MOTHER TERESA WOMEN'S UNIVERSITY

KODAIKANAL - 624 101
Tamil Nadu.

Curriculum Framework and Syllabus for

M.Sc. MICROBIOLOGY

Programme code: PG-MBT

(For the candidates to be admitted from the academic year 2021-2022 onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

M.Sc Microbiology

1. About the Programme:

M.Sc. in Microbiology is a two years postgraduate programme offered in 4 semesters. The program combines the concepts of biology and chemistry to understand living things and their relationship with the ecosystem. The course covers the study of microorganisms and their effect on human life. Microbiologists are needed to do the research required for the future battle against infectious diseases worldwide, understanding the environmental importance of microbes and to exploit them for food production, biotechnological and industrial applications. This advanced course can help students in taking a career in Research as well as getting employed in companies like pharma, healthcare, agri-based and many other life science sectors.

2. Programme Educational Objective:

PEO1	To train the students in basic and advanced areas of microbiology, industrial microbiology, agriculture & environmental microbiology and other related subjects along with sensitizing them to the scope for research.
PEO2	To empower the students with analytical and research skills, to nurture entrepreneurial endeavors
PEO3	To prepare a competent generation of microbiologists, capable of excelling in their careers
PEO4	To develop them with good communicative skills and function effectively as an individual and as a team member in a professional environment.
PEO5	To develop microbiologist with professional ethics in order to address global and societal issues for sustainable development.

3. Eligibility:

- Candidate should have passed a UG degree (B.Sc Microbiology/ Biochemistry/ Zoology/ Botany/Immunology/Biotechnology/Applied Microbiology/Integrated Biology/Medical Microbiology) or equivalent life science degree.
- Candidate should have secured at least 50%.
- A relaxation of 5-10% in the total percentage will be given to SC, ST candidates.
- Candidates sponsored by industries/hospitals/Clinical laboratories may be considered for admission.

4. General Guidelines for PG Programme

i. **Duration:** The programme shall extend through a period of 4 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.

ii. **Medium of Instruction:** English

iii. **Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

Evaluation Pattern	Theory		Practical	
	Min	Max	Min	Max
Internal	**13**	**25**	**13**	**25**
External	**38**	**75**	**38**	**75**

- **Internal (Theory): Test (15) + Assignment (5) + Seminar/Quiz(5) = 25**
- **External Theory: 75**

- **Question Paper Pattern for External examination for all course papers.**

Max. Marks: 75 **Time: 3 Hrs.**

S.No.	Part	Type	Marks
1	**A**	**10*1 Marks=10** Multiple Choice Questions(MCQs): 2 questions from each Unit	**10**
2	**B**	**5*4=20** Two questions from each Unit with Internal Choice (either / or)	**20**
3	**C**	**3*15=45** Open Choice: Any three questions out of 5 : one question from each unit	**45**
Total Marks			**75**

*** Minimum credits required to pass: 90**

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 line space.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

5. Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding
80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	Very Good
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

6. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance less than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

8. Any Other Information

In addition to the above mentioned regulations, any other common regulations pertaining to the PG Programmes are also applicable for this Programme.

9. PROGRAMME OUTCOMES (POs):

On completion of M.Sc Microbiology programme, students will be able to

PO1	apply knowledge to develop critical thinking and practical understanding in the field of microbiology to find solutions for human benefits.
PO2	acquire, retain and apply specialized concept and knowledge relevant to plethora of microbiological field
PO3	gain familiarity with the role of microbes in human disease, the role of microbes in issues of international health, and the human immune response to microbial infection
PO4	gain hands on experience in state-of-the-art laboratory equipment that could enrich them to perform high throughput research on microorganisms and execute diagnostic procedures required in food, dairy and pharmaceutical industries
PO5	communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
PO6	develop the skill to think independently, plan research and execute it in different fields of Microbiology
PO7	opt for higher studies, jobs in various sectors and entrepreneurship abilities in the field of microbiology
PO8	acquire the ability to function effectively on teams to accomplish a common goal.

10. Programme Specific Outcomes (PSOs):

On completion of M.Sc Microbiology programme, Students will be able to

PSO1	get sufficient knowledge in principles and applications of microbiology to be applied as future prospect.
PSO2	develop efficient and effective methodologies based on modern techniques to be used in research institutions and industries.
PSO3	exhibit contemporary theory and research knowledge in microbiology and can peruse career in divers field Industries like pharmaceutical, bio fertilizer industry, aquaculture industries, marine sectors, dairy industries, environmental units, crop production units, food processing industries, national bio-resource development firms, government research institutions etc. as well as in education sectors.
PSO4	start entrepreneurship ventures such as consultancy, training centres, diagnostic centre and new innovation using various funding scheme of government.
PSO5	understand the potentials, and impact of microbiological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.

M.Sc MICROBIOLOGY

Sl. No	Paper Code	Course Title	Credits	Hours		(CIA)	(ESE)	Total
				L	P			
Semester I								
1.	P21MBT11	Core I-General Microbiology	4	5	-	25	75	100
2.	P21MBT12	Core-II Microbial Diversity	4	5	-	25	75	100
3.	P21MBT13	Core-III Microbial Physiology and Metabolism	4	5	-	25	75	100
4.	P21MBT14	Core-IV Microbial Genetics	4	5	-	25	75	100
5.	P21MBP11	Core-V Practical - General Microbiology, Microbial Diversity, Microbial Physiology, Microbial Metabolism and Microbial Genetics	4	-	6	25	75	100
6.	P21CSS11	**Supportive Course I** (Skill)-Computer Skills for Web Designing and Video Editing	2	-	4	25	75	100
		Total	**22**	**30**		**-**	**-**	**700**
Semester II								
7.	P21MBT21	Core VI – Molecular Biology	4	5	-	25	75	100
8.	P21MBT22	Core-VII - Environmental Microbiology	4	4	-	25	75	100
9.	P21MBT23	Core-VIII – Immunotechnology	4	5	-	25	75	100
10.	P21MBT24	Core-IX Advanced Medical Microbiology	4	4	-	25	75	100
11.	P21MBP22	Core-X Practical -Molecular Biology, Environmental Microbiology, Immunotechnology and Advanced Medical Microbiology	4	-	6	25	75	100
12.		**Non Major Elective**	4	4	-	25	75	100
13.	P21MBS22	**Supportive Course II**(Skill) –Biosafety, Bioethics & IPR	2	2	-	25	75	100
		Total	**26**	**30**		**-**	**-**	**700**
Semester III								
14.	P21MBT31	Core XI Food & Dairy Microbiology	4	4	-	25	75	100
15.	P21MBT32	Core-XII Bioprocess Technology	4	4	-	25	75	100
16.	P21MBT33	Core-XIII Soil and Agricultural Microbiology	4	5	-	25	75	100
17.	P21MBT34	Core-XIV Recent trends in Virology	4	5	-	25	75	100
18.	P21MBT35	Core XV –Microbial Biotechnology	4	4	-	25	75	100

19.	P21MBP33	Core-XVI **Practical** -Food Microbiology, Bioprocess Technology, Agricultural Microbiology, Recent trends in Virology and Microbial Biotechnology	4	-	6	25	75	100
20.	P21WSS33	**Supportive Course III** - Women Empowerment	2	2	-	25	75	100
		Total	**26**	**30**				**700**
Semester IV								
21.	P21MBE411/ P21MBE412	**Elective-I*** Biostatistics and Scientific Writing/ Bioinstrumentation techniques/Any MOOC[$]	4	4		25	75	100
22.	P21MBE421/ P21MBE422	**Elective-II*** Bioinformatics/ Proteomics & Genomics/Any MOOC[$]	4	4		25	75	100
23.	P21MBR41	Project	8	22		25	75	100
		Total	**16**	**30**				**300**
			90	**120**				**2300**

Additional Credit Courses (Mandatory)

P21MBI21- Internship/Industrial Training – Two Credits- (Second Semester)
P21MBO31-Online Courses-Two Credits - (Third Semester)
P21MBV11-Value Added Program I-Two Credits (First Semester) Advanced techniques in Clinical Microbiology
P21MBV41-Value Added Program II-Two Credits (Fourth Semester) Public health and hygiene

Non Major Elective (NME)

NME - **P21MBN21** - Food Fermentation Techniques - - II Semester

Outside class hours

- Health, Yoga and Physical Fitness
- Library Information access and utilisation
- Employability Training

*Those who have CGPA as 9, and want to do the project in industry/institution during IV semester, may opt for these two papers in III semester.

[$] Students can take one 4 credit course in MOOC as elective or two 2 credit courses in MOOC as elective with the approval of Department committee.

SEMESTER I

Course Code	P21MBT11	General Microbiology	L	T	P	C
Core I			5	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Evaluate					
Learning objective	• To get an inspiration by knowing the history and development of Microbiology • To know the difference between Prokaryotic and Eukaryotic cell and their organelles • To understand the microbial control measures • To compare and distinguish the basic group of microbes					
Unit I	**History of Microbiology and Microscopy**					
Historical and recent developments -Scope of microbiology- Spontaneous generation and germ theory of disease - Major contribution of scientists–Leeuwenhoek, Edward Jenner, and Alexander - Fleming, Joseph Lister, Robert Koch and Louis Pasteur- Brief view on bacterial classification according to Bergey's manual of Determinative bacteriology. Microscopy: Simple, Compound, Dark field, Phase contrast, Fluorescence and Electron microscopy.						
Unit II	**Ultrastructure and functions of Prokaryote Cell**					
The Prokaryotic cell - cell wall –Gram negative, Gram positive, halophiles. L-forms and Archaebacteria, Cell wall synthesis, cell membrane, capsule type's composition and function. Structure and function of flagella, fimbriae and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials - polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. Nuclear material - bacterial chromosomes and bacterial plasmids.						
Unit III	**Ultrastructure and functions of Eukaryote Cell**					
Cilia, flagella, cytoskeleton, plasma membrane systems, mitochondria, endoplasmic reticulum, golgi apparatus and chloroplast. Comparison of Prokaryotic and Eukaryotic cell.						
Unit IV	**Microbial control**					
Physical methods - Heat, (Low & High temperatures), Filtration, high pressure, Osmotic pressure, Radiation, and Desiccation. Chemical methods – chemical agents, types and mode of action- Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value).						
Unit V	**Microbiological Techniques**					
Cultural techniques: pure culture techniques, types of media - media preparation - preservation of cultures - aerobic and anaerobic culture techniques - growth of bacteria: batch and synchronous culture - factors influencing growth - growth curve-Microbial nutrient – macro nutrients, micro nutrients, growth factors and sources of nutrients- Methods to study microbial morphology - wet mount and hanging drop method. Staining techniques - Gram's, acid fast, spore and capsule staining.						
Textbook	1. Pelczar, M.J., Schan, E.C. and Kreig, N.R.2010. Microbiology – An application based approach, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi. 2. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. Microbiology, Fifth Edition, McGraw Hill, New York. 3. Dubey, R.C. and Maheswari, D.K. A Text book of Microbiology, Revised S. Chand and Company Ltd, NewDelhi; 2013. ISBN -13 978-8121925594.					

