications in microbiology.			
CO2	Promote the technical skills involved in preparation of different types of plant extracts.			
CO3	Explain methods to analyze the antimicrobial activity of medicinal plants.			
CO4	Acquire knowledge on cosmetic microbiology and role of microorganisms in cosmetics.			
CO5	Gain insight into pharmacopeial microbial assays and biosafety.			
UNIT	Contents			No. of Hours
I	Herbs, Herbal medicine - Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Siddha, Unani and Homeopathy.			15
II	Collection and authentication of selected Indian medicinal plants: <i>Emblica officinalis</i> , <i>Withania somnifera</i> , <i>Phyllanthus amarus</i> , <i>Tinospora cordifolia</i> , <i>Andrographis paniculata</i> , <i>Piper longum</i> , <i>Ocimum sanctum</i> , <i>Azardirchata indica</i> , <i>Terminalia chebula</i> , <i>Allium sativum</i> . Preparation of extracts- Hot and cold methods. Preparation of stock solutions.			15
III	Antimicrobial activity of selected Indian medicinal Plants: - <i>In vitro</i> determination of antibacterial and fungal activity of selected whole medicinal plants/ parts – well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.			15
IV	History of Cosmetic Microbiology – Need and Scope of cosmetic Microbiology, - Role of microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing - HACCP protocols in cosmetic microbiology.			15
V	Cosmetic microbiology test methods - Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods - bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives.			15
Text Books				
1.	Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.			
2.	Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN:8178330911.			
3.	Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.			
4.	Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3 rd Edition). CRC Press. ISBN:9780429113697.			
5.	Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press. ISBN-10:0849337135.			
References Books				
1.	Indian Herbal Pharmacopoeia (2002). Vol. I & II Indian Drug Manufacturers Association, Mumbai.			
2.	British Herbal Pharmacopoeia. (1990). Vol. I. British Herbal Medicine Association. ISBN: 0903032090.			

3.	Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (2 nd edition). Saujanya Books, Delhi. ISBN-10:81-900788-5-2/8190078852. ISBN-13:978-81-900788-5-6/9788190078856.
4.	Turner R. (2013). Screening methods in Pharmacology. Elsevier. ISBN:9781483264233.
5.	Cupp M. J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp. 85-93). M. J. Cupp. Humana Press. Totowa, NJ, USA. ISBN-10:1617371904.

Web Resources

1.	https://www.academia.edu/50236711/Modern_Extraction_Methods_for_Preparation_of_Bioactive_Plant_Extracts
2.	https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl
3.	https://pubmed.ncbi.nlm.nih.gov/17004305/
4.	https://www.fda.gov/cosmetics/potential-contaminants-cosmetics/microbiological-safety-and-cosmetics
5.	https://pubmed.ncbi.nlm.nih.gov/15156038/

Pedagogy: Teaching / Learning methods

(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Identify the applications of Indian medicinal plants in treating diseases.	K1&K3
CO2	Identify and authenticate herbal plants.	K2&K3
CO3	Evaluate the antimicrobial activity of medicinal plants.	K5
CO4	Describe the role of microorganisms and their metabolites in the preparation of cosmetics.	K2,K3 &K6
CO5	Validate procedures and biosafety measures in the mass production of cosmetics.	

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M				S									
CO2						S	M							
CO3				S		S			M					
CO4	M				S		S							
CO5						M	S							

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching/ Hours	No. of Credits
I	23P1MBEL2B	Elective II - Essentials of Laboratory Management and Biosafety	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need		
Addresses Environment and Sustainability	√	Addresses Professional Ethics	√	
Addresses Human Values	√			
Course Objectives				
1	To utilize containment principles to ensure biosafety.			
2	To enrich the student role and responsibilities of laboratory hazards and their control.			
3	To know the importance of first aid technique for various common lab accidents.			
4	To acquire knowledge of biosafety level, risk assessment and maintain proper hygiene in the laboratory.			
5	To discuss the biosafety regulations and guidelines and implementation of safety programs.			
UNIT	Contents			No. of Hours
I	Introduction to the laboratory and laboratory biohazards - General laboratory facilities – Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan.			15
II	Common hazards in laboratory: Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling - Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Potential ignition sources in the lab. Stages of Fire. Fire Extinguishers. Fire Response.			15
III	Prevention and First aid for laboratory accidents. Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.			15
IV	Biosafety - Historical background. Blood borne pathogens (BBP) and laboratory - acquired infections. Introduction to biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms. Recommended biosafety. Levels for infectious agents and infected animals. Risk groups with examples - Risk assessment. Safety levels. Case studies. Hygiene, disinfection, decontamination, sterilization.			15
V	Biosafety regulations and guidelines. Centers for disease control and prevention and the National institutes of health. Occupational safety and health administration. Recombinant DNA advisory committee (RDAC), Institutional biosafety committee (IBSC), Review committee on genetic manipulation (RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines.			15
Text Books				
1.	Sateesh M. K. (2013). Bioethics and Biosafety, IK International Pvt Ltd. ISBN : 8190675702.			
2.	Muthuraj M. and Usharani B. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN 10: 1645878856			
3.	Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services. (2016). (5 th Edition). Lulu.com.			

4.	Kanai. L. Mukherjee. (Medical Laboratory Technology(4 th Edition). CBS Publishers.	
5.	Ramakrishnan (2012). Manual of Medical Laboratory Techniques. JP brothers.	
References Books		
1.	World Health Organization, Biosafety programme management. (2010). (4 th Edition). WHO Publications.	
2.	Rashid N. (2013). Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1 st Edition).	
3	Dayuan X. (2015). Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, ISBN-10 : 1842657917	
4.	Ochei J. Kolhatkar(2000). A. (Medical Laboratory Science – Theory and Practice. ISBN; 13:978-0074632239.	
5.	Lynne S. Garcia. Clinical Laboratory Management (2 nd Edition). ASM Press	
Web Resources		
1.	https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf	
2.	https://ucanapplym.s3.ap-south1.amazonaws.com/RGU/notifications/E_learning/Online_study/PG-SEM-IV-Biosafety%20regulation.pdf	
3.	https://consteril.com/biosafety-levels-difference/	
4.	https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf	
5.	https://www.who.int/publications/i/item/9789240011311	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Employ skills on laboratory safety and avoid laboratory accidents.	K2,K4 &K1
CO2	Prevent laboratory hazards by practicing safety strategies.	K2 &K4
CO3	Practice various first aid procedures during common laboratory accidents.	K2&K3
CO4	Ensure biosafety strategies in laboratory.	K5 & K4
CO5	Recognize the importance of biosafety guidelines.	K5 & K6

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S	S	S				S				S			
CO2		S			S		S				S			
CO3	S	S	S		S					S	S			
CO4		S	S	M			S			S	S			
CO5			S	S	S		S			S	S			

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of teaching /Cycle	No, of Credits
I	23P1MBSEC1	Skill Enhancement Course Professional Competency Course - Entrepreneurship in Biobusiness	2	2
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	
Addresses Environment and Sustainability		√	Addresses Professional Ethics	√
Addresses Human Values		√		
Course Objectives				
1	Understanding basic concepts, role and importance of entrepreneurship for economic development.			
2	Developing personal creativity and entrepreneurial initiative, adopting of the key steps in the elaboration of business idea.			
3	Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.			
4	Explain the central components of successful business strategies in biotechnology, and create a business plan.			
5	Acquire knowledge about proposal preparation, funding and face challenges in biobusiness.			
UNIT	Contents			No. of Hours
I	Bioentrepreneurship - Introduction to biobusiness, SWOT analysis of biobusiness. Ownership. Development of Entrepreneurship. Stages in entrepreneurial process. Government schemes and funding. Small scale industries - Definition, characteristics, need and rationale. Entrepreneurship opportunity in agricultural biotechnology - Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope. Case study on Plant cell and tissue culture technique,			6
II	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. Biopesticide/ insecticide production. Biofertilizers. Single cell protein. Therapeutic and Fermented products. Project Management, Technology Management and Startup Schemes - Building Biotech business challenges in Indian context - biotech partners			6
Text Books				
1.	Shimasaki C. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies- Academic Press. ISBN: 978-0-12-404730-3			
2.	Acton A. Q. (2021). Biological Pigments - Advances in Research and Application- (Scholarly Editions). Atlanta, Georgia. ISBN: 978-1-481-68574-0			
3.	Stanbury P. F. and Whitekar. A. Principles of Fermentation Technology, (3 rd Edition). Butterworth-Heinemann. ISBN 10: 0080999530			
4	Anil Kumar (2020). Small Business and Entrepreneurship, Willey Distributions, Dream Tech Press.			
5	Anji Redy (2015). An Unfinished Agenda. ISBN 139780670087808.			

References Books		
1.	Crueger, W, and Crueger. A. (2017). Biotechnology: A Text Book of Industrial Microbiology. (2 nd Edition). Medtech. ISBN-10 : 9385998633	
2.	Teng P. S. (2008). Bioscience Entrepreneurship in Asia. World Scientific Publishing Company, 2008.	
3.	Agarwal S., Kumari S. and Khan S. (2021). Bioentrepreneurship and Transferring Technology into Product Development. BusinessScience Reference. ISBN-10 : 1799874125	
4.	Krishnamurthy A.G. Dirubai Ambani Against All Odds. McGraw Hills.	
5.	Peter F. Drucker. Innovation and Entrepreneurship (1985).	
Web Resources		
1.	https://www.profitableventure.com/biotech-business-ideas/	
2.	https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf	
3.	https://www.nature.com/articles/s41587-021-01110-3	
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003900/	
5.	https://springhouse.in/government-schemes-every-entrepreneur/	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.	K1&K3
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.	K3&K4
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.	K3&,K4
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.	K4&,K5
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.	K5&K6

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO 1	S	S		S	S			S				S		
CO 2	S	S		S			S			S	S			
CO 3	S			S	S			S	S		S			
CO 4		S		S				S			S			
CO 5				S	S			S	S			S		

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching/ Cycle	No. of credits
I	23P1MBAECC1	Ability Enhancement Compulsory Course - Communicative Skill and Personality Development	2	2

Nature of the course

Employability Oriented	√	Relevant to Local need	√	Addresses Gender Sensitization	
Entrepreneurship Oriented	√	Relevant to national need	√	Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to regional need	√	Addresses Human Values	√
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

<ol style="list-style-type: none"> 1. Cultivate positive personality traits for successful life. 2. Groom Winning Attitude among the learners. 3. Assist the learners to identify their own potential and realize their aspirations. 4. Enable a holistic development. 5. Facilitate optimum means of improving personal performance.
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SYLLABUS		
Unit	Content	No. of Hours
I	<ol style="list-style-type: none"> 1. Personality- Definition. 2. Determinants of Personality. 3. Perceptual Process. 4. Personality Traits. 5. Developing Effective Habits. 6. Self Esteem (Freud and Erikson). 7. Self Appraisal and Self Development. 8. Dos and Don'ts to develop positive self esteem. 9. Interpersonal Relationship. 10. Difference between Aggressive, Submissive and Assertive behaviour. 11. Mind Mapping, Competency Mapping, 360 degree assessment. 12. Presentation Skills – Opening, ending, Handling nerves, Handling audience, Power Storytelling, Visual aids, Question and answer session 	15
II	<ol style="list-style-type: none"> 1. Projecting Positive Body Language. 2. Conflict Management. 3. Change Management. 4. Stress Management. 5. Time Management. 6. Goal Setting. 7. Assertiveness and Negotiating Skill. 8. Problem Solving Skill. 	15