References	1. Michael T. Madigan,Kelly S. Bender,Daniel H. Buckley,W Matthew SattleyandDavid A. Stahl. Brock Biology of Microorganisms. 15th edition .Pearson Education. United Kingdom;2018.ISBN-13: 9780134261928 2. Schlegal, H.G.General Microbiology. Seventh edition. Cambridge Univeristy Press, USA; 2006.ISBN-13: 978-0521696210. 3. Jeremy M. Berg ,LubertStryer, John Tymoczko and Gregory Gatto . Biochemistry. 9th edition. WH Freeman; 2019. ISBN-13: 978-1319114657. 4. Tortora G.J., Funke, B.R. and Case, C.L.2009. Microbiology, Ninth Edition, Dorling Kindersely (India) Pvt. Ltd., Noida. 5. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi. 6. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2009. Twelth Edition, Brock Biology of Microorganisms, Mac MillanPress,England. 7. Gerard J. Tortora, Berdell R. Funke and Christine L. Case.Microbiology: An Introduction. 12th edition. Pearson Education; 2016. ISB13 9780321929150. 8. Atlas, R.A. and Bartha, R. Microbial Ecology, Fundamentals and Application, 4th edition, Pearson Education; 1997.ISBN-13 978-978-0805306552.
E-references	1. https://www.nature.com/subjects/microbiology#:~:text=Microbiology%20is%20the%20study%20of,host%20response%20to%20these%20agents. 2. https://www.moscmm.org/pdf/Ananthanarayan%20microbio.pdf 3. https://www.ncbi.nlm.nih.gov/books/NBK21523/

Course outcome

Upon completion of this course, the students will be able to		
CO1	Know the history and development of Microbiology, contributions of various scientists and microscopy.	K1
CO2	Acquire knowledge on prokaryotic and eukaryotic cell structure and its function	K2
CO3	Compare the structure of prokaryotic and eukaryotic cells	K3
CO4	Apply the knowledge to control microbes.	K4
CO5	Gain knowledge on microbiological techniques.	K1

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	M	S	S	S	S	M	S	S	M
CO5	S	S	S	S	S	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT12	MICROBIAL DIVERSITY	L	T	P	C
Core II			5	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To gain knowledge on the principles of microbial diversity, phylogeny and taxonomy. • To understand the different aspects of the classification system • To learn the salient features of bacteria, algae, fungi, virus and Protozoa.					
Unit I	**General Classification**					
General principles of classification of microorganisms – Haekel's three kingtom concept – Whittaker's five kingdom concept – three domain concept of Carl Woese. Evolutionary methods in classification - International codes of nomenclature - Taxonomic approaches and Phylogeny – Brief outline on metagenomics.						
Unit II	**Bacteriology**					
Classification and salient features of bacteria according to Bergey's manual of determinative bacteriology, cyanobacteria, and cyanells. Bacteria and Actinomycetes, Rickettsias, Chlamydiae and mycoplasma according to Bergey's Manual of Determinative Bacteriology (IX Ed.). In-depth study of *E. coli, Rhizobium* sp., *Rhodomicrobium*sp., Methane oxidizing bacteria *Methanobacteria*sp., Cyanobacteria. Economic importance of bacteria						
Unit III	**Phycology and Mycology**					
Classification and salient features of algae – nutrition, thallus characteristics and reproduction. Characteristics of green algae, diatoms, euglenoids, brown Rhodophyta, pyrrophyta. Economic importance of algae. Principles and outline classification of fungi: *Myxomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes, Zygomycetes, Acrasiomycetes*and *Oomycetes.* In-depth study of *Aspergillus*sp., *Candida* sp., *Mucor*sp and *Agaricus*sp. Economic importance of fungi.						
Unit IV	**Virology**					
Classification and salient features of viruses. Nature and properties in relation to classification. Structure and in-depth study of T4, λ, M13 and HIV. Brief outline on virions and Prions.						
Unit V	**Protozology**					
Principles and outline classification of protozoa: Sarcodina, Mastigophora, Ciliata and Sporozoa. Structure and in-depth study of *Entamoebahistolytica and Plasmodium vivax.*						
Textbook	1. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig. (2000). Microbiology. V Ed. TataMcGraw Hill Book Company. 2. Schlegal, H.G. 2008. General Microbiology, Seventh edition, Cambridge Univeristy Press. 3. Dubey, H.C. and D.K.Maheswari, 2010. A text book of Fungi, Bacteria and Viruses.,Vikaas Publishing HouseLtd. Ltd. Pp: 1-341. 4. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed.WCB/McGraw Hill Company. pp: 335 to 553. 5. Alexopoulos, C.J. and Mims, C.W. (1979). Introductory Mycology, John Wiley,New York. 6. John G. Holt. 1994. Bergey's Manual of Determinative Bacteriology. Lippincott Williams and Wilkins. Pp: 351-352; 597-724.					
References	1. Jeffery C. Pommerville (2016). Alcamo's Fundamentals of Microbiology (Third Edition).Jones and Bartlett Learning. LLC, Burlington, MA 01803.					

	2. HansG. Schlegel. 2012. General Microbiology. VII Ed. Cambridge University Press. UK. 3. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi. 4. S. Biwasis and AmitaBiswas. 1998. An Introduction to Viruses. VikaasPublishingHouse Pvt. Ltd. Pp: 1- 17; 209 – 224. 5. Chatterjee, K. D. 1981. Parasitology. Chatterjee Medical Publishers. Pp: 1-106. 6. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms:Milestones in Microbiology. Prentice-Hall International Inc. London.
E-references	1. https://www.nature.com/subjects/microbiology#:~:text=Microbiology%20is%20the%20study%20of,host%20response%20to%20these%20agents. 2. https://www.moscmm.org/pdf/Ananthanarayan%20microbio.pdf

Course outcome

Upon completion of this course, the students will be able to		
CO1	Know the classification of both prokaryotes and eukaryotes.	K1
CO2	Understand the basic principles and methods of classification of bacteria and an in-depth knowledge on *E. coli, Rhizobium* sp., *Rhodomicrobium*sp., *Methanobacteria*sp., *and* Cyanobacteria.	K2
CO3	Understand and interpret the basic principles and methods of classification of algae and fungi and an in-depth knowledge on *Aspergillus*sp., *Candida* sp., *Mucor*sp., and *Agaricus*sp., green algae,diatoms, euglenoids, brown rhodophyta and Pyrrophyta.	K2
CO4	Acquire knowledge about the the basic principles and methods of classification of viruses and an in-depth knowledge on T4, λ, M13 and HIV	K2
CO5	Understand and interpret basic principles and methods of classification of protozoa and an in-depth knowledge on *Entamoebahistolytica and Plasmodiumvivax.*	K2

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	M	S	S	S	S	M	S	S	M
CO5	S	S	S	S	S	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT13	MICROBIAL PHYSIOLOGY AND METABOLISM	L	T	P	C
Core III			5	-	-	4
Cognitive Level	K2: Understand K4: Evaluate					
Learning objective	• To understand the microbial growth and effect of environment on microbial growth • To understand the Prokaryotes membrane transport system • To attain knowledge on the physiology and metabolism of microbial system.					
Unit I	**Growth of Bacteria**					
Phases of growth, Growth kinetics - batch culture, continuous culture and synchronous culture - induction of synchrony. Factors affecting growth - nutrition, aeration, temperature and pH. Physiological adaptation to extreme environmental conditions. Sugar degradation: EMP, ED, Pentose pathway cycle and TCA cycle. Nutritional types and metabolic diversity - types based on carbon, energy and electron sources. ETC, electron transport phosphorylation, uncouplers and inhibitors						
Unit II	**Bacterial Photosynthesis**					
Historical background. General types of microbial photosynthesis - oxygenic and anoxygenic. Structure of photosynthetic pigments – chlorophylls, bacteriochlorophyll, carotenoids and phycobilins. Photosynthetic bacteria - green sulphur and purple. Mechanism of photosynthesis - non-cyclic and cyclic electron transport. Photophosphorylation. Carbon assimilation - calvin, reverse citric acid cycle and hydroxyl propionate cycle.						
Unit III	**Membrane transport**					
Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+ -glucose symporter. ABC transporters. Ion channels - voltage-gated ion channels (Na+ /K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporin and bacteriorhodopsin.						
Unit IV	**Protein and Lipid metabolism**					
Biosynthesis of Fatty acids.Nucleic acid pathway – De Novo Synthesis and Salvage pathway. **Sporulation:** Biosynthesis of bacterial cell wall - Spore structure and function - Cell division – endospore – structure – properties – Stages of germination.						
Unit V	**Microbial adaptation**					
Nutrient stress and starvation stress. Fermentative pathways in specific group of microbes: alcoholic, lactic acid, formic, mixed, propionic, butyric, butanol, butane diol fermentation. Anaerobic respiration. Osmotic stress and osmoregulation; Aerobic to anaerobic transitions; Oxidative stress; pH stress and acid tolerance; Thermal stress and heat shock response. Bioluminescence and Quorum Sensing.						
Textbook	1. Moat, A.G. and Foster, W. Spector, M.P. Microbial Physiology.4th edition .John Wiley and Sons, New York 2002. 2. Schlegel, H.G.2008. General Microbiology, Seventh Edition, Cambridge University Press, Great Britain.					
References	1. 1.Michael T. Madigan, Kelly S. Bender,Daniel H. Buckley,W Matthew Sattley and David A. Stahl. Brock Biology of Microorganisms. 15th edition .Pearson Education. United Kingdom;2018. ISBN-13: 978013426192. 2. David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry. Eighth edition|. Macmillan;2021. 3. Satyanarayana, U. and Chakrapani, U. Biochemistry, Fifth Edition.					

	Elsevier India; 2020.ISBN: 9788131262535. 4. 4.Donald Voet, Judith G. Voet and Charlotte W. Pratt. Fundamentals of Biochemistry: Life at the Molecular Level. 5th Edition. Wiley; 2016. ISBN: 978-1-118-91840-1. 5. 5.Srivastava, M.L. Microbial Biochemistry. First edition.Alpha Science International Ltd; 2008.ISBN-13 978-1842654248. 6. Deb, A.C. Fundamentals of Biochemistry. 9th edition. New Central Book Agency (p) Ltd; 2001.ISBN-13: 978-8173811449. 7. Jeremy M. Berg,LubertStryer, John Tymoczko and Gregory Gatto . Biochemistry. 9th edition. WH Freeman; 2019.ISBN-13: 978-1319114657.
E-references	1. https://www.biotecharticles.com/Biology-Article/The-Process-of-Bacterial-Photosynthesis-and-its-Importance-671.html.

Course outcome

Upon completion of this course, the students will be able to		
CO1	Understand the growth of microbes and its metabolism	K2
CO2	Have knowledge on bacterial photosynthesis	K2
CO3	Understand the transport mechanisms through the membranes	K2
CO4	Inculcate knowledge on protein and lipid metabolism	K2
CO5	Know the process of stress pathway and analyze its response	K4

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	S	S	S	S	S	S	S
CO2	M	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT14	MICROBIAL GENETICS	L	T	P	C
Core -IV			5	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To learn the mechanisms of genetic transfer in different organisms • To know the molecular nature of mutations in cells. • To acquire knowledge on DNA damage and repair mechanisms • To understand the transposable elements and gene regulation in living organisms.					
Unit I	**Introduction about Microbial Genetics**					
Mechanisms of Genetic transfer - Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.						
Unit II	**Mutation**					
Origin of mutation. Biochemical basis of mutation: Spontaneous mutation – random and non – adaptive mutation, mutation rates. Origin of spontaneous mutation – isolation of mutants. Selection of bacterial variation: Direct - fluctuation test, indirect - replica plating. Mutagenesis and mutagenic agents. Detection of mutagen - Ames test, in vitro mutagenesis. Molecular basis of mutation.						
Unit III	**DNA damage & repair**					
DNA damages, hit theory, UV radiation. DNA repair: post irradiation effects on survival levels - photo reactivation, liquid holding recovery. Biochemical repair mechanism: excision, recombination and SOS repair.						
Unit IV	**Transposable elements**					
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Eukaryotic transposable elements - Yeast (Ty retro transposon), Drosophila (P elements), Maize (Ac/Ds). Uses of transposons and transposition.						
Unit V	**Gene concept**					
Regulation of bacterial gene expression. Lactose system - coordinate regulation, Lac components, positive and negative regulation, catabolite repression. Tryptophan operon - attenuation. Arabinose operon and its regulation.						
Textbook	1. Malacinski, G.M. 2015. Freifelder"s essentials of Molecular biology, 4th edn. Jones &Barlett learning, New Delhi 2. Channarayappa, 2015. Molecular Biology, University Press, Hyderabad.					
References	1. Benjamin Lewin.Genes VIII. International edition.PearsonEducation ;2003. 2. David Freifelder. Molecular Biology. Second Edition. Narosa Publishing house. New Delhi; 2004. 3. Jeyanthi, G.P. Molecular Biology. MJP Publishers. Chennai; 2009. 4. Kornberg, A. and Baker, A. DNA Replication. Second Edition. University Science Books; 2005. 5. LewinB.GeneVII.Oxford University Press ,Southern Africa; 2000 6. Singer, M. and Paul Berg.Genes& Genomes. University Science Books. California; 1996. 7. Jeremy M. Berg , Lubert Stryer, John Tymoczko and Gregory Gatto . Biochemistry. 9th edition. WH Freeman; 2019.					

	8. Alexander G. McLennan, A. D. Bates ,M. R. H. White,P.C. Turner and Philip C Turner . Instant Notes in Molecular Biology, Springer-Verlag New York; 1997. 9. De Roberties E.D.P and E.M.F.DeRoberties 2011. Cell and Molecular Biology.VIIIEdn. Lippincott Williams & Wilkins, Pheladelphia.
E-references	1. https://www.biologydiscussion.com/dna/dna-damage-types-and-repairmechanismswithdiagram/16332#:~:text=DNA%20has%20many%20elaborate%20mechanisms,mismatched%20with%20the%20complementary%20strand.

Course outcome

Upon completion of this course, the students will be able to		
CO1	acquire knowledge on genetic transfer mechanisms.	K1
CO2	know the mutations and detection of mutagens.	K1
CO3	understand the DNA damage and repair mechanisms.	K2
CO4	understand the transposable elements and their applications.	K2
CO5	understand the gene regulations with operon models.	K2

Mapping of COs with POs & PSOs:

CO	**Pos**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	M	S	S
CO3	S	S	M	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	M	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

.

Course Code	P21MBP11	PRACTICAL GENERAL MICROBIOLOGY, MICROBIAL DIVERSITY, MICROBIAL PHYSIOLOGY, MICROBIAL METABOLISM AND MICROBIAL GENETICS	L	T	P	C
Core V			-	-	6	4

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To learn the preparation of culture media, sterilization methods. • To learn isolation and identification of microbes in both morphological and biochemical methods. • To know the various gene transfer techniques • To develop skill on isolation and identification of mutated microbes in the laboratory.

Experiments in Microbiology & Physiology

1) Microscope – components and its operation.
2) Principles and methods of sterilization
3) Preparation of culture media, inoculation techniques – Serial dilution and plating techniques.
4) Morphological characteristics of bacteria and identification of microbes – staining techniques – Simple, Gram's, Capsule and Spore.
5) Determination of growth phases of yeast and *E.coli*
   a) Calculation of generation time
   b) Relationship between OD and colony forming units
   c) Calculation of growth rate.
6) Spectrophotometry – Principles and operation, methods of quantification.
7) Micrometry
8) Physiological groupings of bacteria.
   a) IMViC
   b) Hydrolysis – Starch, Protein, Lipid
   c) TSI
   d) Oxidative fermentation, Oxidase, Catalase, Coagulase.
9) Chromatography
   Separation of aminoacids – i) Paper chromatography – ascending and descending.

Experiments in Microbial Genetics

1) Gene transfer in bacteria – Transformation, Conjugation, Transduction
2) Isolation and separation of genomic DNA and plasmid DNA by Electrophoretic Techniques.
3) Spontaneous and induced mutation – isolation of antibiotic resistant and auxotrophic mutants.
4) Determination of lethal death time of UV mutation
5) Auxotrophic mutant and drug resistant mutant
6) Replica plating method
7) Gradient Plate technique.
8) Complementation Test
9) Ames Test

Textbook	1. James G. Cappuccino and Natalie Sherman. Microbiology. 10th edition.Pearson Education ;2007.ISBN-13 : 978-813171437. 2. Rajan S and Selvi Christy R. Experiments procedures in Life science. CBS

	Publishers & Distributors Pvt Ltd, India; 2018. ISBN 13: 9789386478252.
References	1. David R Brooke. Bergey's Manual of systematic bacteriology (Vol 1), Eastern Halz, Springer publication, US. 2007. 2. Gunasekaran P. Laboratory Manual in Microbiology. New Age International Pvt. Ltd. Publishers. New Delhi; 2005.ISBN:81-224-0783-8 3. Kanika Sharma. Manual of Microbiology – Tools and Techniques. 2nd Edition, Ane Books Pvt. Ltd. New Delhi. 2009.ISBN13:978-81-8052-143-0. 4. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry. 5th edition. Cambridge University press, Britain;2005. 5. Nizhny Novgorod. Laboratory manual on Biochemistry: Publishing House of Nizhny Novgorod State medical academy. 2008.
E-references	1. https://www.biologydiscussion.com/dna/dna-damage-types-and-repair-mechanismswithdiagram/16332#:~:text=DNA%20has%20many%20elaborate%20mechanisms,mismatched%20with%20the%20complementary%20strand.

Course Outcome

Upon completion of this course, the students will be able to		
CO1	gain practical knowledge in basic techniques of Microbiology and Biochemistry	K2
CO2	acquire knowledge in analysis and estimation of biomolecules	K2
CO3	become expertise in various microbial techniques	K3
CO4	get practical skill in specimen collection and processing	K2
CO5	perform mutation studies and, isolation of genomic and plasmid DNA	K3

Mapping of COs with POs & PSOs:

CO	Pos								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	M	S	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

SEMESTER –II

Course Code	P21MBT21	MOLECULAR BIOLOGY	L	T	P	C
Core -VI			5	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Evaluate					
Learning objective	• To update the knowledge on molecular genetics of prokaryotes. • To gain knowledge on DNA Replication • To know about the central dogma of molecular biology					
Unit I	**Introduction to Molecular Biology**					
Introduction and historical development - Central dogma of Molecular biology. The Logic of molecular biology – the efficient argument, examination of models and strong inference. Molecules of life – DNA world – RNA world and protein world. Prokaryotic and Eukaryotic Chromosome organization. Genes – definition, types and functional organization. Structure of DNA - primary, secondary and different forms (A, B & Z). Gene transfer mechanism-bacterial transformation, conjugation and transduction.						
Unit II	**Mutagenesis**					
Mutation – Types of mutations - Spontaneous and induced mutations – Point mutation and chromosomal mutations; Base – analog, physical agents, chemical mutagens, intercalating substances and mutator genes. Mutants – Types and Uses – bacterial mutants, plant mutants and animal mutants						
Unit III	**DNA Replication**					
Basic rule. The Geometry of DNA replication – Semi conservative replication of double–stranded DNA and Circular DNA molecules. Enzymology – DNA Polymerases I and III, DNA ligase and DNA gyrase. Events in the replication fork – Continuous and discontinuous. Plasmid and j174 DNA replication- DNA damages – DNA repair mechanism – photoreactivation, excision repair, recombinant repair and DSOS function.						
Unit IV	**Transcription**					
Basic factors of RNA Synthesis - RNA ploymerases – I, II and III – Transcription Mechanisms in prokaryotes and eukaryotes – chain Initiation, elongation and termination. Significance of pribnow box, TATA box, CAAT box and enhancers in transcription initiation. Rho dependent and Rho independent termination of transcription. Classes of RNA Molecules –Messenger, ribosomal and transfer RNA. Post –transcriptional modification - RNA splicing – role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping andtailing of 5’ and 3’ termini of Eukaryotic mRNA molecules.						
Unit V	**Translation**					
Genetic code – Definition, deciphering of codons – Universality of the code – Wobblehypothesis and codon degeneracy - codon dictionary. Mechanism of protein synthesis - importance of Initiation(IF), elongation(EF) and releasing factors(RF) - post translationalmodifications – protein splicing and folding – role of molecular chaperones. Regulation of geneexpression in prokaryotes – the operon model. Lactose, galactose and tryptophan operon. Feedback inhibition and Allosteric enzymes.						
Textbook	1. Frifelder, D. 2004. Molecular Biology 2nd edition. Narosa Publishing House, New Delhi 2. Ajoy Paul. Text Book of Cell and Molecular Biology. Books and Allied Ltd; 2011.ISBN- 13: 978-8187134749.					
References	1. Krebs J.E, Goldstein E.S and Kilpatrick S.T. Lewin's GENES XII. 12th edition. Jones and Bartlett Publishers;2017. ISBN-13 : 978-1284104493 2. Watson James D. , Baker Tania A. , Bell Stephen P., Gann					

	Alexander , Levine Michael , Losick Richard. Molecular Biology of the Gene .7th Edition .Pearson;2013.. 3. Arthur Kornberg and Tania A. Baker. DNA replication. Second edition. University Science Books; 2005. ISBN-13 : 978-1891389443. 4. Karp G. 2013. Cell and Molecular Biology Concepts and Experiments. John Wiley & Sons, Inc. 5. Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing Ltd., USA
E-references	1. https://www.atdbio.com/content/14/Transcription-Translation-and-Replication

Course Outcome

Upon completion of this course, the students will be able to		
CO1	understand the structure and organizations of DNA molecules	K2
CO2	obtain the knowledge about mutagenesis	K2
CO3	have clear knowledge on structure of nucleic acid and Replication.	K3
CO4	understand the mechanisms of mRNA and protein synthesis.	K2
CO5	compare the transcription and translation process	K4