	9. Decision Making Skills. 10. Leadership Qualities of a Successful Leader. 11. Attitudes – Positive Attitudes. 12. Public Speaking – Engaging, Connecting, and Influencing the audiences. 13. Employability Skill – Group Discussion, Interview Questions, Psychometric analysis.	
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Textbook:

1. Andrews, Sudhir. *How to Succeed at Interviews*. 21st (rep) New Delhi:Tata McGraw Hill 1988.
2. Hurlock.E.B (2006) :*Personality Development*, 28th Reprint. New Delhi: Tata McCraw Hill.
3. Kumar, Pravesh.*All about Self Motivation*. New Delhi:Goodwill Publication House. 2005.
4. Preston,David Lawrence.*365 Steps to Self-Confidence*. Mumbai: Jaico Publishers, 2007
5. Stephen.P.Robbins and Timothy. A.Judge: *Organisation Behaviour*.16thEdition.Prentice Hall. 2014

References:

1. Grellet ,Françoise. *Developing Reading Skills*. Cambridge: Cambridge University Press, 2007.
2. Kristine, Brown and Susan Hood.*Academic Encounters Life in Society Reading, Study Skills, Writing*. , New Delhi:Cambridge University Press,2010.
3. Little ,Graham R .*Operations Team Leadership*. Mumbai :Jaico Publishers, 2006.
4. Nurnberg ,Maxwell and Morris Rosenblum *How to Build a Better Vocabulary*. New York :Warner Books, 1989.
5. O’ Connell ,Sue with LousieHashemi.*Cambridge First Certificate: Listening and Speaking –*, Cambridge University Press, Cambridge, 2000.
6. Pfeifer , William Sanborn and T.V.S.Padmaja*Technical Communication : A Practical Approach*, (Sixth edition) New Delhi: Pearson, 2006.
7. Withrow, Jean, Gay Brookers and Martha Cumings .*Inspired to Write*. New York: Cambridge University Press, 2004.

Web resources:

- <https://www.managementstudyguide.com/personality-development.htm>
- <https://www.artofliving.org/in-en/personality-development>
- <https://study.com/academy/lesson/what-is-conflict-management-definition-styles-strategies.html>
- <https://www.hays.com.au/career-advice/upskilling/soft-skills>
- <https://www.skillsyouneed.com/presentation-skills.html>

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Assignment, PPT presentation, Group Discussion, e-content, Seminar, Tasks, Role play, Debate, Group Activities etc.

Course Out comes

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

CO Number	CO Statement	Cognitive Level
CO1	understand the significance of developing progressive and positive personality	K1,K2
CO2	Gain self-confidence and broaden perception of life.	K3
CO3	Maximize their potential and steer that into their career choice.	K4
CO4	Enhance one's self image and self-esteem.	K3, K5
CO5	Find a means to achieve excellence and derive fulfillment.	K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Specific Outcomes

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

3 - Strongly Correlated; 2 - Moderately Correlated;

1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Course Title	Hours of Teaching/ Cycle	No. of Credits
II	23P2MBC3	Medical Bacteriology and Mycology	6	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization	√	Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.			
2	Explain morphology, characteristics and pathogenesis of bacteria.			
3	Discuss various factors leading to pathogenesis of bacteria.			
4	Acquire knowledge on antifungal agents and their importance.			
5	Describe various diagnostic methods available for fungal disease diagnosis.			
UNIT	Contents			No. of Hours
I	Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.			18
II	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of <i>Staphylococci</i> , <i>Streptococci</i> , <i>Pneumococci</i> , <i>Neisseriae.</i> , <i>Bacillus</i> , <i>Corynebacteria</i> , <i>Mycobacteria</i> and <i>Clostridium</i> , <i>Spirochaetes- Leptospira</i> , <i>Treponema</i> and <i>Borrelia</i> .			18
III	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae - <i>E.coli</i> and <i>Klebsiella</i> ; <i>Proteus</i> , <i>Salmonella</i> , <i>Shigella</i> ; <i>Yersinia</i> , <i>Pseudomonas</i> , <i>Vibrio</i> , <i>Mycoplasma</i> , <i>Helicobacter</i> , <i>Rickettsiae</i> , <i>Chlamydiae</i> , <i>Bordetella.</i> , Nosocomial, zoonotic and opportunistic infections -prevention and control.			18
IV	Morphology, characteristics, pathogenesis, laboratory diagnosis and treatment of mycotic diseases from clinical specimens. Dermatophytes and agents of superficial mycoses. <i>Trichophyton</i> , <i>Epidermophyton</i> & <i>Microsporum</i> . Yeasts of medical importance – <i>Candida</i> , <i>Cryptococcus</i> . Mycotoxins. Antifungal agents, testing methods and quality control.			18
V	Dimorphic fungi causing Systemic mycoses, <i>Histoplasma</i> , <i>Coccidioides</i> , <i>Sporothrix</i> , <i>Blastomyces</i> . Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents- types and mode of action.			18
Text Books				
1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.			
2.	Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18 th Edition). Churchill Livingstone, London.			
3.	Finegold, S. M. (2000) Diagnostic Microbiology, (10 th Edition). C.V. Mosby Company, St. Louis.			
4.	Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology, (4 th Edition). Wiley Publishers.			
5.	Chander J. (2018). Textbook of Medical Mycology. (4 th Edition). Jaypee brothers Medical Publishers.			
References Books				
1.	Salle A. J. (2007). Fundamental Principles of Bacteriology. (4 th Edition). Tata McGraw-Hill Publications.			
2.	Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14 th edn, Churchill Livingston.			

3.	Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22 nd edn. Cambridge University Press.
4.	Topley and Wilson's. (1998). <u>Principles of Bacteriology</u> .9 th edn. Edward Arnold, London.
5.	Murray P.R., Rosenthal K.S. and Michael A. (2013). <u>Medical Microbiology</u> . Pfaller. 7 th edn. Elsevier, Mosby Saunders.
Web Resources	
1.	http://textbookofbacteriology.net/nd
2.	https://microbiologysociety.org/members-outreach-resources/links.html
3.	https://www.pathselective.com/micro-resources
4.	http://mycology.cornell.edu/fteach.html
5.	https://www.adelaide.edu.au/mycology/

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Collect, transport and process of various kinds of clinical specimens.	K1
CO2	Analyze various bacteria based on morphology and pathogenesis.	K2&K4
CO3	Discuss various treatment methods for bacterial disease.	K4&K5
CO4	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents..	K2&K3
CO5	Apply various immunodiagnostic method to detect fungal infections.	K5&K6

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M				S				M					
CO2	M				S				M					
CO3	M				S				M					
CO4					S				M					
CO5					S				M					

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
II	23P2MBC4	Medical Virology and Parasitology	5	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization	√	Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values				
Course Objectives				
1	Describe the replication strategy and cultivation methods of viruses.			
2	Acquire knowledge about oncogenic virus and human viral infections.			
3	Develop diagnostic skills, in the identification of virus infections.			
4	Impart knowledge about parasitic infections.			
5	Develop diagnostic skills, in the identification of parasitic infections.			
UNIT	Contents			No. of Hours
I	General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).			15
II	Morphology, Epidemiology, Pathogenesis, laboratory diagnosis and treatment of the following viruses: DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo - H1N1 Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, SARS CoV-2, Emerging and reemerging viral infections			15
III	Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics. Diagnosis of viral infections –conventional serological and molecular methods. Antiviral agents and viral vaccines.			15
IV	Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – <i>Entamoeba</i> , <i>Giardia</i> , <i>Trichomonas</i> , <i>Balantidium</i> . <i>Toxoplasma</i> , <i>Cryptosporidium</i> , <i>Leishmania</i> , <i>Trypanosoma</i> and <i>Plasmodium</i> .			15
V	Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – <i>Taenia solium</i> , <i>T. saginata</i> , <i>Echinococcus</i> . Trematodes – <i>Fasciola hepatica</i> , <i>Paragonimus</i> , <i>Schistosomes</i> . Nematodes - <i>Ascaris</i> , <i>Ankylostoma</i> , <i>Trichuris</i> , <i>Trichinella</i> , <i>Enterobius</i> , and <i>Wuchereria</i> . Other parasites causing infections in immune compromised hosts, Diagnosis of parasitic infections – collection of sample, microscopic, serological and molecular diagnosis. Antiprotozoan and antihelminthic drugs.			15
Text Books				
1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd.			
2.	Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.			
3.	Rajan S. (2007). Medical Microbiology. MJP publisher.			
4.	Paniker J. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi.			
5.	Arora, D. R. and Arora B. B. (2020). Medical Parasitology. (5 th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.			

Reference Books		
1.	Carter J. (2001). Virology: Principles and Applications (1 st Edition). Wiley Publications.	
2..	Willey J., Sandman K. and Wood D. Prescott's Microbiology. (11 th Edition). McGraw Hill Book.	
3.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19 th Edition). Lange Medical Publications, U.S.A.	
4.	Finegold S.M. (2000). Diagnostic Microbiology. (10 th Edition). C.V. Mosby Company, St. Louis.	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Demonstration, Experimentation, Tutorial, Assignment, PPT presentation ,Quiz, Group Discussion.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Collection of different clinical samples, transport, culture and examination.	K1
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	K2
CO3	Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	K3
CO4	Perform antibiotic sensitivity tests and compare with the standard tests.	K4&K5
CO5	Screening of industrially important microbes for metabolite production.	K4&K5

Cognitive Level: K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1					M		L	L		M				
CO2					M		L	L		M				
CO3					M		L	L		M				
CO4					M		L	L		M				
CO5					M		L	L		M				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching/Hours	No. of Credits
II	23P2MBCP2	Practical II - Medical Bacteriology and Mycology, Medical Virology and Parasitology	5	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization	√	Relevant to Global development need	√	
Addresses Environment and Sustainability		Addresses Professional Ethics		
Addresses Human Values				
Course Objectives				
1	Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.			
2	Impart knowledge on fungal infections and its diagnosis.			
3	Diagnose parasitic			
4	To gain knowledge about industrially important microbes.			
5	Screen and utilize microorganisms for effective industrial production of metabolites.			
UNIT	Contents			No. of Hours
I	Staining of clinical specimens - Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria.			15
II	Examination of different fungi by Lactophenol cotton blue staining and KOH staining. Cultivation of fungi and their identification - <i>Mucor</i> , <i>Rhizopus</i> , <i>Aspergillus</i> , <i>Penicillium</i> . Microscopic observation of different asexual fungal spores. Microscopic observation of fungal fruiting bodies. Identification of Dermatophytes. Isolation and characterization of bacteriophage from natural sources by phage titration.			15
III	Examination of parasites in clinical specimens - Ova/cysts in faeces. Concentration: methods – Flootation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods- Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. Identification of common arthropods of medical importance - spotters of <i>Anopheles</i> , <i>Glossina</i> , <i>Phlebotomus</i> , <i>Aedes</i> , Ticks and mites.			15
IV	Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test. Cultivation of viruses –Egg Inoculation methods. Diagnosis of Viral Infections –ELISA –HIA. Spotters of viral inclusions and CPE-stained smears.			15
V	Microbiological assay of antibiotics by cup plate method and other methods. Sterility testing of pharmaceuticals.			15
Text Books				
1.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2 nd Edition. Publisher-Taylor and Francis.			

2.	Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.	
3.	Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.	
4.	Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.	
5.	Morag C. and Timbury M.C. (1994). Medical Virology. 4 th edn. Blackwell Scientific Publishers.	
References Books		
1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi.	
2.	Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.	
3.	Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.	
4.	Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22 nd Edition. Cambridge University Press.	
5.	Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7 th Edition. Elsevier, Mosby Saunders	
Web Resources		
1.	http://textbookofbacteriology.net/	
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/	
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/	
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/	
5.	https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics-and-biotechnological-applications/vaccines-and-antiviral-agents	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Demonstration, Experimentation, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Collection of different clinical samples, transport, culture and examination.	K1
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	K2&K5
CO3	Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	K3&K4
CO4	Perform antibiotic sensitivity tests and compare with the standard tests.	K3&K4
CO5	Screening of industrially important microbes for metabolite production.	K5&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1							M	M	M					
CO2							M	M	M					
CO3							M	M	L	L				
CO4							M	M	M	L				
CO5							M	M	M					

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of credits
II	23P2MBEL3A	Elective - III - Clinical and Diagnostic Microbiology	5	3
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization		√	Relevant to Global development need	√
Addresses Environment and Sustainability			Addresses Professional Ethics	√
Addresses Human Values				
Course Objectives				
1	Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.			
2	Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.			
3	Elucidate various diagnostic procedures in microbiology.			
4	Acquire knowledge on different methods employed to check antibiotic sensitivity.			
5	Gain knowledge on hospital acquired infections and their control measures.			
UNIT	Contents			No. of Hours
I	Microbiology Laboratory Safety Practices -General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.			12
II	Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.			12
III	Diagnosis of microbial diseases - Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.			12
IV	Antibiotic sensitivity tests - Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution - Agar dilution & broth dilution - MBC/MIC - Quality control for antibiotics and standard strains.			12
V	Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.			12
Text books				
1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi. ISBN-10:0443047219 / ISBN-13-978-0443047213.			
2.	Tille P. M. (2021). Bailey and Scott's Diagnostic Microbiology. (15 th Edition). Elsevier. ISBN:9780323681056.			
3.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19 th Edition). Lange Medical Publications, U.S.A.			
4.	Mukherjee K.L. (2000). Medical Laboratory Technology. Vol. 1-3. (2 nd Edition). Tata McGraw-Hill Education. ISBN-10:0074632604.			
5.	Sood R. (2009). Medical Laboratory Technology – Methods and Interpretations. (6 th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN:9788184484496.			
References Books				
1.	Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Tenover F.C. (2003). Manual of Clinical Microbiology. (8 th Edition). American Society for Microbiology, Washington, DC. ISBN:1-555810255-4.			

2.	Bennett J. E., Dolin R. and Blaser M. J. (2019). Principles and Practice of Infectious Diseases. (9 th Edition). Elsevier. EBook ISBN:9780323550277. Hardcover ISBN:9780323482554.
3.	Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7 th Edition. Hodder Arnold Publication. ISBN-10:0340554231 / ISBN-13:9780340554234.
4.	Koneman E. W., Allen S. D., Schreckenber P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7 th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378.
5.	Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2 nd Edition). Cambridge University Press. ISBN13:978-0-521-67631-1 / ISBN-10:0-521-67631-2.
Web Resources	
1.	https://www.ncbi.nlm.nih.gov/books/NBK20370/
2.	https://www.msmanuals.com/en-in/home/infections/diagnosis-of-infectious3disease/diagnosis-of-infectious-disease
3.	https://journals.asm.org/doi/10.1128/JCM.02592-20
4.	https://www.sciencedirect.com/science/article/pii/S2221169116309509
5.	http://www.textbookofbacteriology.net/normalflora_3.html

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Apply Laboratory safety procedures and hospital waste disposal strategies.	K1&K2
CO2	Collect various clinical specimens, handle, preserve and process safely.	K2&K4
CO3	Identify the causative agents of diseases by conventional and molecular methods following standard protocols.	K4&K5
CO4	Assess the antimicrobial susceptibility pattern of pathogens.	K5&K6
CO5	Trace the sources of nosocomial infection and recommend control measures.	K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4-Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1					S	M	M							
CO2						M	S							
CO3						M	S		M		S			
CO4							S		M					
CO5					S		M							

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
II	23P2MBEL3B	Elective III - Bioremediation	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented		Relevant to national need	√	
Addresses Gender Sensitization	√	Relevant to Global development need		
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Describe the nature and importance of bioremediation and use in real world applications.			
2	Describe the typical composition of waste water and application of efficient technologies for water treatment.			
3	Explain the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.			
4	Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.			
5	Familiarize the role of plants and their associated microbes in remediation and management of environmental pollution.			
UNIT	Contents			No. of Hours
I	Bioremediation - process and organisms involved. Bioaugmentation - <i>Ex-situ</i> and <i>in-situ</i> processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.			15
II	Microbes involved in aerobic and anaerobic processes in nature. Water treatment - BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.			15
III	Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents.			15
IV	Microbial leaching of ores - process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable plastics, super bug.			15
V	Phytoremediation of heavy metals in soil - Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.			15
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)				
Course Outcomes				
CO1	Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.			K1
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.			K2
CO3	Identify, formulate and design engineered solutions to environmental problems.			K3&K4
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.			K5

CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting <i>Rhizobacteria</i> in phytoremediation.	K5&K6
Text Books		
1.	Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2 nd Edition). Galgotia Publications.	
2.	Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3 rd Edition). Printice-Hall, India.	
3.	Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2 nd edition, CRC Press.	
4.	Liu, D.H.F and Liptak, B.G (2005). Hazardous Wastes and Solid Wastes, Lewis Publishers..	
5.	Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1 st edition. MJP Publishers	
References Books		
1.	Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1 st Edition). Apple Academic Press.	
2.	Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.	
3.	Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1 st Edition). Springer-Verlag Berlin Heidelberg, Germany.	
4.	Atlas, R.M & Bartha, R. (2000). Microbial Ecology. Addison Wesley Longman Inc.	
5.	Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1 st edition. I.K. International Publishing House Pvt. Ltd.	
Web Resources		
1.	Bioremediation- Objective, Principle, Categories, Types, Methods, Applications (microbenotes.com)	
2.	https://agris.fao.org > agris-search	
3.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation	
4.	https://www.intechopen.com/chapters/70661	
5.	https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Differentiate <i>Ex-situ</i> bioremediation and <i>In-situ</i> bioremediation. Assess the roles of organisms in bioremediation.	K1&K2
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.	K2
CO3	Identify, formulate and design engineered solutions to environmental problems.	K3&K4
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.	K4&K5
CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting <i>Rhizobacteria</i> in phytoremediation.	K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S	M		M	S									
CO2	S			M	S						S			
CO3					S		S	S			S			
CO4					S	S	S	S	S					
CO5	M				S	M	S	S						

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
II	23P2MBEL4A	Elective IV - Bioinformatics	5	3
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability			Addresses Professional Ethics	√
Addresses Human Values				
Course Objectives				
1	Discuss about various biological data mining concepts, tools.			
2	Elucidate the principles and applications of sequence alignment methods and tools.			
3	Demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.			
4	Acquaint with various approaches in predicting 3D and 2D structure of proteins.			
5	Describe various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics.			
UNIT	Contents			No. of Hours
I	Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).			15
II	Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.			15
III	Computational Protein Structure prediction – Secondary structure – Homology modelling- Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements- Molecular graphics – Molecular file formats- Molecular visualization tools.			15
IV	Prediction of Properties of Ligand Compounds – 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes – Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds			15
V	Molecular Docking- Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.			15
Text Books				
1.	Lesk A. M. (2002). Introduction to Bioinformatics. (4 th Edition). Oxford University Press.			
2.	Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley- VCH.			

3.	Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4 th Edition). Prentice-Hall of India Pvt.Ltd.
4.	Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addison Wesley Longman Limited, England.
5.	Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2 nd edn.CBS Publishers, New Delhi.
References Books	
1.	Baxevanis A. D. and Ouellette F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (2 nd Edition). John Wiley and Sons.
2.	Bosu O. and Kaur S. (2007). Bioinformatics - Database, Tools, and Algorithms. Oxford University Press.
3.	David W. M. (2001). Bioinformatics Sequence and Genome Analysis (2 nd Edition). CBS Publishers and Distributors(Pvt.)Ltd.
4.	Xiong J, (2011). <u>Essential bioinformatics</u> , First south Indian Edition, Cambridge University Press.
5.	Harshawardhan P.Bal, (2006). <u>Bioinformatics Principles and Applications</u> , Tata McGraw-Hill Publishing Company Limited.
Web Resources	
1.	https://www.hsls.pitt.edu/obrc/
2.	https://www.hsls.pitt.edu/obrc/index.php?page=dna
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4.	https://www.ebi.ac.uk/
5.	https://www.kegg.jp/kegg/kegg2.html

Pedagogy:Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Access to databases that provides information on nucleic acids and proteins.	K1
CO2	Invent algorithms for sequence alignment.	K2&K4
CO3	Construct phylogenetic tree.	K3&K4
CO4	Predict the structure of proteins.	K4&K5
CO5	Design drugs by predicting drug ligand interactions and molecular docking.	K5&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M			M		M			M	M			M	
CO2							S		S	S			S	
CO3						S			S	S				
CO4				S		S	S		S				S	
CO5				S	S	S	S		S	S			S	

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2MBEL4B	Elective IV –Nanobiotechnology	5	3
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability			Addresses Professional Ethics	
Addresses Human Values				
Course Objectives				
1	Analyze nanomaterials based on the understanding of nanobiotechnology.			
2	Discuss the methods of fabrication of nanomaterials.			
3	Gain Knowledge on characterization of nanomaterials.			
4	Discover nanomaterials for targeted drug delivery.			
5	Explain nanomaterials in nanomedicine and environmental pollution.			
UNIT	Contents			No. of Hours
I	Introduction to nanobiotechnology, Nano size-changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials), Class of nanomaterials and their applications. Need for nanomaterials and the risks associated with the materials.			15
II	Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.			15
III	Characterization of nanoparticles – Based on particle size/morphology- Dynamic light scattering (DLS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Based on surface charge-zeta potential, Based on structure –X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX), Based on optical properties- UV – Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer (VSM).			15
IV	Nanomaterial based Drug delivery and therapeutics-surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.			15
V	Nanomaterials in diagnosis-Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.			15
Text Books				
1.	Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.			
2.	Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.			
3.	Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.			
4.	Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.			
5.	Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.			