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	M	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT22	ENVIRONMENTAL MICROBIOLOGY	L	T	P	C
Core VII			4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the current views of microbial association in various environments. • To evaluate the continuing roles played by microbes in the environment. • To understand the bioremediation and microbial leaching techniques					
Unit I	**Soil characteristics & Biogeochemical cycling**					
Physio-chemical properties of soil - Rhizosphere and rhizoplane organisms. Mineralization and immobilization. Biogeochemical cycling: Carbon cycling, nitrogen cycling, phosphorus cycling and sulphur cycling. Ecological groups based on oxygen requirement, nutrition, temperature, habitat (soil, water & air).						
Unit II	**Microbial analysis water and air**					
Microbial analysis of drinking water: Tests for coliforms (presumptive, confirmed and completed tests). Purification of water: Sedimentation, Filtration (slow and rapid sand filters) and Disinfection. Aeromicrobiology - Phylloplanemicroflora (morphological, physiological characters: nutrition, radiation, relative humidity and temperature) – Air Pollution – aerosol, droplet nuclei and infectious dust. Examination of air microflora. Extremophiles – Halophiles, psychrophiles, Polyextremophile – *Deinococcoccusradiodurans*						
Unit III	**Nature of sewage and its composition**					
Physical, chemical and biological properties of sewage (BOD, COD etc). Sewage systems and types. Sewage Treatment: Single Dwelling Unit, municipal sewage treatment - primary, secondary (Trickling filters, activated sludge process, Oxidation lagoons and Imhoff tank) and tertiary treatments (Ion exchange, adsorption, reverse osmosis).Utilization of solid and liquid waste pollutants for production of Single-Cell protein. Solid waste management – Composting.						
Unit IV	**Bioremediation & Microbial leaching**					
Polluted heterogeneous environment. Indicator organisms for pollution and abatement of pollution. Bioremediation – Types (In situ & Ex situ methods) and uses - Microbes and Environmental clean-up - Genetically Engineered microbes for Bioremediation. Microbial leaching: -copper and uranium mining.						
Unit V	**Biosafety & Environmental monitoring**					
Environmental regulations - Biohazards - Types of hazardous emission - Biosafety measures - Biomonitority of waste water toxics - Monitoring of Genetically Engineered Microbes in the Environment.						
Textbook	1. Raina M. Maier, Ian L. Pepper and Charles P. Gerba. 2000. Environmental Microbiology. Academic Press. New York. 2. Pelczar, M.J., Schan, E.C. and Kreig, N.R.2010. Microbiology – An application based approach, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi. 3. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. Microbiology, Fifth Edition, McGraw Hill, New York. 4. Atlas,R.A.&Bartha,R.2000.Microbial Ecology, Fundamentals and Application, Benjamin Cummings, New York. 5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press					

	6. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st Edition, Springer, New York 7. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer - Verlag, Berlin Hedeilberg 8. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
References	1. Mara. D and Horan. N. The Handbook of Water and Waste Water Microbiology. 2003 Academic. Press, California. 2. Clescri, L.S., Greenberk, A.E. and Eaton, A.D. Standard Methods for Examination of Water and Waste Water, 1998, 20th Edition, American Public Health Association. 3. Patel, A.H. Industrial Microbiology, 1996, 2nd Edition Macmillan India Ltd., New Delhi. ISBN 10-9385750259 4. SubbaRao, N. S. Soil Microbiology. 1995. 4th Edition. Oxford & IBH Publishing Co. Pvt.Ltd.New Delhi. pp: 11-49 & 292-301. 5. SubbaRao, N.S. 1995. Biofertilizers in Agriculture and Forestory.3rd Ed., Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi. 6. Salle, A.J. Fundamental Principles of Bacteriology, 1992. 7th Edition. McGraw Hill Publishing Co. Ltd., New York. pp: 649-709 & 794-843. 7. Kumar, H.D. Biotechnology, 1991 2nd Edition, East - West Press Private Ltd., New Delhi. 8. Pelczar.M.J. and Reid 1986 Microbiology. 5th Edition. Tata McGraw Hill Co., New Delhi. pp:593-617. 9. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press. 10. Brock, T.D, Smith, D.W. and Madigan M.T 1984, Biology of Microorganisms. IV Ed., Prentice Hall Int. Inc., London. 11. Campbell, R. 1983. Microbial Ecology, II Ed., Blackwell Scientific Publishers, London. 12. Alexander, M. 1971. Microbial ecology, John Wiley & Sons Inc., New York.
E-references	1. https://gurujistudy.com/2nd-year-microbiology-of-air-aeromicrobiology-notes-study material/#:~:text=Microbiology%20of%20Air%20Notes,%2C%20sneezing%2C%20talking%20and%20laughing.&text=Droplets%20are%20usually%20formed%20by,may%20contain%20thousands%20of%20microbes.

Course Outcome

Upon completion of this course, the students will be able to		
CO1	learn the soil characteristics and biogeochemical cycle.	K1
CO2	know the microbial analysis of drinking water and aeromicrobiology.	K2
CO3	know the different aspects of waste management and perform sewage treatment systems.	K2
CO4	acquire knowledge on bioremediation and microbial leaching.	K3
CO5	know the biosafety and environmental monitoring regulations.	K2

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	S	S	S	S	S	S	S
CO2	S	M	S	S	S	S	S	S	M	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	M	S	S
CO4	S	S	S	S	S	M	S	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT23	IMMUNOTECHNOLOGY	L	T	P	C
Core VIII			5	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the basics of the immune cells • To know the types of immunity, antigen and antibody reaction and transplantation of immunity. • To learn the importance of immuno techniques. • To update the knowledge on current immunological developments.					
Unit I	**Introduction to immune system**					
Historical background, general concepts of the immune system; Innate and adaptive immunity; Inflammation - general properties; Structure, properties and functions of the immune cells & lymphoid organs: Hematopoeisis, T and B-lymphocytes, NK cells; monocytes, and macrophages, neutrophils, eosinophils, and basophils, Mast cells and dendritic cells, Thymus and bone marrow, Lymph nodes, spleen, MALT, GALT and CALT						
Unit II	**Antigens and Antibodies**					
Antigens and haptens – Types and properties of antigen (foreignness, molecular size, heterogeneity of antigen). B and T cell epitopes. T -dependent and T-independent antigens. Antibodies : Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype); Genesis of antibody variability; Hybridoma technology, monoclonal antibodies and abzymes.						
Unit III	**Humoral Immune response**					
Interaction of T cells, MHC and B cells. B cell receptor complex, proliferation, antibody diversity, understanding self – non self-discrimination, T_H cell subpopulation, organization of T cell receptor, cell mediated effectors responses and differentiation – Complement system: Components of the complement activation - classical, alternative and lectin pathways. - Consequences of complement activation – phagocytosis – Hypersensitivity – types, components and consequences						
Unit IV	**Cell mediated immunity**					
T cells – activation, proliferation and differentiation – Cytotoxic response –types. Antigen presenting cells, antigen processing and presentation pathway (cytosolic and endocytic). Cytokines -properties and functions of interleukins (IL-1 to IL-5, IL-10, IL-12) and inferferon (IFN-γ). Immunization types, modes – adjuvants. Immune regulation. Immune tolerance. Immuno modulation. Autoimmune diseases in human – organ specific, systemic – mechanisms						
Unit V	**Transplantation immunology**					
Graft rejection – basic mechanism. Tumor immunology – changes in the surface of the tumor cells – immune response. Immunobiology of AIDS and COVID. Lymphocyte Disease. Immunotechnology– ELISA, immunoprecipitation, RIA.						
Textbook	1. Jenni Punt, Sharon Stranford , Patricia Jones and Judith A Owen .Kuby Immunology. Eighth edition. WH Freeman; 2018. ISBN-13: 978-1319114701. 2. Abul Abbas ,Andrew Lichtman and Shiv Pillai. Cellular and Molecular Immunology. Cellular and Molecular Immunology.9th Edition; 2017.					
References	1. Benjamin Elie – Immunology, 3rd Edition. 2. Roitt., Brostaff J. and Male D. 2001 Immunology VI edition, Mosby,					

	London 3. Coleman, R.M., M.F. Lombard., & N.E. Sicared. 1992. Fundamental Immunology, second edition, Wm.C. Brown Publishers, USA. 4. Abul Abbas, Andrew H. Lichtman, Shiv Pillai., 2016. Basic Immunology, 5th Edition. Elsevier. 5. Goldsby, R.A., T.J. Kindt., & B.A. Osborne. 2000. Kuby Immunology. Fourth edition. W.H. Freeman and Company, New York. 6. Abbas, A.K., A.H. Lichtmann and Y.S. Pober. 2000, Cellular and Molecular Immunology, fourth edition, W.B. Saunders company, London
E-references	1. http://www.sacema.org/uploads/Introduction-to-Medical-Immunology.pdf 2. http://dl.mehrsys.ir/pdfbooks/Roitt_s%20Essential%20Immunology%20Thirteenth%20Edition(www.myuptodate.com).pdf

Course outcome

Upon completion of this course, the students will be able to		
CO1	Specify the lymphoid organs, cells of the immune system and their functions.	K2
CO2	Learn the definition, properties and role of antigens and antibody	K1
CO3	Understand the genetic mechanism for antibody diversity and comprehend the role of complement system.	K2
CO4	Develop the understanding of autoimmune disease mechanisms.	K3
CO5	Acquire the knowledge on the tissue transplantation**.**	K3

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	**S**	S	S	S	M	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S	S	M	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT24	ADVANCED MEDICAL MICROBIOLOGY	L	T	P	C
Core IX			4	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To understand the common infections and diseases of medical importance and pathogenic action, • To impart and explain the students with the advanced knowledge on the characteristics of medically important human microbial pathogens. • To understand the current techniques in medical microbiology					
Unit I	**Introduction to Medical Microbiology**					
History, Koch & River's postulates, Role of Microbiology in Medicine, Classification of medically important microbes. Normalmicroflora of the human body (skin, throat, gastrointestinal tract, urogenital tract) and host pathogen interaction. Nosocomial infections and community based infections. Transmission of infection. Sample collection, transport and diagnosis. Principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes)						
Unit II	**Bacterial diseases**					
List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control. Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilusinfluenzae*, *Mycobacterium tuberculosis.* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori.* Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponemapallidum*, *L*eptospira*interrogans*						
Unit III	**Viral diseases**					
General properties, epidemiology, pathogenesis, lab diagnosis, treatment and prophylaxis of medically important viral diseases caused by:Influenza viruses, Measles, Mumps, Rubella, Chicken Pox, Hepatitis A,B,C, D and E, Poliomyelitis, HIV, Human Papilloma Virus, Herpes, Rabies, Yellow fever. Emerging Viral Diseases - Dengue, Swine Flu, Nipha, Ebola, JapaneseEncephalitis viruses, Chikungunya, SARS and Corona Virus.						
Unit IV	**Protozoan and Fungal diseases**					
Protozoan disease -Morphology and pathogenesis, laboratory diagnosis and treatment of medically important protozoan diseases caused by: *Entomoebahistolytica, Giardia lamblia, Trichmonasvaginalis, Plasmodium vivax, Leishmaniadonovani, Taeniasolium, Ascarislumbricoides.* Fungal diseases –pathogenesis, symptoms diagnosis, treatment and prevention measures; Cutaneous mycoses -*Tineapedis* (Athlete's foot), Systemic mycoses –Histoplasmosis and Opportunistic mycoses - Candidiasis						
Unit V	**Antimicrobial agents**					
General characteristics and mode of action. Antibacterial agents: Five modes of action with one example each - Inhibitor of nucleic acid synthesis; cell wall synthesis; cell membrane function; protein synthesis and metabolism. Antifungal agents - Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents - Mechanism of action of Amantadine, Acyclovir, Azidothymidine, Antibiotic resistance, MDR, XDR, MRSA, NDM-1						
Textbook	1. David Greenwood. Mike Barer, Richard Slack and Will Irving. Medical Microbiology. A Guide to Microbial Infections: Pathogenesis, immunity, Laboratory investigation and Control, 18th edition, Churchill Livingstone. 2012.					