References Books	
1.	Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
2.	Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
3.	Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
4.	Rehm, B. (2006). Microbial Bionanotechnology: Biological Self-Assembly Systems and Biopolymer-Based Nanostructures. Horizon Scientific Press.
5..	Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press
Web Resources	
1.	https://www.gale.com/nanotechnology
2.	https://www.understandingnano.com/resources.html
3.	http://dbtnanobiotech.com/index2.php
4.	http://www.istl.org/11-winter/internet1.html
5.	https://www.cdc.gov/niosh/topics/nanotech/default.html

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Employ knowledge in the field of nanobiotechnology for development.	K1
CO2	Identify various applications of nanomaterials in the field of medicine and environment.	K2&K5
CO3	Examine the prospects and significance of nanobiotechnology.	K3&K4
CO4	Identify recent advances in this area and create a career or pursue research in the field.	K4&K6
CO5	Design non-toxic nanoparticles for targeted drug delivery.	K5&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S			M					M					
CO2	S								S					
CO3	S					M					S			
CO4	S				S		M		S					
CO5	S				S		M		S		S			

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2MBSEC2	Skill Enhancement Course Vermitechnology	2	2
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values				
Course Objectives				
1	Introduce the concepts of vermicomposting.			
2	Acquire the knowledge of the vermicomposting process.			
3	Explain the trouble shooting, harvesting and packaging of vermicomposts.			
4	Gain knowledge on applications of vermin composts and their value added products.			
UNIT	Contents			No. of Hours
I	Introduction to Vermiculture - Definition, classification, history, economic importance. Applications of Vermiculture - Vermiculture Biotechnology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Vermiwash-vermicompost tea-vermi meal-enriched vermicompost - pelleted vermicompost.			6
II	Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre- composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.			6

Text Books	
1	Ismail S. A. (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2	Rathoure A. K., Bharati P. K. and Ray J. (2020). Vermitechnology, Farm and Fertilizer. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3	Christy M. V. 2008. Vermitechnology, (1 st Edition), MJP Publishers.
4	The complete technology book on Vermiculture and Vermicompost with manufacturing Process, machinery equipment details and Plant Layout. AB Press.
5	Keshav Singh (2014). A Textbook of vermicompost: Vermiwash and Biopesticide.
References Books	
1	Roy D. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
2	Kumar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
3	Lekshmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.
4	Edwards CA, Arancon NQ Sherman RL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1 st edn. CRC Press.
5	Ismail, S.A. (1997). Vermiculture-The Biology of Earthworm. 1 st edn. Orient longman.
Web Resources	
1.	https://en.wikipedia.org/wiki/Vermicompost
2.	http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
3.	https://www.kngac.ac.in/elearning-portal/ec/admin/contents/4_18K4ZEL02_2021012803204629.pdf
4.	https://composting.ces.ncsu.edu/vermicomposting-2/
5.	https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Compare and contrast the uses of vermicompost to the soil.	K1&K2
CO2	Recommend different species of earthworms after acquiring knowledge on its biology.	K2&K3
CO3	Design the vermicomposting process.	K3&K4
CO4	Assess the Best Practices of Vermicomposting	K5
CO5	Recommend the applications of vermicompost to different soils and for different crops.	K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S			M	S				S					
CO2	S			M		S			S					
CO3	S			S		S	S	S						
CO4						S	S	S	S					
CO5	S			M	S	M	S							

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of teaching/ Hours	No. of Credits
II	23P2MBAECC2	Ability Enhancement Compulsory Course - Language Lab	2	2

Nature of the course

Employability Oriented	√	Relevant to Local need	√	Addresses Gender Sensitization	
Entrepreneurship Oriented	√	Relevant to national need	√	Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to regional need	√	Addresses Human Values	√
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

1. To understand the Cultural Tourism and its importance.
2. To know about the Performing Arts and Classical Dance.
3. To know the fairs and festivals in India.
4. To understand the Pilgrimage Tourism in India and its importance.
5. To understand the works of ITDC and Government policies.

Unit – I LSRW

Listening Skills: Introduction to Phonetics – Speech Sounds – Vowels and Consonants, Listen to News, poem, songs, Motivational speech, stories, movies, interesting facts, sign of zodiac, dialogues, idioms, dictation – Common errors

Speaking Skills: Stress, Intonation, Homophone, Silent Letters, Greetings, Small Talk, Telephone English, Role Play, Tongue Twisters, Welcome Speech & Vote of Thanks, Compering, Declamation, Sing Along, Brain Storming, JAM (Just A Minute)

Reading Skills: Reading test, Skit, Proof Reading, Oral Reading Fluency, Reading Stories,

Writing Skills: learn English Grammar through Tamil Translation, Reading Comprehension-short stories, informational passages, Advanced Critical reading –Intelligence Augmentation, Dialogues, Sentence Completion, Word Definition, Classic Analogy Bridges, Sentence Analogies, Same Sound, Divided Syllables, Finish the Story, Answering the questions, Practical Writing, Making a formal Argument, Free Writing, Using Precise Language

Unit – II Career and Soft Skills

Career Skills: Body Language (BL) : BL Interview, BL Model, BL Tips, Business English, Communication skills, GD, Interview Skills

Soft Skills: Assertiveness, Creativity, Critical Thinking and Problem Solving, Empathy, Enthusiasm and attitude, Goal Setting, Great interviews, Negotiation Skills, Personality Development, Professionalism, Self Esteem, Stress Management, Team Building, Time Management, Motivation and Attitude, Interpersonal relationship and skills, Networking,

Reference:

1. Materials prepared by the Department of English for Writing skills
2. Soft Skills – Know Yourself and know the world, Dr.K.Alex, Chand Publications, 3rd revised edition 2014
3. Software : Express Pro Lite

The Language Lab focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

Course Objectives:

- 1, To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- 2To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
- 3To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- 4To improve the fluency of students in spoken English and neutralize their mother tongue influence
- 5To train students to use language appropriately for public speaking and Interviews

Learning Outcomes: Students will be able to attain

- 1Better understanding of nuances of English language through audio- visual experience and group activities
- 2Neutralization of accent for intelligibility
- 3Speaking skills with clarity and confidence which in turn enhances their employability skills

Minimum Requirement of infrastructural facilities for Language Lab:

1. Computer Assisted Language Learning (CALL) Lab:

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

- i) Computers with Suitable Configuration
- ii)High Fidelity Headphones

2. Interactive Communication Skills (ICS) Lab:

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public-Address System, a LCD and a projector etc.

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
III	23P3MBC5	Soil and Environmental Microbiology	6	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Understand the role of microorganisms in soil fertility.			
2	Discuss the benefits of interactions among soil microbes and acquire awareness about microbes as biofertilizers and biocontrol agents.			
3	Create awareness. about components of environment, environmental pollution, and detection methods.			
4	Acquire in depth knowledge about solid and liquid waste treatments.			
5	Develop knowledge about organic matter degradation, bioremediation, and the environment risk assessment.			
UNIT	Contents			No. of Hours
I	Soil Microbiology– Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major group of microorganisms in soil. Quantification of soil microflora, role of microorganism in soil fertility. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation- Chemistry and Genetics of BNF (Biological Nitrogen Fixation) Phytopathology and Disease cycle of Plant pathogens - Tikka and Citrus canker, Types of disease symptoms, Structural and Inducible biochemical defenses - Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Plantibodies, Phenolics, Phytoalexins.			18
II	Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria– symbiotic (<i>Bradyrhizobium</i> , <i>Rhizobium</i> , <i>Frankia</i>), Non-Symbiotic (<i>Azospirillum</i> , <i>Azotobacter</i> , Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. Biofertilizers and Biocontrol agents – Types, benefits and application. Advantages, social and environmental aspects - Bt crops, golden rice.			18
III	Components of Environment: Hydrosphere, lithosphere, atmosphere, and biosphere – definitions with examples; Energy flow in the ecosystem- Carbon, Nitrogen, Sulfur and Phosphorous cycles. Physical factors affecting distribution of microorganisms in various environmental infections – water - diarrhoea, typhoid and air borne - Asprgillois, tuberculosis and pollution - diseases. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Space microbiology - Microbiological research in space environment.			18
IV	Waste management – Solid waste - types - management - Factors affecting solid waste management. Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process. Quality assessment of decontaminated matters and other biological effluents. Biological reference standards. Utilization of Solid Waste as Food, Feed and Fuel- Composting, Vermicomposting, Biomanure and Biogas production, E-waste management.			18
V	Degradation of organic matter - lignin, cellulose, hemicellulose, pectin, common pesticides- herbicides (2,4-D) and pesticides (DDT), heavy metals. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers. Biodegradation of Hydrocarbons. Biodeterioration of Textiles and Leather. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, EIA guidelines, US Environment protection Agency norms.			18

Text Books	
1.	Subba Rao. N. S. (2017). Soil Microbiology. (5 th Edition). MedTech Publishers.
2.	Daniel. C. J. (2006). Environmental Aspects of Microbiology. (2 nd Edition). Bright Sun Publications.
3.	Rangaswami. G. and Mahadevan. A. (2006). Diseases of Crop Plants in India. (4 th Edition). Prentice-Hall of India Pvt. Ltd.
4.	Sharma P. D. (2010). Microbiology and Plant pathology. (2 nd Edition). Rastogi Publications.
5.	Subba Rao. N.S. (2005). Soil microorganisms and Plant Growth. (4 th Edition). Oxford and IBH Publishing Pvt. Ltd.

References Books	
1.	Pepper I. L., Gerba C. P. and Gentry T. J. (2014). Environmental Microbiology (1 st Edition). Academic Press, Elsevier.
2.	Bitton, G. (2011). Wastewater Microbiology. (4 th Edition). Wiley-Blackwell.
3.	Bridgewater L. (2012). Standard Methods for the Examination of Water and Wastewater. American Public Health Association.
4.	Shrivastava A.K. (2003). Environment Auditing. A. P. H. Publishing Corporation.
5.	Tinsley, S. and Pillai, I. (2012). Environmental Management Systems – Understanding Organizational Drivers and Barriers. Earthscan.

Web Resources	
1.	https://academic.oup.com/femsec/article/93/5/fix044/3098413
2.	http://www.fao.org/3/t0551e/t0551e05.htm
3.	www.environmentshumail.blogspot.in/
4.	https://www.frontiersin.org/articles/10.3389/fpls.2017.01617/full
5.	https://serc.carleton.edu/microbelife/index.html

Pedagogy : Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Depict diversity and significance of soil microbes and predict the role of microbes in biological nitrogen fixation.	K2&K3
CO2	Utilize the knowledge of microbial interactions, with beneficial application of biofertilizers for sustainable agriculture and benefits of biopesticides.	K3
CO3	Explain the different types of microorganisms in water. Identify the causes of water pollution and the methods for quality assessment of water and control of water borne diseases.	K1&K2
CO4	Apply knowledge about waste treatments and microbial decomposition and bio-remediation process in environmental cleanup.	K4&K5
CO5	Plan a clear approach on environmental issues. Control pollution and explain protection laws to public.	K5

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	M													
CO2	M						M	M						
CO3	M				S	S	S	S						
CO4	M				M									
CO5	M				M									

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching	No. of Credits
III	23P3MBC6	Molecular Biology and Recombinant DNA Technology	6	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need		
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Provide knowledge on the structure, replication and repair mechanisms of DNA. Illustrate the structure, functions and significance of RNA.			
2	Discuss the gene regulatory mechanisms in prokaryotes and eukaryotes and importance of mutations.			
3	Provide in depth knowledge about artificial gene transfer mechanisms and selection of Recombinants.			
4	Impart knowledge on various molecular techniques and their importance in biotechnology.			
5	Explain the applications of genetic engineering in various fields.			
UNIT	Contents			No. of Hours
I	DNA replication – modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, r-RNA and t-RNA. Ribosomes. Genetic Code and Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications.			18
II	Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems - repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations - base substitutions, frame shift, deletion insertion, duplication, inversion. Silent, conditional and lethal mutation. Chemical mutagenesis. Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test)			18
III	Tools and methods in gene cloning. Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques - electroporation, microinjection, protoplast fusion and microparticle bombardment. Screening for recombinants. Gene cloning vectors for prokaryotes and eukaryotes - cloning properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors - Expression of foreign genes in bacteria, animal, plant, algae and fungi – merits and demerits.			18
IV	Genomic DNA and cDNA library - Construction and Screening. Substrative hybridization for tissue specific DNA libraries. Techniques in genetic engineering Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking, Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array. Protein engineering and techniques Sitedirected mutagenesis – methods - Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. Protein folding, protein sequencing, protein crystallization. Applications of protein engineering.			18

V	Plant biotechnology - constituents and concepts of sterilization - preparation, isolation and selection of explant. Suspension cell culture, callus culture, protoplast isolation, culture & fusion. Anther and pollen culture for production, Transgenic Plants. Animal biotechnology – equipment and media used for animal cell culture technology. Primary and established cell line culture and culture media. Applications of animal cell cultures. Serum protein media viability and cytotoxicity. Applications of Genetic Engineering - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy - Germline and Somatic Cell Therapy - Ex-vivo Gene Therapy. <i>In-vivo</i> Gene Therapy. Vectors in Gene Therapy-Viral and Non-Viral Vectors.	18
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Text Books

1.	Malacinski G.M. (2008). Freifelder’s Essentials of Molecular Biology. (4 th Edition). Narosa Publishing House, New Delhi.
2.	Snusted D.P. and Simmons M. J. (2019). Principles of Genetics. (7 th Edition). John Wiley and Soms, Inc.
3.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.
4.	Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7 th Edition). Blackwell Publishing.
5.	Maloy S. R. Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2 nd Edition). Narosa Publishing House Pvt. Ltd.