	2. Ananthanarayanan and C.K.JeyaramPaniker, 2009. Text Book of Microbiology, Eigth Edition, Orient Longman, Chennai.
References	1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) 2. Jawetz, Melnick and Adelberg's. Medical Microbiology. 28th edition. McGraw Hill Publication; 2020. 3. Chatterjee K.D. Parasitology Protozoology and Helminthology.13th edition. CBS;2019. ISBN-13 : 978-8123918105. 4. David Greenwood, Richard Slack, John Pertherer and Mike Barer, 2009. Medical Microbiology - A Guide to Microbial infections, pathogenesis, immunity, lab diagnosis and control, 17th Edition, Elsevier Publications. 5. JeyaramPanicker , Textbook of Microbiology, 4th Edition, 2000, Orient Longman Publishers.
E-references	1. https://www.pdfdrive.com/medical-microbiology-e18737002.html

Course outcome

Upon completion of this course, the students will be able to		
CO1	Know the applications of various field of medical microbiology	K1
CO2	Understand the causative agent, epidemiology, Pathogenesis of bacteria	K2
CO3	Obtain the idea about the medical virology.	K2
CO4	Get the knowledge about the protozoan diseases.	K2
CO5	Gain the knowledge about the characteristics and mode of action of antimicrobial agents.	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	**S**	S	S	S	M	S	S	S	S	S	S	S	S
CO2	M	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBP22	PRACTICAL	L	T	P	C
Core X		MOLECULAR BIOLOGY, ENVIRONMENTAL MICROBIOLOGY, IMMUNOTECHNOLOGY AND ADVANCED MEDICAL MICROBIOLOGY	-	-	6	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To know the preparation of culture media and sterilization methods. • To perform the isolation and separation techniques of genomic DNA. • To understand the working principles of ELISA and blotting techniques. • To develop skill relevant to precipitation methods.					
Experiments in Molecular Biology	1. PCR – RAPD 2. SDS – PAGE					
Experiments in Environmental Microbiology	1. Microbial analysis of drinking water - Tests for coliforms (presumptive, confirmed and completed tests). 2. Biodegradation of oil/dye					
Experiments in Immuno technology	1. Blood Collection – plasma separation 2. Haemagglutination 3. ELISA 4. Western Blot 5. VDRL test 6. CRP test 7. RA test 8. ASO test 9. Widal test 10. Precipitation method a. Immunodiffusion (Single & Double) b. Immuno electrophoresis					
Experiments in Advanced Medical Microbiology	1. Clinical analysis of the following bacteria – *Staphylococcus, Streptococcus, Salmonella* and *Pseudomonas.* 2. Antibiotic sensitivity test.					
Textbook	1. James G. Cappuccino and Natalie Sherman. Microbiology. 10th edition.PearsonEducation ;2007.ISBN-13 : 978-8131714379. 2. Reddy, S.M. and Ram Reddy, S.R. 2000. Microbiology - A Laboratory Manual, BSC Publishers & Distributors. 3. Hudson. L., Hay F.C., 1989 Practical Immunology, , 3rd ed., Blackwell Publishing, London.					
References	1. Atlas, R.A. and Bartha, R. Microbial Ecology, Fundamentals and Application, 4th edition, Pearson Education;1997.ISBN-13 978-978-0805306552. 2. Handbook of Microbiological Media – HiMedia,Fourth edition. Taylor &Francis.ISBN: 9781439804063, 9781439804063. 3. Myers R.M. and Koshi G. 1982. Diagnostic Procedures in Medical Microbiology and Immunology / Serology, Microbiology Laboratories, Christian Medical College and Hospital, Vellore.					
E-references	1. https://www.nvcc.edu/biotech/_docs/Immunology_Manual.pdf					

Course outcome

Upon completion of this course, the students will be able to		
CO1	Learn to perform the agarose gel electrophoresis	K1
CO2	Interpret the PCR reactions.	K2
CO3	Do immune electrophoresis, immunodiffusion assay.	K3
CO4	Have a practical knowledge about the precipitation methods.	K3
CO5	Develop the skills on screening of clinical samples.	K3

Mapping of COs with POs &PSOs:

CO	**Pos**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	**S**	M	S	S	S	S	S	S	M	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	M	S	M	S
CO4	S	S	M	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBN 21	Non Major Elective	L	T	P	C
Elective I		Food Fermentation Techniques	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the current views of fermentation in food. • To evaluate the continuing roles played by microbes in the fermentation techniques. • To understand the preservation techniques					
Experiments	1. Food – Constituents of food properties and significance. 2. Food Fermentation – Definition and health benefits 3. Preparation of fermented foods – Idli, Dosa, Wine 4. Contamination of foods, factors influencing the spoilage of foods (Physical and chemical methods). 5. Food Preservation – Definition and importance 6. Preservatives – types and role 7. Methods of food preservation 8. Preparation of preserved food – JAM, Pickle 9. Food borne diseases – Basic account and its prevention.					
Textbook	1. Frazier WG and Westhoff Dc. Food Microbiology. 2014. Tata McGraw Hill Publishing Company, 5th edition 2. Adams M.R and Moss M.O. Food Microbiology. 2003 Royal Society of Chemistry Publication, Cambridge,					
References	1. Bandwart GJ. Basic Food Microbiology, 2nd Edition, SK Jain for CBS Publishers & Distribution ISBN:9788123906461 2. Lund BM, Baird Parker AC, and Gould GW. The Microbiological Safety and Quality of Foods. (2000) Vol. 1-2, ASPEN Publication, Gaithersberg, MD. 3. Tortora GJ, Funke BR, and Case CL. Microbiology: An Introduction. (2008) 9th edition. Pearson Education. 4. HarshadKiranKalwit, Sanjeevkurmar Sharma - Objectives of food science (2021) 11th Edition ISBN: 978-81-944137-9-0 5. Jim Mclauchlin, Christi. Food Poisoning and Food Hygiene (2007) 7th Edition 6. Robinson R.K. Dairy Microbiology Handbook:The microbiology of milk and milk products(2005) 3rd Edition ISBN 978-0-471-2275 7. Rajamanickam, C.2001 Experimental protocols in basic molecular biology, Osho Scientific Publications, Madurai.					
E-references	1. https://en.wikipedia.org/wiki/Food_spoilage#:~:text=Food%20spoilage%20is%20the%20process,product%20is%20packaged%20and%20stored. 2. https://www.britannica.com/topic/food-preservation					

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Learn the nutritional values in foods.	K1
CO2	Know the food fermentation process.	K2
CO3	Know the different aspects of food spoilage.	K2
CO4	Acquire knowledge on food preservatives.	K3
CO5	Know the diseases caused by spoiled food.	K2

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBS22	Biosafety, Bioethics & IPR	L	T	P	C
Supportive course II			2	-	-	2
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To understand the key concept and historical background of biosafety • To know the importance of biosafety guidelines and regulations. • To know the function of institutional biosafety committee. • To study the application of GMOs in various field and methods to release GMO's in the environment • To acquire the knowledge on patenting process					
Unit I	**Introduction of Biosafety**					
Primary containments for biohazards, Biosafety levels, recommended biosafety levels for specific microorganism, infectious agents and Infected animals. Biosafety guidelines by Govt. of India, Role of Institutional biosafety committee, GEAC, RCGM, Cartagena protocol. CPCSEA Guidelines						
Unit II	**Introduction to bioethics**					
Concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and Environment benefits and risks, GM crops, Release of GMO to the environment. Risk of genetic engineering.						
Unit III	**Animal rights**					
Ethical legal and Socio economic aspects of Gene therapy. Reproductive cloning - Somatic, Embryonic and Adult stem cell research Transgenic plants and animals. ELSI of human genome project and Ethics of human cloning.						
Unit IV	**Introduction to IPR**					
Types; copy rights, patents, trademarks, trade secret design rights, Traditional knowledge, geographical indication-patentable and non-patentable – PCT, importance of IPR, Types of Patent applications, PCT cost, procedure and requirements for international patenting- patent infringement – scope, litigation, meaning, case studies & examples. Biopiracy						
Unit V	**Patent Procedure**					
Introduction to WTO, GATT,WIPO,TRIPS, Patenting in India, Indian patent act, WIPO treaty budaspest treaty, publication of patents-Gazette of India, Patenting by research students, lectures and scientist University/Organizational rules in India and aboard.						
Textbook	1. Subbaram N.S.Patent Law Practices & Procedures, Second edition. Lexis Nexis; 2007.ISBN-13 : 978-8180384103. 2. Fleming,D.A. and D.L. Hunt.2001. Biological safety Principles & practices (3rd Ed.) ASM Press, Washington . 3. Rajmohan Joshi,2006. Biosafety and Bioethics, Gyan Publishing House, New Delhi					
References	1. Sree Krishna V. Bioethics and Biosafety in Biotechnology.First edition. New AgeInternational (P) Limited Publishers;2007. ISBN-13: 978-8122420852. 2. Glick B.R. Patten C. Principles and Applications of Recombinant DNA.Fifth edition. Taylor & Francis;2017. ISBN-13 : 978-1683670360. 3. Bioethics and Biosafety (2008) M. K. Sateesh, I. K. International Pvt. Ltd, New Delhi, India. 4. Intellectual Property Rights (2008) Prabuddha Ganguly, Tata McGraw Hill Publishing Company, India. ISBN: 9780070077171					

	5. Thomas,J.A. and R.L. Fush,2002 Biotechnology and Safety Assessment (3rd Ed.), Academic Press .
E-references	1. http://www.patentoffice.com/index.php

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Know about the bioethics and Institutional biosafety committee	K1
CO2	Gain knowledge on Genetically Modified Organisms	K2
CO3	Understand the level of biosafety and risk management	K2
CO4	Know about intellectual property rights	K1
CO5	Obtain knowledge on the patent procedure	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	S	S	S	S	M	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