References Books

1.	Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7 th Edition). John Wiley and Sons, Ltd.
2.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.
3.	Russell P.J. (2010). Genetics - A Molecular Approach. (3 rd 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.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.

Web Resources

1.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
2.	https://geneticeducation.co.in/what-is-transcriptomics
3.	https://www.molbiotools.com/usefullinks.html
4.	https://geneticeducation.co.in/what-is-transcriptomics
5.	https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Analyze, demonstrate and appreciate DNA replication and protein synthesis.	K1&K2
CO2	Investigate the types of mutation and its impact on microbes. Illustrate various strategies on gene cloning.	K5&K6
CO3	Analyze, modify and characterize DNA modifying enzymes.	K4&K5
CO4	Illustratively assess the molecular techniques for DNA and protein analysis.	K1&K2
CO5	Adopt the applications of Genetic Engineering in the field of agriculture and medicine towards scientific research.	K3

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4-Analyze;K5-Evaluate;K6- Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1				S	M	S	L	L	S	L	L			
CO2				S	M	S	L	L	S	L	M			
CO3				S	M	S	L	L	S	L	M			
CO4				S	M	S	L	L	S	L	L			
CO5	S		S	S	S	S	S	S	S	M	L			

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching	No. of credits
III	23P3MBCP3	Practical III - Soil and Environmental Microbiology, Molecular biology & Recombinant DNA technology	5	4
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	
Addresses Environment and Sustainability		√	Addresses Professional Ethics	
Addresses Human Values				
Course Objectives				
1	Illustrate the significance of artificial transformation and mutations.			
2	Discuss blotting techniques and PCR.			
3	Analyze and estimate water quality and potability			
4	Prepare Biofertilizers, vermicompost and test their efficiency			
5	Familiarize with common plant infections			
UNIT	Contents			No. of Hours
I	Plasmid transformation in <i>E.coli</i> Detection of Antibiotic resistant mutants Identification of mutants by replica plating method			15
II	Amplification of DNA by PCR Western blotting - Demonstration Southern blotting – Demonstration			15
III	Detection of Water hardness A) Microbiological analysis of water Total Heterotrophic Count B) Test for indicator organisms 1) MPN 2) Membrane Filtration Physical, chemical, assessment of water Physical - Color, pH, Chemical - alkalinity, acidity, DO, BOD, COD Enumeration of bacteria and fungi from air – Air sampler Isolation of free-living nitrogen fixers from soil and <i>Rhizobium</i> from root nodules of leguminous plants. Isolation and enumeration of phosphate-solubilizing bacteria from soil			15
IV	Preparation of Biofertilizers and testing the efficiency of prepared biofertilizers R:S ratio of soil microbes Estimation of soil enzymes- urease and phosphatase Study of phylloplane microflora by leaf impression method Isolation of cellulose degrading bacteria Preparation of vermicompost Isolation of VAM fungi from soil, root Isolation of plant pathogen - <i>Alternaria</i> & <i>Curvularia</i> spp., Cultivation of edible mushroom from solid waste Cultivation of <i>Azolla</i>			15
V	Visual examination, observation, and identification of some common plant infections. Demonstrate the Koch postulates using plant pathogens Collection of 5 herbarium specimens of infected leaves.			15

Text Books	
1.	Russell P. J. (2019). Genetics – A Molecular Approach (3 rd Edition). Pearson Education, Inc.
2.	Glick B. R. and Patten C. L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA (5 th Edition). ASM Press.
3.	Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
4.	James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5 th Edition). The Benjamin publishing company. New York.
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. (3 rd Edition). American Society for Microbiology.

References Books	
1.	Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7 th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
2.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7 th Edition). John Wiley and Jones, Ltd.
3.	Dale J. W., Schantz M. V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.
4.	Pepper I., Gerba C. and Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual. (2 nd Edition). Academic Press, Elsevier.
5.	Yates M.V., Nakatsu C.H., Miller R.V. and Pillai, S.D. (2016). Manual of Environmental Microbiology. (4 th Edition). Wiley.

Web Resources	
1.	https://www.molbiotools.com/usefullinks.html
2.	https://geneticgenie.org3 .
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

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Demonstration, Experimentation, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion.)

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Utilize various molecular techniques for gene manipulation and detection of mutants.	K1 & K2
CO2	Undertake novel research with techniques like PCR and blotting analysis.	K4 & K5,
CO3	Assess the microbial quality of water and air and relate the results to standards.	K4 & K5
CO4	Synthesize biofertilizers and vermicompost. Cultivate mushrooms using solid waste.	K5
CO5	Identify various plant pathogens	K1 & K2

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1				S	M	S	S	M	S	M	S			
CO2				S	M	S	S	M	M	S	S			
CO3	M			S	S		S	M						
CO4	M			S	S		S	S						
CO5					M					M				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours of Teaching Cycle	No. of credits
III	23P3MBEDC	Extra Disciplinary Course – Mushroom Cultivation Technology	4	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Assess the history and scope of edible mushroom cultivation			
2	Recognize the preparation of mother spawn in saline bottle			
3	Provide the infra structure of mushroom bed preparation			
4	Examine the nutritive value of various types of mushroom			
5	Elucidate account on food preparation in mushroom recipes			
UNIT	Details			No. of Hours
I	Introduction – history and scope of edible mushroom cultivation – Types of edible mushrooms, medicinal and poisonous mushroom available in India – <i>Calocybe indica</i> , <i>Volvariella volvacea</i> , <i>Pleurotus citrinopileatus</i> and <i>Agaricus bisporus</i> . Nutritive value – proteins, amino acids, mineral elements, Carbohydrates, Crude fibre content and Vitamins – medicinal value of <i>Ganoderma</i> .			9
II	Pure culture – preparation of medium (PDA and Oatmeal agar medium) - sterilization – preparation of test tube slants to store mother culture – culturing of <i>Pleurotus</i> mycelium on petriplates, preparation of mother spawn in saline bottle and polypropylene bag and their multiplication.			9
III	Cultivation Technology: Design and infrastructure of mushroom farm – Mushroom bed preparation – paddy straw, sugarcane thrash, maize straw, banana leaves - Factors affecting the mushroom bed preparation – Low cost technology - Composting technology in Mushroom production; Psychedelics mushroom, Himalayan mushroom, Catterpillar mushroom- <i>Cordyceps sinensis</i> .			9
IV	Post harvesting technology - Storage : Short-term storage (Refrigeration – upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions; Value added products from mushroom.			9
V	Food Preparation – Types of food prepared from mushroom; Soup, Cutlet, Omlette, Samosa, Pickles, Curry, mushroom kuruma and Briyani – Research Centres – National level and Regional level – Cost benefit ratio – Marketing in India and abroad and Export value.			9
Text Books				
1.	Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayaranjan, R., (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore			
2.	Swaminathan, M., (1960). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore 560 018.			
3.	Tewari, Pankaj Kapoor, S.C., (1988). Mushroom Cultivation, Mittal Publications, Delhi.			
4.	Nita Bahi (1984-1988). Handbook of Mushrooms, II Ed, Vol. I & II.			
5.	Paul Stamets, J.S and Chilton J.s (2004). Mushroom cultivation. A practical guide to graining mushroom at home Agarikon Press			

References Books		
1.	Paul Stamets, J.S and Chilton J.S. (2004). Mushroom cultivation. A practical guide to graining mushroom at home Agarikon Press.	
2.	Swaminathan, M., (1960). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore 560 018.	
Web Resources		
1.	https://en.wikipedia.org/wiki/Mushroom	
2.	https://www.agricultureinindia.net/cultivation/mushroom-cultivation/mushroom-cultivation-introductionclassification-steps-pests-and-diseases-agriculture/20733	
3.	https://beef2live.com/story-an-introduction-mushrooms-0-220270	
4.	https://www.techno-preneur.net/technology/project-profiles/food/mush-cult.html#:~:text=The%20basic%20raw%20material%20for,will%20be%20required%20for%20processing.	
5.	https://agricoop.nic.in/sites/default/files/ICAR_8.pdf	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the morphology and types of mushroom. Learn the prospects and scope of mushroom cultivation.	K1&K2
CO2	Understand the process and steps involved in mushroom production, various methods of culture media spawn and compost preparation.	K1&K2
CO3	Evaluate the important of different types of mushrooms and their cultivation. Apply the knowledge of mushroom cultivation and initiate a start up.	K5&K6
CO4	Analyze the nutritive value of typical mushroom	K4&K5
CO5	Analyze the economics of mushroom cultivation.	K1&K2

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO 1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO 1	S	S	S		S	S								
CO 2			S	S									M	
CO 3		S	S	S			S		S					
CO 4		S	S		S				S					
CO 5	S		S		S	S			S	M				

S-Strong (3), M-Medium (2) L-Low (1)

Semester	Course code	Course Title	Hours of Teaching/ Cycle	No. of Credits
III	23P3MBCIM	Industry Module - Fermentation technology	5	3
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability		√	Addresses Professional Ethics	
Addresses Human Values		√		
Course Objectives				
1	Discuss about fermentation and its types, sensitize on methods of strain development for improved yield.			
2	Impart knowledge on the fermenter design and types.			
3	Acquire knowledge on the effective recovery and purification of the products.			
4	Explain the importance of pharmaceutical microbiology.			
5	Illustrate methods for production products using microorganisms and their quality control.			
UNIT	Contents			No. of Hours
I	Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculums for fermentation process. Media for industrial fermentation - Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter pre-culture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.			15
II	Fermenter – Design, types and construction, Instrumentation and control. Productivity. Yield coefficients. Heat production. Aeration and agitation. Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.			15
III	Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth processing, aqueous multiphase extraction - concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.			15
IV	Overview of pharmaceutical microbiology - Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, ophthalmologic preparation, implants.			15
V	Production of pharmaceutical products and quality assurance – Vaccines, immunodiagnosics, immuno-sera, immunoglobulin. Antibiotics - Penicillin, Griseofulvin, Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.			15
Text Books				
1.	Patel A. H. (2016). Industrial Microbiology. (2 nd Edition). Laxmi Publications, New Delhi.			
2.	Casida L. E. J. R. (2019). Industrial Microbiology. New Age International Publishers.			
3.	Sathyanarayana U. (2005). Biotechnology. (1 st Edition). Books and Allied (P) Ltd.			
4.	Reed G. (2004). Prescott and Dunn's Industrial Microbiology. (4 th Edition). CBS Publishers & Distributors.			