SEMESTER III

Course Code	P21MBT31	FOOD & DAIRY MICROBIOLOGY	L	T	P	C
Core XI			4	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods. • To understand the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods. • To identify the ways to control microorganisms in foods. • To obtain knowledge about the food borne diseases					
Unit I	**Factors affecting industrial microbes**					
Foods as a substrate for microorganisms - Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.						
Unit II	**General principles underlying spoilage**					
Chemical changes caused by microorganisms – Fitness or unfitness of food for consumption, causes of spoilage, classification of foods by ease of spoilage, factors affecting kinds and numbers of microorganisms in food, factors affecting the growth of microorganisms in food, chemical changes caused by microorganisms.						
Unit III	**Contamination and spoilage**					
Cereals and cereal products, vegetables and fruits, meat and meat products, milk and milk products, spoilage if heated canned foods and other miscellaneous foods						
Unit IV	**Food borne diseases**					
(causative agents, foods involved, symptoms and preventive measures) – Salmonellosis. Food intoxications: mycotoxins, viruses, seafood toxins, poisoning by chemicals; Investigation of food-borne disease outbreaks.						
Unit V	**Food preservation and sanitation**					
General Principles of Food preservation – Asepsis, removal, anaerobic condition; preservation by use of high temperature; preservation by use of low temperature; preservation by drying; preservation by food additives; preservation by radiation Food sanitation and control - HACCP, Indices of food sanitary quality and sanitizers						
Textbook	1. Frazier WG and Westhoff Dc. Food Microbiology. 2014 Tata McGraw Hill Publishing Company, 5th edition New Delhi 2. Adams, M.R. and M.O Moss - Food Microbiology 2008 the Royal Society of Chemistry, Cambridge. 3. Lelieveld.HLM, DomagojGabric, John Holah. Handbook of Hygiene Control in the Food Industry. 2016 2st Edition. Woodhead Publishing ISBN 9780081001974 4. Jay, J.M, Martin J, Loessner David A. Golden - Modern Food Microbiology. 2005 7th Edition. CBS Publishers and Distributors, New Delhi.ISBN 0-387-23180-3					

References	1. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India. 2. Adams, M.R. and Moss, M.O. 2006. Food Microbiology, New Age International (Rt) Ltd., New Delhi. 3. Davidson PM, Mathew Taylor T, Jairus R.D. David, (1993). Antimicrobials in Foods. Marcel. Dekker 4th Edition, New York. 4. Dillion VM and Board RG. (1993). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon. ISBN 978-0851988788. 5. Garbutt, J. 1997. Essentials of Food Microbiology, Arnold – International Students edition, London
E-references	1. https://en.wikipedia.org/wiki/Food_spoilage#:~:text=Food%20spoilage%20is%20the%20process,product%20is%20packaged%20and%20stored. 2. https://www.britannica.com/topic/food-preservation

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Know about the substrates of Industrial organisms	K1
CO2	Gather information regarding the factors affecting the microbial growth in food	K2
CO3	Know about the contamination of a variety of foods.	K1
CO4	Gather information regarding microbes causing food intoxication and food-borne diseases.	K2
CO5	Identify the ways to control microorganisms in food product and hence know the principles involved in food preservation.	K2

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	M	S	S
CO3	S	M	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	M	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT32	BIOPROCESS TECHNOLOGY	L	T	P	C
Core XII			4	-	-	4
Cognitive Level	K2: Understand K3: Apply					
Learning objective	1. To demonstrate the basic principles of microbiology associated with the production and recovery of important bioproducts used in industry today. 2. To understand the fundamental quality control techniques conducted on raw materials and finished products. 3. To know the principles and practices in the main applications of micro-organisms to the industrial production of foods and other useful products 4. To apply the techniques used in the different phases of industrial microbiology discovery, production (including fermentation and scale-up), bio processing and cell banking.					
Unit I	**An introduction to industrial microbiology**					
Types of fermentation- Component parts of fermentation process Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process						
Unit II	**Thermo dynamics**					
Mass transfer in reactors - Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.						
Unit III	**Upstream Processing**					
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 and Sterilization. Stages of upstream-Growth of inoculums, Fermenter preculture and Production fermentation.						
Unit IV	**Downstream processing**					
Biomass separation by centrifugation, filtration, flocculation, freeze drying, lyophilization, Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multi-phase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.						
Unit V	**Microbial production of commercially important products**					
Organic acid (citric acid &acetic acid), Enzymes (Amylase and Protease), Amino acids (Lysine and Glutamic acid), Antibiotics (Penicillin& Streptomycin), Vitamins (Riboflavin, and ascorbicacid), hormones (auxins, gibberellins). Biosynthesis of Ergot alkaloids. Microbial transformation- steroids and sterols. Non steroid compounds. Vaccines and toxoid production.						
Textbook	1. Casida, L.E.J.R**.** Industrial Microbiology. 2015 (2nd Edition) New Age International, New Delhi. ISBN 8122438024 2. Fratamico, P.M, Bhunia A.K, Smith J.G – Foodborne pathogens					

	microbiology & Molecular biology 2005 ISBN 190445500X. 3. Stanbury PF., Whittakar A., and Hall SJ. Principles of Fermentation Technology, 1994 2nd edition. Elesvier science ISBN 0-7506-4501-6 4. Ponmurugan, P., R.Nithya and M.Fredinose 2012. Experimental Procedure in Bioprocess Technology and Downstream Processing.Anjana Book House. Chennai 5. Kalaichelvan, P.T. and Arul Pandi, I. 2007. Bioprocess Technology, MJP publishers, Chennai.
References	1. Peter F.Stanbury, Allan Whitaker and Stephen J.Hall – Principles of fermentation technology (3rd Edition) 2016 ISBN 978-0-08-099953-1 2. Anton Moser – Bioprocess technology kinetics & Reactors Springer Verlag 1988 New York wein ISBN 978-1-4613-8750-3 3. PogakuRavindra Editor – Advances in Bioprocess Technology 2015 Springer ChemHedelberg, New York Dordrent London ISBN 978-3-319-17915-5 4. Aminul Islam &PogakuRavindra – Biodiesel production with green technologies 2017 Springer International publishing Switzerland ISBN 978-3-319-45273-9 5. lickinger, M.C. and Drew, S.W. 1999. Encyclopaedia of Bioprocess Technology Fermentation, Biocatalysis and BioseperationVil.V., John Wiley and Sons Publications.
E-references	1. https://bioprocessing.weebly.com/upstream-processing.html

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Understand the different types of fermentor	K2
CO2	Gain the knowledge of thermodynamics and sterilization of bioreactor.	K2
CO3	Discuss about the upstream processing	K3
CO4	Acquire the knowledge about the downstream processing.	K3
CO5	Have the idea of role of microbes in commercial products.	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S	S	M	M
CO3	S	M	S	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT33	SOIL AND AGRICULTURAL MICROBIOLOGY	L	T	P	C
Core XIII			5	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To impart in-depth information on soil and agriculture • To make the students understand the role of microbes in agriculture • To learn the overview of plant microbe interaction. • To understand infection process and control measures • To know the importance of biofertilizers and biopesticides • To know the various techniques involved in biofertilizers and biopesticides production					
Unit I	**Soil Microbiology**					
Soil profile formation, Composition of Lithosphere, Soil Microbes, and Factors influencing soil microbial population. The soil environment-Distribution and abundance, generic groups and nutrition of bacteria, actinomycetes, fungi, algae, protozoa and viruses						
Unit II	**Microbial transformations**					
Microbial Transformations of minerals sedimentary cycle (Phosphrous, sulphur, iron and other elements) and gaseous cycles – Nitrogen, oxygen, Carbon - Chemistry, cycles, mineralization and immobilization and oxidation/reduction. Biological Nitrogen fixation-Legume-Rhizobium symbiosis Ammonia assimilation in Nitrogen-Fixing legume nodules-Hydrogen Metabolism, action of Hydrogenase, include the other enzymes) - factors controlling the Legume.						
Unit III	**Plant pathogenic microorganisms**					
Algal, fungal, bacterial, viral, mycoplasma, Nematode diseases and symptoms. Mode of entry of pathogens and factors affecting disease incidence - Plant disease resistance and various control measures. Phenolic compounds. Interaction of plant pathogens with host.						
Unit IV	**Biofertilizer**					
Classification of biofertilizers& Role of biofertilizers – Nitrogen fixers – Symbiotic (*Rhizobium* sp, *Anabenaazollae*) and Non Symbiotic –*Azotobacter* sp and *Azospirillum* sp & Cyanobacteria (BGA). Phosphate solubilizing microbes. Mycorhizae and plant growth promoting rhizobacteria (PGPR). **Biopesticides** – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis*, *B.popillae*& Pseudomonas sp.), Fungal (Entomophthoramusca, Beaveria sp., Metarrhizium sp. &Verticillium sp.), Protozoan (Mattesia sp., Nosema sp., Octosporamuscaedomesticae&Lambornella sp.)						
Unit V	**Quality control**					
(BIS specification), marketing, Evaluation of field performance and economics of production. Role of biofertilizer in integrated nutrient management. Regulation and standards, Marketing and Monitoring field performance						
Textbook	1. Gupta, S.K.2014 Approaches and trends in plant disease management. Scientific publishers, Jodhpur, India. 2. Purohit SS – Principles of Agricultural Microbiology 2016 Agrobios ISBN 13:978-8177545951 3. SubbaRao, N.S. 2000. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 4. John L.Havlin, Samuel L.Tisdale, Werner L. Nelson, James D. Beaton – Soil fertility & Fertilizers 2016 8th Edition 5. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons,						

	Inc, New York 6. Cooke BM, Gareth Jones D, Bernard Kaye – The epidemiology of plant disease 2nd Edition 2006 ISBN 978-1-4020-4581-3
References	1. Insam H, Riddech N, Klammer S (Eds) – Microbiology of composting 2002 Springer- velag Berlin Heidelberg ISBN 978-3-642-08705 2. Bernard R Glick & Jack J Pasternak – Molecular Biotechnology- Principles & applications of Recombinant DNA 1994 ISBN 1-55581-071-3 3. Purohit, S. S., Kothari, P.R. &Mathur. Basic and Agricultural Biotechnology, 1993 Agrobotanical Publishers (India). Bikaner. 4. Jamaluddin*et al.*, Microbes and sustainable plant productivity. 2013 Scintific Publishers Jodhpur, India. G 5. SubbaRao, N. S. 1997. Biofertilizers in Agriculture and Forestry, III Ed., Oxford & IBH Publishing Co.Pvt.Ltd.,New Delhi. ISBN: 9061914051
E-references	1. https://www.biologydiscussion.com/nitrogen-fixation/types-nitrogen-fixation/nitrogen-fixation-types-physical-and-biological-nitrogen-fixation-with-diagram/14969#:~:text=Biological%20nitrogen%20fixation%20(BNF)%20is,Azospirillum%20and%20Azotobacter%20and%20BGA.