5.	Waites M. J., Morgan N. L., Rockey J. S. and Higton G. (2013). Industrial Microbiology: An Introduction. Wiley Blackwell Publishers.
References Books	
1.	Stanbury P. T. and Whitaker. (2016). Principles of Fermentation Technology. (3 rd Edition). Pergamon Press. NY.
2.	Handa S. S. and Kapoor V. K. (2022). Pharamcognosy, (4 th Edition). Vallabh Prakashan Publishers, New Delhi.
3.	Kokate C. K., Durohit A. P. and Gokhale S. R. Pharmacognosy. (2002). (12 th Edition). Nirali Prakasham Publishers, Pune.
4.	Hugo W. B. and Russell A. D. (2004). Pharmaceutical Microbiology. (7 th Edition). Blackwell Scientific Publication, Oxford.
5.	Wallis, T.E. (2005). Text book of Pharmacognosy. (5 th Edition). CBS publishers and distributors, New Delhi.
Web Resources	
1.	https://ib.bioninja.com.au/options/untitled/b1-microbiology_organisms/fermenters.html
2.	https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html
3.	https://www.sciencedirect.com/topics/biochemistry-genetics-andmolecular-biology/ethanol-fermentation
4.	https://www.usp.org/sites/default/files/usp/document/harmonization/genmethod/q05b_pf_ira_34_6_2008.pdf
5.	http://www.simbhq.org/

Pedagogy: Teaching / Learning methods
(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Develop microbial strains, carry out fermentation and recover the products of the process.	K1&K2
CO2	Design fermenters according to needs for various products.	K4&K5
CO3	Recover the end products of the fermentation process economically.	K5
CO4	Utilize the knowledge on pharmaceutical microbiology for industrial production of products.	K4&K5
CO5	Produce therapeutic products from microbes employing technology and analyze the quality the products.	K1&K2

Cognitive Level: K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1						L	L	M	L					
CO2						L	M	L	S					
CO3				M		L	M	M	L					
CO4						L	L	M						
CO5						L	M	L						

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course Code	Course Title	Hours of Teaching/ Cycle	No. of Credits
III	23P3MBSEC3	Skill Enhancement Course - Organic Farming and Bio fertilizer Technology	2	2
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization	√	Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics	√	
Addresses Human Values	√			
Course Objectives				
1	Impart knowledge on the importance, types and advantages of organic farming thereby creating awareness on conserving environment and natural resources, encouraging sustainable agriculture.			
2	Familiarize with the basic concepts of farm development and relate the development of organic farming in their countries to meet global trends.			
3	Explain the various types of biofertilizer and the scope in its production.			
4	Discuss about biofertilizer production and its field application, promoting economy.			
5	Develop the skill to analyze the quality of packaging, storage, assess the shelf life and bioefficacy of biofertilizers			
UNIT	Contents			No. of Hours
I	Organic farming – Definition, relevance. Biological nutrient management - Organic manures, vermicompost, green manure, organic residue, biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, biopesticides etc. Organic and conventional farming. Organic and chemical farming – Comparison. Certification and Schemes. Organic certification in brief. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes - NPOF, NHM, HMNEH, NPMSH&F and RKVY.			6
II	Biofertilizers - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- <i>Azospirillum</i> , <i>Azotobacter</i> , <i>Bacillus</i> , <i>Pseudomonas</i> , <i>Rhizobium</i> and <i>Frankia</i> . Cyanobacterial biofertilizers- <i>Anabaena</i> , <i>Nostoc</i> , <i>Hapalosiphon</i> and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers - Storage, shelf life, quality control and marketing.			6
Text Books				
1.	Sharma A. K. (2001). Hand book of Organic Farming. Agrobios.			
2.	Gaur A. C. (2006). Hand book of Organic Farming and Biofertilizers. Ambika Book Agency.			
3.	Subba Rao N.S. (2017). Bio-fertilizers in Agriculture and Forestry. (4 th Edition). Med Tech publisher.			
4.	Subba Rao N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4 th Edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.			
5.	Sathe T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.			

References Books	
1.	Rakshit A. and Singh H. B. (2015). ABC of Organic Farming. (1 st Edition). Jain Brothers.
2.	Dubey R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
3.	Bansal M. (2019). Basics of Organic Farming. CBS Publisher.
4.	Bhoopander G., Ram Prasad., (2019) Biofertilizer for sustainable agriculture and Environment, Springer
5.	Niir Board., (2012) (1 st Edition) Biofertiliser and organic farming
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://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE

	Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)	
	Course Outcomes	
CO Number	On completion of this course, students will;	
CO1	Produce biofertilizers and distinguish between organic and conventional farming.	K5&K6
CO2	Plan a Complete Farm Business including marketing, operation and financial outline.	K4
CO3	Practice the application of microbial bio-fertilizers in large scales, thereby increasing soil fertility.	K1&K2
CO4	Develop integrated farming for sustainable agriculture.	K5&K6
CO5	Promote the quality of packaging, storage, increase shelf life, accelerate the bio efficacy of bio fertilizers as per BIS standards	K5&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S		S	S	S	S	S	S	S	S	S	S		S
CO2	S	S	S	M	M	M	S	M						
CO3				S	S	S								
CO4						M			S	S				
CO5					M		S	S			S		M	S

S-Strong (3), M-Medium (2) L-Low (1)

Semester	Course Code	Course Title	Hours Teaching	No. of Credits
III	23P3MBAECC3	Ability Enhancement Compulsory Course - Research Methodology	2	2

Nature of the course

Employability Oriented		Relevant to Local need		Addresses Gender Sensitization	
Entrepreneurship Oriented		Relevant to regional need		Addresses Environment and Sustainability	√
Skill development Oriented	√	Relevant to national need		Addresses Human Values	
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

1. make the students to learn the principles and applications of biological techniques.
2. train the students to understand the main principles in biostatistics and apply statistical methods in biological experiments.
3. learn the students to understand the problem selection for research and project design
4. lay a strong foundation for the students to understand the basics of research publication, journal metrics and ethics in research.

SYLLABUS

Unit	Content	No. of Hours
I	BASIC LABORATORY REQUIREMENTS: Handling and maintenance of chemicals, solvents and glassware. Sterilization methods – Heat sterilization (Autoclave) and Chemical sterilization. Distillation, Pipetting, Filtering, Decanting and Lyophilization processes. Principle and application of Laminar Airflow chamber. Basic principle and applications of pH meter. Principle and application Crystellography.	9
II	RESEARCH DESIGN AND PUBLICATION ETHICS : Choosing a problem for research – Review of literature – Primary, Secondary and Tertiary sources – Analysis of data – Bibliography. Reporting the results of research in conferences – Oral presentation and Poster Presentation. Journal: peer reviewed and non-peer reviewed journals - Impact factor - Citation. Indexing databases - Web of Science and Scopus. Publication ethics - COPE, Scientific misconducts and Predatory publications.	9

Textbook:

1. Gurumani N, 2006. Research Methodology for Biological Sciences, MJP Publishers, Chennai.
2. Kothari CR, 2009. Research Methodology: Methods and Techniques (2nd Revised Edition), New Age International Publishers, New Delhi, India.
3. Ravichandran K, Ravichandran AT, Ayyanar M, Kavitha P, 2022. Research Methodology and Publication Ethics, A Researcher's Handbook, Jazym Publications, Trichy, India.

4. Mani K, Vijayaraj S, Padmanaban. Bioinformatics for Beginners.

References:

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
3. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.
4. Zar, J.H., 1984. Biostatistics Analysis, Prentice Hall International, England Cliffs, New Jersey.
5. SreeRamulu, V.S., 1988. Thesis Writing, Oxford & IBH Pub., New Delhi.

Web resources:

1. <https://www.kobo.com/in/en/ebook/bioinstrumentation-1>
2. <https://www.worldcat.org/title/bioinstrumentation/oclc/74848857>
3. <https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/B01JP3M9TW>
4. <https://en.wikipedia.org/wiki/bioinstrumentation>
5. <https://www.britannica.com/science/chromatography>

Pedagogy: Lecture, Assignment, PPT Presentation, Quiz, Group Discussion, Seminar.

Course Outcomes

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

CO Number	CO Statement	Cognitive Level
CO1	learn and remember the basic laboratory requirements.	K1
CO2	gain some knowledge on principles and application of bioinstruments	K2
CO3	evaluate the various aspects research and research design in thesis writing.	K5
CO4	create awareness on the standards of research journals and check plagiarism.	K6

K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	2	2	3	3	3	3	2	3	3
CO3	3	1	2	3	3	3	3	1	3	3
CO4	3	2	1	3	3	3	2	1	3	2
CO5	3	1	2	2	3	3	3	2	3	3

S-Strong (3)

M-Medium (2)

L-Low (1)

Semester	Course code	Course Title	Hours Teaching/Cycle	No. of Credits
IV	23P4MBC7	Food and Dairy Microbiology	6	4
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need		
Skill development Oriented		Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need		
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values				
Course Objectives				
1	Discuss microorganisms involved in food spoilage.			
2	Illustrate bacterial and nonbacterial food borne infections important in public health.			
3	Familiarize various national and international aspects of food safety and quality assurance.			
4	Elaborate on microbiology of milk, preservation techniques and production of dairy products.			
5	Explain Dairy plant hygiene, quality control and waste disposal.			
UNIT	Contents			No. of Hours
I	Microorganisms of food- Scope of food Microbiology. Contamination and spoilage of food –vegetables, fruits, poultry, fish, eggs, meat, meat products and canned foods. Food Preservation - Temperature (low and high), drying, radiation and chemicals.			18
II	Food microbiology and public health. Food hazards. Food infections - <i>Bacillus cereus</i> , <i>Vibrio parahaemolyticus</i> , <i>Escherichia coli</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Yersinia enterocolitica</i> , <i>Listeria monocytogenes</i> and <i>Campylobacter jejuni</i> . Nonbacterial food borne illness - Helminthes, nematodes, protozoa, toxigenic fungi and food borne virus.			18
III	Quality assurance of food - International aspects of Quality and safety assessment of foods. Microbiological quality standards for food. Government regulatory practices and policies - FDA, HACCP, BIS (IS), FSSAI-2014. Food adulteration and common food additives.			18
IV	Introduction to Dairy microbiology – Milk production and hygiene. Microorganisms associated with milk. Microbial metabolites and their role in spoilages- souring, curdling, gassiness, ropiness, proteolysis, lipolysis, abnormal flavour and colour. Antimicrobial systems in raw milk. Microbiological grading of raw milk. Milk borne diseases and their control. Bacteriological aspects of milk processing – Thermization, pasteurization, boiling, sterilization, UHT, bactofugation, and membrane filtration; Probiotics, prebiotics, postbiotics.			18
V	Composition and chemistry of cream, butter, ghee, ice-cream, cheese, yoghurt, kefir, koumiss, rennin, condensed and dried milks, infant food. Spoilage of ghee and use of antioxidants. Chemistry of milk fermentation. physico-chemical changes in the manufacture and storage of milk powder, lactose, crystallization and its significance. Dairy plant hygiene and sanitation. Disposal of dairy waste. Microbiological standards for Milk and Milk products- PFA BIS, Codex/ ISO standards.			18
Text Books				
1.	Adams M. R. and Moss M. O. (1996). Food Microbiology, New Age International (P) Limited Publishers, New Delhi.			

2.	Frazier W.C., Westhoff. D. C. and Vanitha K.N. (2013). Food Microbiology. (6 th Edition). McGraw Hill Education.	
3.	Jay J. M., Loessner M. J. and Golden D.A. (2006). Modern Food Microbiology. (7 th Edition). Springer.	
4.	Doyle M. P., Buchanan R. L. (2012). Food Microbiology: Fundamentals and Frontiers. (4 th Edition). American Societyfor Microbiology Press.	
5.	Ray B. and Bhunia A. (2013). Fundamentals of Food Microbiology. (5 th Edition). CRC Press.	
References Books		
1.	Robinson R. K. (2000). Dairy Microbiology 3 rd edn, Elsevier Applied Science, London.	
2.	Adams M.R, and Moss M.D, (2005). Food Microbiology 4 th edn, New Age International Pvt. Ltd., Publishers.First edition.	
3.	Banwarst. G.J. (2003). Basic Food Microbiology 2 nd edn, CBS Publishers and distributors.	
4.	Hobbs, B.C. and Roberts, D, (1968), Food Poisoning and Food Hygiene 7 th edn. Edward Arnold: London.	
5.	Vijaya R K, (2004). Food Microbiology 1 st edn. MJP Publishers, Chennai.	
Web Resources		
1.	https://www.fssai.gov.in	
2.	https://www.who.int/news-room/fact-sheets/detail/food-safety	
3.	https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines	
Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)		
Course Outcomes		
Course Outcomes		
CO1	Utilize the knowledge on process of food contamination and spoilage to preserve food.	K5&K6
CO2	Use the knowledge on food borne disease to protect public health.	K3&K4
CO3	Familiarize various national and international aspects of food safety and quality assurance.	K1&K2
CO4	Prepare dairy products and perform quality checks.	K1&K5
CO5	Apply microbiological standards to milk and milk products.	K2&K3

Cognitive Level: K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1							S	M	M					
CO2					S		M	M	M					
CO3				S			M	M						
CO4							M	M						
CO5							M	M						

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours Teaching/ Cycle	No. of Credits
IV	23P4MBC8	Bioinstrumentation and Biostatistics	5	4
Nature of the course				
Employability Oriented		√	Relevant to Local need	
Entrepreneurship Oriented		√	Relevant to regional need	
Skill development Oriented		√	Relevant to national need	
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability			Addresses Professional Ethics	√
Addresses Human Values				
Course Objectives				
1	Discuss the methods and technology			
2	Explain about the principles and application			
3	Discuss the basic concepts of Biostatistics.			
4	Describe statistical software for analysis.			
5	Explain the tests of significance.			
UNIT	Details			No. of Hours
I	Filtration – methods, filter media, filter aid, ultra filtration, Industrial filters – dead end filter, cross flow filter, Rotary vacuum filter, frame filter etc. Radioactive isotopes, half life of isotopes and tracer technique – autoradiography – scintillation and GM counters. Colorimeter, Flame photometer, atomic absorption spectrophotometer, NMR and FTIR.			15
II	Principle and application of chromatography, adsorption affinity and ion exchange, Gel permeation - GCMS and HPLC. Centrifugation- Principles, types, simple and differential, Ultra centrifugation, Isopycnic and rate zonal centrifugation – preparative and analytical – principles and application of pH meter - UV-Vis - Spectrophotometer.			15
III	Introduction to Biostatistics - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation. Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range, mean deviation and coefficient of variation. Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, correlation coefficient.			15
IV	Correlation and regression - Positive, negative, calculation of Karl-Pearsons coefficient of correlation. Linear regression and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. Tests of significance - Tests of significance: Small sample test (Chi-square test, t test, F test), large sample test (Z test) and standard error.			15
V	Probability and distributions - Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. RSM: methods for process optimization set up CCD, Box Behnken, optimal RSM design, regression models FDS curves, surface contours, multi linear constraints and categorical factors to optimal design.			15
Text Books				
1.	Sharma K. R. (2002) Research methodology. National Publishing House, New Delhi. Gurumani, N., (2006). Research Methodology for Biological Sciences 1 st Ed, MJP Publishers, Chennai.			
2.	Daniel W.W. (2005). Biostatistics; A foundation for analysis in the health sciences. (7 th Edition). Jhon Wiley & sons Inc, New York.			
3.	Rao P. S. S. and Richard J. (2006). Introduction to Biostatistics & Research methods. Prentice-Hall, New Delhi.			
4.	Veerakumari L. (2015) Bioinstrumentation 1 st edn. MJP Publishers.			
5.	Ahuja V.K. (2017) Laws Relating to Intellectual Property Rights. Lexis Nexis.			

References Books	
1.	Zar J. H. (2006). Biostatistical Analysis. (4 th Edition). Pearson Education Inc. New Jersey.
2.	Beins B. C. and McCarthy M.A. (2011). Research Methods and Statistics. Pearson Education Inc. New Jersey.
3.	Adams K. A. and Lawrence E. M. K. (2014). Research Methods, Statistics, and Applications. SAGE Publications, Inc., New Delhi.
4.	Anderson J.B. and Poole M. (2011). Assignment and Thesis Writing. 4 th edn. Wiley India Private Limited.
5.	Kothari C.R. and Garg G (2004) Research Methodology: Methods and Techniques. 2 nd Edition. New Age International Publishers
Web Resources	
1.	https://www.studocu.com/en-ca/document/mount-royal-university/quantitative-research-methods-and-data-analysis/lecture-notes-all-lectures/344093
2.	https://www.khanacademy.org/math/statistics-probability/sampling-distributions-library
3.	https://testbook.com/learn/maths-mean-median-mode/
4.	https://rcub.ac.in/econtent/ug/bcom/sem4/Business%20Statistics%20Unit%204%20Correlation%20and%20Regressiondf
5.	https://www.cse.iitk.ac.in/users/piyush/courses/pml_fall17/material/probabilty_tutorial.pdf

Pedagogy: Teaching / Learning methods
(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Evaluate the methods and uses of various types of filtration techniques	K4&K5
CO2	Analyze the principles and applications of chromatography	K4&K5
CO3	Recommend the utilization of biostatistics tools for analysis of biological data.	K1&K2
CO4	Prove and justify hypothesis for a particular research.	K6
CO5	Apply software tools for interpretation of biological data.	K1&K2

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	L			L					L	L				
CO2	M	M	M	M	M	M			M	M			M	
CO3					S	S			S	S			S	
CO4			S	S					S	S				
CO5				M					M	M			M	

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours Teaching	Credits
IV	23P4MBCP4	Practical IV - Food and Dairy Microbiology, Bioinstrumentation and Biostatistics	5	4
Nature of the course				
Employability Oriented	√	Relevant to Local need		
Entrepreneurship Oriented	√	Relevant to regional need		√
Skill development Oriented	√	Relevant to national need		√
Addresses Gender Sensitization		Relevant to Global development need		√
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
CO1	Enumerate bacteria in milk for quality analysis.			
CO2	Discuss tests for checking the quality of milk and milk products.			
CO3	Gain knowledge on microbes present in fermented foods and spoiled food.			
CO4	Explain isolation, identification and characterization of food borne pathogens.			
CO5	Analyze enzyme producing bacteria and detect toxins in spoiled food.			
UNIT	Contents			No. of Hours
I	Milk microbiology –Breed count, Direct microscopic count and Standard plate count, Presumptive test for coliforms.			15
II	Testing the quality of milk - Methylene blue reductase test, Resazurin test and alkaline phosphatase test.			15
III	Isolation of microbes from fermented foods – bacteria, fungi and yeast.			15
IV	Isolation of bacteria, fungi and yeast from spoiled food.			15
V	Analysis of enzyme producers. Production and detection of aflatoxins from spoiled food. Examination of fungi and bacteria in spoiled food using LPCB and Gram staining.			15
Text Books				
1.	Ray B. and Bhunia A. (2013). Fundamentals of Food Microbiology. (5 th Edition). CRC Press.			
2.	Garg N., Garg K. and Mukerji K. G. (2013). I K. International Pvt. Ltd.			
3.	Doyle M. P., Buchanan R. L. (2012). Food Microbiology: Fundamentals and Frontiers. (4 th Edition). American Society for Microbiology Press.			
4.	Robinson R. K. (2000). Dairy Microbiology ^{3rd} Edition , Elsevier Applied Science, London.			
5.	Adams M.R, and Moss M.D, (2005). Food Microbiology 4 th Edition, New Age International Pvt. Ltd., Publishers. First edition.			
References Books.				
1.	Hobbs, B.C. and Roberts, D, (1968), Food Poisoning and Food Hygiene 7 th Edition Edward Arnold: London.			
2.	Vijaya R K, (2004). Food Microbiology 1 st Edition. MJP Publishers, Chennai.			
3.	Banwarst. G.J. (2003). Basic Food Microbiology 2 nd Edition, CBS Publishers and distributors.			
4.	Narang S. P. (2004). Food Microbiology – Methods of Enumeration. APH Publishing Corporation, New Delhi.			
5.	Jay J. M., Loessner M. J. and Golden D.A. (2006). Modern Food Microbiology. (7 th Edition). Springer.			
Web Resources				
1.	https://www.fssai.gov.in			
2.	https://www.who.int/news-room/fact-sheets/detail/food-safety			

3.	https://academic.oup.com/bioscience/article/65/8/758/240222
4.	https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-A_review
5.	https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_StarterCultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download

Pedagogy:Teaching / Learning methods
(Please mention teaching / Learning methods like Lecture, Demonstration, Experimentation, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Check the quality of milk	K1&K2
CO2	Analyse quality checking of milk	K3
CO3	Knowledge of staining to differentiate the microbes	K1&K2
CO4	Data and types of microbes from fermented foods and spoiled food.	K5&K6
CO5	Knowing the enzyme production by bacteria and fungi, toxicity of food	K1&K2

**Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;
K5-Evaluate;K6-Create**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1							M			M				
CO2					S		M			M				
CO3					L					M				
CO4					M					M				
CO5					M					M				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours Teaching/ Cycle	Credits
IV	23P4MBEL5A	Elective - V Biosafety, Bioethics and IPR	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics		
Addresses Human Values	√			
Course Objectives				
1	Create a research environment. Encourage investigation, analysis and study the bioethical principles, values, concepts, and social and juridical implications in the areas of science, biotechnology and medicine.			
2	Discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotechnological products.			
3	Familiarize fundamental aspects of Intellectual property Rights in the development and management of innovative projects in industries.			
4	Acquire knowledge about bioethics, biodiversity and Genetically modified foods and food crops			
5	Provide students with an understanding of bioethics in research associated with medicine			

UNIT	Details	No. of Hours
I	Intellectual Property Rights: Different forms of Intellectual Property Rights – their relevance, importance to industry, Academia. Role of IPR's in Biotechnology, Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. International organizations and IPR - Overview of WTO, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.	15
II	Process involved in patenting. Patent Search - Procedural steps in patenting, process of filing, PCT application, pre-grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping.	15
III	Patentability of biotechnology inventions - Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Biotechnological inventions as patentable subject matter, territorial nature of patents - from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, tentative harmonisation efforts, implications of setting up a uniform world patent system.	15
IV	Introduction to bioethics - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods and food crops, organisms and their possible health implications and mixing up with the gene-pool.	15
V	Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: stem cell research, human genome project, use of animals in research, human volunteers for clinical research, studies on ethnic races. Nuremberg code.	15