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Understand the role of microbes in the soil.	K2
CO2	Acquire knowledge on the role of microbes in different cycles.	K3
CO3	Learn the plant and microbes interactions in infection side.	K1
CO4	Know the role of biofertilizers and biopesticides in pest control	K1
CO5	Have indepth knowledge on application of biofertilizers.	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT34	RECENT TRENDS IN VIROLOGY	L	T	P	C
Core XIV			5	-	-	4

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To learn about general account of viruses, bacteriophages, plant, animal and human viral diseases. • To gain knowledge about instrumentation relevant to virology. • To understand the serological techniques
Unit I	**Introduction to virology**
Discovery, nomenclature, classification (Outline of viral classification - Baltimore) and properties of viruses, Morphology and ultrastructure – capsid and their arrangement, envelope - types and their composition, viral genome – types and structure. Sub viral agents- viroids, prions, virusoids and satellite viruses.Viral Vaccines, Interferon and Antiviral drugs.	
Unit II	**Characterization and Cultivation of viruses**
Embryonated eggs, Primary and secondary cell cultures, monolayer cell cultures- cell strains, cell lines and transgenic system. Serological methods- haemagglutination, haemagglutination inhibition, complement fixation, immunofluorescence, ELISA, RIA and assay of viruses, RT-PCR.	
Unit III	**Bacteriophages**
one step growth curve, Life cycle- Lytic and Lysogenic, Classification, Morphological groups - virulent dsDNA phage, ssDNA phage, phage lambda, Temperate and Transposable phage, Phage Mu, M13, T4, P1, Bacteriophage typing, Phage therapy (bacteriophage therapy), Cyanophages, Mycoviruses (Mycophages), Rhizobiophages.	
Unit IV	**Animal Viruses**
Classification, Multiplication, Epidemiology, Pathogenesis, Diagnosis, Prevention and Treatment - DNA containing viruses- Papovavirus, Simian Virus – 40 (SV40), Adenoviruses, Herpes viruses, Corona viridae, Pox viruses. RNA containing viruses- Picornavirus, Togaviruses (Arboviruses), Rhabdoviruses, Orthomyxoviruses, Reoviridae, Retroviridae, Human Immuno Deficiency virus (HIV), SARS, Influenza viruses and Emerging viruses.	
Unit V	**Plant Viruses**
History, Classification and nomenclature, Transmission, Multiplication, symptoms and control of plant viral diseases- Tobacco virus group, Potex virus, Poty virus, Tymo virus, Tomato spotted wilt, Cauliflower mosaic virus, Potato leaf roll virus, Rice tungro virus, Sugarcane Mosaic virus.	
Textbook	1. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Theodora Hatziioannou, Principles of virology, volume 1, 2020. 2. Dimmock, N.J., A.J. Easton, K.N.Leppard. 2008. Introduction to modern virology. Blackwell Science.U.K.
References	1. Alan J. Cann. Principles of Molecular Virology. 6th edition, Academic press, California. 2015. 2. Baishali C, Sumanta K Dutta, PatraLekha RC and Ranjita S. Topley and Wilson's: Principles of bacteriology, Virology and immunity. 11th edition, vol 4, Edward Arnold, London. 2005. 3. Dimmock NJ and Primerose SB. Introduction to modern virology. 6th edition. Blackwell scientific publication, Oxford, London. 2007. 4. Dimmock NJ, Easton AJ and Leppard K. Introduction to Modern Virology, Oxford: Blackwell Publishers, London. 2007. 5. James G Cappuccino and Natalie Sherman. Microbiology. 10th edition,

	The Benjamin/Cummings pub.co. California. 1996. 6. John Carter and Venetia Saunders. Virology: Principles and applications, 2nd Edition, John wiley and son's publishers, USA. 2013. 7. Kenneth M Smith. A text book of plant viral diseases, 3rd edition, Elsevier Inc, New York. 1972. 8. Morag C Timbury. Medical virology. 11th edition. Churchill Livingston, London. 1997. 9. Maureen A Harrison and Ian F Rae. General techniques of cell cultures, Cambridge University Press, England. 2010. 10. Nayudu MV. Plant viruses, Tata Mc Graw Hill education, US. 2008. 11. Nicklin J, Greame Cook and Killington, R. Instant notes in Microbiology, 2nd Edition, Viva Books private Limited, New Delhi. 2003. 12. Robert I Krasner. The Microbial challenge: Human Microbe Interaction, American Society for Microbiology, 2nd edition, Washington. 2002. 13. Roger Hull. Mathews' Plant Virology, 4th edition, Academic press- A Harcourt Science and technology company, New York. 2002. 14. Villarreal LP. Viruses and the Evolution of Life. ASM Press, Washington DC. 2005.
E-references	1. https://www.pdfdrive.com/medical-microbiology-virology-immunology-e43491517.html

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Acquire the knowledge about classification and properties of virus.	K3
CO2	Understand the methods of diagnosis and serology.	K2
CO3	Understand the life cycle of phages and its types.	K2
CO4	Know about pathogenesis, diagnosis, prevention and treatment of animal and human viruses.	K2
CO5	Analyze the classification and properties of plant viruses.	K3

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	M	M	S	SS	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBT35	MICROBIAL BIOTECHNOLOGY	L	T	P	C
Core XV			4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the strategy of recombinant DNA technology • To learn about the molecular tools and cloning strategies. • To understand the current affairs of genetic engineering • To obtain knowledge about the hybridization techniques					
Unit I	**Introduction to microbial biotechnology**					
Basic techniques of rDNA technology - Enzymes used in cloning - Restriction Enzymes, Ligases, DNA polymerases, RNA Polymerases, Reverse Transcriptase, terminal polymerase, RNAase, DNAase, phosphatase, polynucleotide kinase, S1 nuclease. Cloning vectors:Plasmids, bacteriophage based vectors: Cosmids, M13. shuttle vectors, Expression vector,animal viral vectors (Baculovirus based vectors, mammalian SV40-based expression vectors), BAC, YAC (yeast YIp, YEp and YCp vectors), and TA. Outline strategy of molecular cloning - Use of linkers and adaptors. Cloning Expression - *E.coli*lac and T7 promoter						
Unit II	**Methods in Molecular Cloning**					
Transformation of DNA: Chemical method, Electroporation,Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery. DNA Amplification - PCR: Basics of PCR and RT-PCR. DNA sequencing - DNA Sequencing: traditional and automated sequencing (di-deoxy chain termination, chemical degradation, shotgun sequencing, contig assembly and pyrosequencing).						
Unit III	**Construction and Screening of Genomic and cDNA libraries**					
Preparation and uses. Comparative genomics: analysis and comparison of size and complexity of genomes. Hybridization: colony and plaque hybridization, in – situ chromosomal hybridization and chromosome walking, Nucleic acid blotting:Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting. Primer walking and shotgun sequencing. VNTRs, DNA fingerprinting, SNPs, RFLP						
Unit IV	**RNA level expression**					
Profiling with microarrays, MPSS, Chromatin immune precipitation. Protein level expression - yeast two hybrid system, yeast surface display, phage display. Loss of function Knockout, knockdown, antisense RNA and RNAi, CRISPR- Cas system						
Unit V	**Applications of Recombinant DNA Technology**					
Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccinesand edible vaccines, Golden rice, protein engineering and site directed mutagenesis. Ethical, legal and social issues						
Textbook	1. Old R.W and Primrose S.B. 2001. Principles of Gene Manipulation, 6th edition 2. Glick B.R and Pasternak J.J. 2007. Molecular Biotechnology, 3rd edition. 3. Gupta P.K. 2010, Elements of Biotechnology, 2 nd edition, Rastogi publications, New Delhi 4. Dubey R.C. 2009.A text book of Biotechnology. S.Chand& Company, New Delhi					
References	1. Balasubramanian, D., C.F.A. Bryce, K.Dharmalingam, Y.Green,					

	KunthalaJeyaraman. 2004. Concepts in Biotechnology. Universities (P) ltd. Hyderabad. 2. Brown, T.A. 2006. Gene Cloning, Fifth Edition, Chapman and Hall Publication, USA. 3. Chawla, H.S.2000 Introduction to Biotechnology, Oxford & IBH Publishing Co. Pvt.Ltd.New Delhi. 4. Crueger, W. and A. Crueger, 2000. Biotechnology: A Test Book of Industrial Microbiology, 2nd edn. Panima Publishing Corporation, New Delhi.
E-references	1. https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture1.pdf 2. https://samples.jblearning.com/076371075X/Wheelis_CH01_001%20copy.pdf

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Understand the basic techniques in rDNA technology.	K2
CO2	Know about the methods in molecular cloning.	K1
CO3	Compare genomic and cDNA library	K3
CO4	Recognize the importance of gene level expression.	K2
CO5	Know the application of rDNA technology.	K1

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S	S	M	M
CO3	S	M	S	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code P21MBP33	PRACTICAL FOOD MICROBIOLOGY, BIOPROCESS TECHNOLOGY, AGRICULTURAL MICROBIOLOGY, RECENT TRENDS IN VIROLOGY AND MICROBIAL BIOTECHNOLOGY	L	T	P	C
Core XVI		-	-	6	4
Cognitive Level	K1: Recall K2: Understand K3: Apply				
Learning objective	• To learn the isolation of nitrogen fixers from the soil samples. • To enumerate the microbial population in food samples. • To know the usage of root infectious study. • To develop skill relevant to immobilization techniques.				
Experiments in Food Microbiology	1. Monitoring of Milk quality by Dye reduction methods. **2.** Enumeration of microbial population in fruits, vegetables, meat, soft drinks and any preserved food. **3.** Isolation of spoilage- associated microbes from food				
Experiments in Bioprocess Technology	1. Batch fermentation for production of microbial enzymes. 2. Immobilization Principle and Methods 3. Wine production				
Experiments in Agricultural Microbiology	Enumeration of total microflora from soil, water and air samples 1. Isolation of N_2 fixers - *Rhizobium, Azotobacter&Azospirillum*. 2. Isolation of Phosphate solubilizing microbes 3. Localization of AMF Colonization. 4. Root infectious study				
Experiments in Recent trends in Virology	1. Isolation and characterization of bacteriophage and cyanophage from natural resources 2. Phage titration – T4 phage 3. Cultivation of animal virus – Chick embryo				
Experiments in Microbial Biotechnology	1. Plasmid isolation 2. Digestion of isolated DNA with restriction enzyme – EcoRI				
Textbook	1. Cappuccino, G. James. and Natalie Sherman, Gram stain, Microbiology A Lab. Manual, 1999. 2. Mahendra K. Rai. Hand Book of Microbial Biofertilizers, (2006) 1st Edition The Haworth Press, Inc. New York. ISBN 9781560222705 .				
References	1. K.R Aneja - Experiment in Microbiology, Plant Pathology Tissue Culture and Mushroom Cultivation,2003 New Age International Ltd. ISBN: 81-224-1494-X 2. Atlas, M. Ronald, Alfred E. Brown. and Lawrence C. Parks, Gram stain, Experimental Microbiology, 1995. ISBN 0815103247 9780815103240 3. Handbook of Microbiological Media – HiMedia 4th Edition 2010 ISBN 13-9781439804063. 4. Reddy, S.M. *et al*. Bioinoculants for Sustainable Agriculture and Forestry, (2001) Scientific Publishers.ISBN 8172333072 5. SubbaRao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi. ISBN 1886106185				

	6. Saleem F and Shakoori AR - Development of Bioinsecticide, (2012) Lap Lambert Academic Publishing GmbH KG 7. Harrigan, W.F. 1998. Laboratory Methods in Food Microbiology, Third Edition
E-references	1. https://www.ncbi.nlm.nih.gov/books/NBK20261/

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Learn the production of wine and its estimation method.	K1
CO2	Gain the knowledge about the isolation of nitrogen fixers.	K2
CO3	Analyze the quality of food in our daily life.	K3
CO4	Know the isolation of spoilage in foods.	K1
CO5	Gain the knowledge about the Phage infection..	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	M	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