Text Books	
1.	Usharani B., Anbazhagi S. and Vidya C. K. (2019). Biosafety in Microbiological Laboratories. (1 st Edition). Notion Press. ISBN-101645878856
2.	Satheesh M. K. (2009). Bioethics and Biosafety. (1 st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703
3.	Goel D. and Parashar S. (2013). IPR, Biosafety and Bioethics. (1 st Edition). Pearson education: Chennai. ISBN-13: 978-8131774700
4.	Raj Mohan joshi. Biosafety and Bioethics. Wiley Publications.
5.	Sibi. G Intellectual, Property Rights, Bioethics, Biosafety and Entrepreneurship in biotechnology. (2021). Wiley Publications.
References Books	
1.	Nithyananda K. V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
2.	Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited,
3.	Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis.
4.	Tony Hope (2004). Medical Ethics: A very Short introduction,. Oxford Publication.
5.	Goel Parashar. IPR, Biosafety and Bioethics (2013). Pearson Publications.
Web Resources	
1.	http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf .
2.	https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
3.	https://www.cdc.gov/training/quicklearns/biosafety/
4.	https://bioethics.msu.edu/what-is-bioethics
5.	https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

Pedagogy:Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Execute the role of IPR, Patent, Trademarks and its importance.	K5&K6
CO2	Develop patent procedure, patent filling and its mapping.	K1&K2
CO3	Become Patent attorneys and Patent officers.	K1&K2
CO4	Apply bioethics in GMO, food crops and its biodiversity.	K4&K5
CO5	Analyze the importance of bioethics in research associated with HGP, clinical research, stem cell therapy.	K4

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S	S	S		S	S								
CO2			S	S									M	
CO3		S	S	S			S		S					
CO4		S	S		S				S					
CO5	S		S		S	S			S	M				

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours Teaching/ Cycle	Credits
IV	23P4MBEL5B	Elective - V Water Conservation and Water Treatment Technology	5	3
Nature of the course				
Employability Oriented	√	Relevant to Local need	√	
Entrepreneurship Oriented	√	Relevant to regional need	√	
Skill development Oriented	√	Relevant to national need	√	
Addresses Gender Sensitization		Relevant to Global development need	√	
Addresses Environment and Sustainability	√	Addresses Professional Ethics	√	
Addresses Human Values	√			
Course Objectives				
1	Explain how societal and climatic changes will distress water supply and water demand in future			
2	Ascertain promising elucidations to the global water crisis and assess the pros and cons			
3	Acquire knowledge to identify the quality of water by standard method			
4	Illustrate the methods of water treatment technologies and assessing the impact of HWTS			
5	Describe the application and uses of various emerging water treatment technologies			
UNIT	Contents			No. of Hours
I	Water Scarcity; Major Causes of Water Scarcity, Types of Water Scarcity, Water Footprint- Effects of Water Scarcity Across the Globe-, Water Scarcity in India; Effects of Water Scarcity in India - Social and Political Effects and Economic Risks of Water Scarcity in India.			15
II	Multi-pronged approach to Prevent Water Scarcity; Aquifer Recharging, Water reuse and Zero-Liquid Discharge Technology, Coastal Reservoir, Desalination Plants-Measures for Preventing Water Scarcity in India - Jal Shakti Abhiyan Campaign, Atal Bhujal Yojana, Adoption of Composite Water Management Index (CWMI), Water conservation resource management, Rain Water Harvesting.			15
III	Water Quality and Pollution; Impurities in the water, Characteristics of different water sources Vulnerability of the water sources to contamination, Water quality criteria - Quality of surface waters, flowing waters, impounded waters, Groundwater, Water quality standards, Microbiological quality of drinking Water, Chemical quality of drinking water.			15
IV	Water Treatment Technologies; Sedimentation, Filtration, Coagulation and flocculation, Water softening and adsorption processes, membrane filtration, microfiltration, ultrafiltration and nanofiltration, water disinfection, Activated carbon filtration, Household Water Treatment and Safe Storage (HWTS). Methods for household water treatment Safe water storage, Household water treatment and safe storage decision tree, Assessing the impact of HWTS, Government policies for HWTS.			15
V	New and Emerging Drinking Water Treatment Technologies; Nanotechnology, Acoustic nanotube technology, Photocatalytic water purification technology, Aquaporin Inside™ technology, Automatic Variable Filtration (AVF) technology, Sun Spring System, Desalination.			15
Text Books				
1.	Vasileios A., Tzanakakis N. Paranychianakis V. and Angelakis A. N. (2020). Water Supply and Water Scarcity. MDPI, ISBN 978-3-03943-306-3 (Hbk). ISBN 978-3-03943-3070.			
2.	Pannirselvam M., Shu Li.,Griffin G., Philip L., Natarajan A. and Hussain S. (2019). Water Scarcity and Ways to Reduce theImpact. ISBN: 978-3-319-75199-3.			

3.	Tiwari A., Kumar A., Singh A., Singh T.N., Suozzi E., Matta G. and Russo S. (2022). Water Scarcity, Contamination and Management. Elsevier. ISBN: 9780323853781.
4.	Daniel, C.J. (1996). Environmental Aspects of Microbiology, 1 st edn. Bright Sun Publications
5.	Maier RM, Pepper IL, Gerba CP (2008). Environmental Microbiology, 2 nd edn. Academic Press
References Books	
1.	Fujita K. and Mizushima T. (2021). Sustainable Development in India -Groundwater Irrigation, Energy Use, and Food Production. ISBN 9780367460976.
2.	Gupta R. (2008). Water Crisis in India. Atlantic Publishers. ISBN: 9788126909582, 9788126909582.
3.	Ahuja S. (2013). Monitoring Water Quality-Pollution Assessment, Analysis, and Remediation. Elsevier. Book ISBN: 9780444594044. Hardcover ISBN: 9780444593955.
4.	Saeid Eslamian ., Faezeh Eslamian ., (2021) Water harvesting and conservation – Basic Concepts and fundamentals, WileyPublications.
5.	Buckley RG. (2016) Environmental Microbiology 1 st edn. CBS Publishing.
Web Resources	
1.	https://link.springer.com/book/10.1007/978-1-59745-278-6
2.	https://apps.who.int/iris/handle/10665/206916?show=full
3.	https://www.acs.org/content/acs/en/policy/publicpolicies/sustainability/water-statement.html
4.	https://www.toftigers.org/best-practice/water-conservation-and-treatment/
5.	https://doh.wa.gov/community-and-environment/wastewater-management/site-sewage-systems-oss

Pedagogy: Teaching / Learning methods

(Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Appraise issues of water scarcity, stress, and conflict on global population.	K1&K2
CO2	Apprehend the multiple approaches against water scarcity and to understand various government schemes for water conservation.	K4&K5
CO3	Relate the connection between water quality and public health.	K1&K2
CO4	Design and execute standard strategy for successful HWTS implementation.	K4&K5
CO5	Cogitate the purpose, principles, operation, and limitation of various modern water treatment technologies.	K5&K6

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1	S	S		S	S					S				
CO2	S	S			S					S				S
CO3				S		S				S				
CO4				S	S	S			S					
CO5					S		M	S	S	S	S			

S-Strong(3), M-Medium(2) L-Low(1)

Semester	Course code	Course Title	Hours teaching/ Cycle	No. of Credits
IV	23P4MBSEC4	Skill Enhancement Course - Microbial Quality Control and Testing	2	2
Nature of the course				
Employability Oriented		√	Relevant to Local need	√
Entrepreneurship Oriented		√	Relevant to regional need	√
Skill development Oriented		√	Relevant to national need	√
Addresses Gender Sensitization			Relevant to Global development need	√
Addresses Environment and Sustainability		√	Addresses Professional Ethics	
Addresses Human Values		√		
Course Objectives				
1	Explain various microbiological quality standards for food, water and air regulatory practices and policies.			
2	Discuss collection, processing and preservation of water samples from industries in different areas.			
3	Enumeration and isolation of microorganism from the water samples.			
4	Enumeration and isolation of microorganism from the air samples.			
5	Gain knowledge on sterility testing of different components in industries and quality control techniques.			

UNIT	Contents	No. of Hours
I	Concepts of quality control techniques - quality assurance, Total Quality Management (TQM) Continuous Quality Improvement (CQI) Quality Assurance (QA) preanalytical and post analytical techniques, ATCC, MTCC, microbial based assay. Quality control in food - Food X ray inspection, PPE Equipment, IoT sensors, preventive quality control and reality quality control. Quality control of pharma products. Quality assurance framework, assessment of pharmaceutical quality, determinants of pharmaceutical quality, practical approaches to quality assurance.	6
II	Microflora of water. Microbiological analysis of water sample. Microbiological analysis of water sample collection, drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: MPN tests, (b) Membrane filter technique and (c) Presence/absence tests Control of microbes in water: Microflora of air - Bioaerosols, (bacteria, Viruses, fungi) Collection of air samples and analysis. Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, isolation and Identification. Control Measures of Bioaerosols - UV light, HEPA filters, desiccation, Incineration.	6
Text Books		
1.	Aneja R. P., Mathur B.N., Chandan R. C. and Banerjee, A. K. (2002). Experiments in Microbiology.	
2.	Adams M. R. and Moss M. O. (2006). Food Microbiology. (2 nd Edition). Royal Society of Chemistry.	
3.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.	
4.	Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.	
5.	Rosamund M. Baird., Norman A. (2019). Handbook of Microbiological quality control in Pharmaceuticals and Medical Devices. CRC Press.	

References Books	
1.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2 nd Edition). -Taylor &Francis.
2.	Sundararaj T. (2003). Microbiology Laboratory Manual. (2 nd Edition). Published by A. Sundararaj
3.	Hoges N. A., Denyer S P. and Baird R.M. (2003). Handbook of microbiological quality control. Microbial Quality Assurance in Pharmaceuticals, cosmetics & Toiletries. by Sally F. Bloomfield
4.	Amitava Mitra. Fundamentals of Quality control and Improvement. (3 rd Edition). Wiley Publications
5.	David Roesti, Marcel Goverde (2019). Pharmaceutical Microbiological Quality Assurance and control: Practical guide for non- sterile Manufacturing. Wiley Publishers.
Web Resources	
1.	https://www.researchgate.net/publication/320730681
2.	https://www.fssai.gov.in
3.	https://mofpi.nic.in/Schemes/implementation-haccp-iso-22000-iso-9000-ghp-gmp-etc
4.	https://www.who.int/news-room/fact-sheets/detail/food-safety
5.	https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines

Pedagogy: Teaching / Learning methods (Please mention teaching / Learning methods like Lecture, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Apply knowledge in quality analysis techniques suitable for industries.	K4&K5
CO2	Perform water managements, water harvesting and treat sewage, water pollutions and remedies.	K1&K2
CO3	Detect portability of water. Test water quality.	K4&K5
CO4	Impart knowledge on bioaerosols, impact and prevention	K1&K2
CO5	Apply quality control techniques for food and pharma products	K4&K5

Cognitive Level : K1-Remember;K2-Understanding;K3-Apply;K4 -Analyze;K5-Evaluate;K6-Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
CO1				M	L		S	S						
CO2				M	L		M	M						
CO3				S	L		S	S						
CO4				S	L		S	S						
CO5				S	L		M	M						

S-Strong(3), M-Medium(2) L-Low(1)