SEMESTER -IV

Course Code	P21MBE411	Choice 1	L	T	P	C
ELECTIVE I		BIOSTATISTICS AND SCIENTIFIC WRITING	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To make the students excel in biostatistics. It will be useful in their scientific research field to analyze their data. • To obtain knowledge on scientific writing. • To evaluate the data collection and their processing methods					
Unit I	**Introduction to Biostatistics**					
Definition of statistics. Statistical survey – Organizing, planning and executing the survey population and universe - the sample and population statistical inference - parameter and statistics Source of data - Primary and secondary data, collection, observation, interview, enquiry forms, questionnaire schedule and check list. Classification and tabulation of data. Handling of bulky data – construction of a histogram - interpretation of histogram the normal distribution - representing the normal curve as straight line.						
Unit II	**Measures of central tendency**	**12 hours**				
Arithmetic mean, median, mode, quartiles, deciles and percentiles. Uncertainties in estimating a mean. Measures of variation -range, quartile deviation, mean deviation, standard deviation, Coefficient of variation. Correlation analysis -Scatter diagram, Karl's Pearson's coefficient of correlation and Spearman's rank method. Regression analysis						
Unit III	**Data collection, pooling and analysis**	**12 hours**				
Proportion data - Examples of Proportion data – MPM - sterility testing of medicines - animal toxicity - infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data – Chi - square test - goodness of fit to normal distribution. Count data - Examples of count data (bacterial cell count radioactivity count, colony and plaque count, etc.). Statistical treatment to count data – passion distribution - standard error - confidence limits of counts.						
Unit IV	**Analysis of variance**	**12 hours**				
Introduction -one way and two way classification – procedure-F and t test and its applications. Line fitting through graph points-standard curves(fitting the best straight line through series of points)-standards curves and interpolations of unknown y-values thereon. Duncan's Multiple Range test. Design of experiment-Completely randomized block design, Randomized block design.						
Unit V	**Methodology for scientific writing and oral presentation**	**12 hours**				
Compilation of experimental record – program of writing - use of vocabulary - use of good English - art of illustration - report writing – editing and correcting – technique of oral presentation. Sources of information: Journals, e - journals, books, biological abstracts, Preparation of index cards, Review writing, Article writing – structure of article. Selection of journals for publication - Impact factor – Citation index and H index.						
Textbook	1. Jerrold H. Zar. Biostatistical Analysis. 4th ed. Pearson Education;2006. 2. Khan., IA, Khanum, A. (2004) Fundamentals of Biostatistics second					

	edition, Ukaaz publications, Hyderabad, Andhra Pradesh 3. Anderson, J., Durosn, B.H. and Poole, M. 1986. Thesis and assignment writing, Wiley Eastern Ltd., New Delhi. 4. Gupta S.P. Statistical Methods. Sultan Chand, New Delhi: 1992.
References	1. Vijayalakshmi G. &Sivapragasam C. Research Methods: Tips and Techniques. MJP Publishers, Chennai: 2009. 2. Gurumani N. An Introduction to Biostatistics. MJP Publishers ,Chennai; 2004. 3. Daniel, W.W (2006) Biostatistics-A foundation for analysis in health sciences, John Wiley (Asia) & sons, Singapore. 4. Sampathkumar V.S. Bio-Statistics. ManonmaniamSundaranar University publication, Tirunelveli;1997. 5. Arora, P.N and P.K.Malhan 2008. Biostatistics. Himalaya Publications, Mumbai. 6. Verma B.L., Shukla G.D and Srivastava. R.N., Biostatistics – Perspectives in Health Care, Research and Practice, CBS Publishers & Distributors, New Delhi; 1993 7. Gupta C.B. An introduction to statistical methods. Vikas Publishers, New Delhi; 1992. 8. Daroga Singh and Chaundjari F.S. Theory and Analysis of Sample survey.Wiley Eastern Ltd., New Delhi;1986.
E-references	1. nu.libguides.com/biostatistics 2. https://newonline courses.sciences.psu.edu/

Course outcome

Upon completion of this course, the students will be able to		
CO1	Know the basics of biostatistics	K1
CO2	Calculate arithmetic mean, median and mode	K3
CO3	Learn the analyses data and pooling the data	K2
CO4	Make standard curve and interpolations of unknown y-values theorem.	K3
CO5	Enable to do scientific writing and oral presentation	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S	M	S	S
CO3	S	M	M	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBE412	Choice 2	L	T	P	C
ELECTIVE I		BIOINSTRUMENTATION TECHNIQUES	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Evaluate					
Learning objective	• To know the fundamental principles of microscopes. • To learn the principles and applications of biomolecules separation methods. • To understand the radioactive measuring techniques. • To gain knowledge about various working principles and applications of bio instruments.					
Unit I	**Buffer in biological system**		**12 hours**			
Biological relevance of pH, measurement of pH, pKa of functional groups in biopolymers such as proteins and nucleic acids. Importance of buffers in biological systems, ion selective electrodes, and oxygen electrode. Osmotic pressure in biological systems, viscosity and determination of molecular weight using viscometers.						
Unit II	**Microscopy**		**12 hours**			
Basic principles of light microscopy, phase contrast microscopy, electron microscopy, and fluorescence microscopy. Sedimentation methods: Principles of centrifugation, preparative, differential and density gradient centrifugations, analytical, ultracentrifugation						
Unit III	**Separation Methods**		**12 hours**			
Principles and applications of separation methods: Paper, Thin layer, ion exchange, and gas chromatography, affinity chromatography, Gel filtration, HPLC, Electrophoresis: SDS-PAGE and isoelectric focusing, Capillary electrophoresis, Northern blot, Southern blot, Western blot Analysis. 2D electrophoresis, Pulse-field gel electrophoresis.						
Unit IV	**Spectroscopy**		**12 hours**			
Electromagnetic radiations, Interaction of light with matter; Principles and Biological applications of Colorimetry, Spectrophotometry. UV, Atomic absorption spectroscopy, Electron spin resonance spectroscopy, NMR spectroscopy, Polarimetry, Principles and applications of X-ray Diffraction. MALDI-LCMS.						
Unit V	**Radioactivity**		**12 hours**			
half-life, decay constant, average life, units of radioactivity, Radioactivity measuring techniques. Radiation dose units, Roentgen, REM maximum permissible dose, dosimetry and dosimeters; radiation monitoring hazards, Biological effects of radiation, Radioisotopes in medicine.						
Textbook	1. Wilson, K. and Walker, J. 2003. Principles and Techniques of Practical Biochemistry, 5th Edition Cambridge University Press, New York. 2. Veerakumari, L. 2009. Bioinstrumentation. MJP Publishers, Chennai.					
References	1. Sawhney, S.K. and Singh, N. 2000. Introductory Practical Biochemistry. Narosa Publishing House, New Delhi. 2. Techniques in Molecular Biology Ed. Walker &Gastra, Croom Helm, 1983. 3. Principles of instrumental analysis, 2nd Ed, Holt-Sanders, 1980. 4. An introduction to spectroscopy for Biochemistry. Ed. Brown S.N., Academic press. 5. Palanichamy, S. and Shanmugavelu, M. 2011. Principles of Biophysics, 2nd Edition, Palani Paramount Publications, Palani.					

	6. Holme and Hazel peck. Analytical Biochemistry. Prentice Hall.3rd edition ;1998.ISBN-13 : 978-0582294387. 7. Plummer, D.T. 2008. An Introduction to Practical Biochemistry. Tata McGraw Hill Publications, New Delhi. 8. David T. Plummer. An introduction to practical biochemistry. McGrew-Hill Education. Third edition;2006.ISBN-13 : 978-0070994874 9. Chatwal, G.R and Anand, S.K. 2009. Insturmental Methods of Chemical Analysis. Himalaya Publishing House, New Delhi. 10. Edshall& Wyman. Biophysical chemistry. Academic press,First edition;1958. 11. Biochemical calculations Seigal, IH, 2nd Edit, John Wiley & sons Inc.,1983,
E-references	1. https://application.wiley-vch.de/books/sample/3527338802_c01.pdf

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Understand the basics of pH and buffer preparation.	K2
CO2	Gain knowledge about fundamental principles of microscope.	K1
CO3	Learn about the separation methods of biomolecules.	K1
CO4	Acquire skill in spectroscopic techniques.	K3
CO5	Gain knowledge about application of radioactivity.	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	S	S	S	S	M	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBE421	Choice I	L	T	P	C
Elective-II		BIOINFORMATICS	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the sequencing methods and database searching methods • To obtain knowledge on submission process of protein and nucleotide sequence to the databases. • To learn the methods to find the structure of specific compounds, • To obtain knowledge on visualization tools and evolutionary tools					
Unit I	**History, development and types of computers**					
General awareness of computer systems – hardware and software (CPU and other peripheral devices, computer arithmetic, computer logic, programming languages – machine language, assembly language, higher level languages). Introduction – Email – World Wide Web – Surfing. Search engines						
Unit II	**Sequence analysis**					
need and importance – pairwise alignment – dynamic programming – Global (Needleman – Wunsch) and Local (Smith Waterman) Alignment concepts – Database searching tools – Sequence Database, Structural Database, Sequence alignment tools - Entrez, BLAST, FASTA – multiple alignment – Clustal – Construction of Phylogenetic trees – Softwares for phylogenetic trees						
Unit III	**Proteomics**					
Structural classification of proteins (SCOP, CATH and other classification) – Structural and functional genomics – Proteomics – Protein sequencing and Protein structure prediction. Primer designing – Insilco tools						
Unit IV	**Evolutionary analysis**					
Distance – Clustering methods – Rooted and Unrooted tree representation – Bootstrapping strategies. Maximumlikehood method, Parsimony Method. Neural Networks – Concepts and Secondary Structure Prediction – Hidden Markov Models –Gene Identification and other application						
Unit V	**Microarray**					
Microarray – types – Stanford Microarray Database –Microarray analysis – Hierarchical clustering and Self organizing Maps. 3D structural analysis of biomolecules – molecular visualization tools – Protein Docking.						
Textbook	1. Andreas D Bakevanis, Gary D.Bader, David, S. Wishart - Bioinformatics 4th Edition (2020) ISBN 978-1-119-33558-0 2. Mount, W. 2001. Bioinformatics Sequence and Genome Analysis. Cold Spring harbour Laboratory Press, New York 13. 3. Pevsner 2003. Bioinformatics and Functional Genomics. Wiley Dreamtech India Ltd., New Delhi 4. Twyman, R.H. 2003. Instant notes on Bioinformatics. Viva Books Pvt. Ltd., NewDelhi					
References	1. Baxevanis, A.D. and Quellette, B.F.F. 2009. Bioinformatics. A practical guide to the analysis of genes and proteins. II edn. Wiley-Intern Science Publication, New York. 2. Lesk, M.A. 2008. Introduction to Bioinformatics. Oxford Univ. Publisher 3. Gautham N – Bioinformatics databases and Algorithms 2006 ISBN 978-1-84265-300-5					

	4. Vikramsingh, Dilbagsingh, Jogindersingh – Bioinformatics computing 2007 ISBN 978- 81-7319-794-9 5. Introduction to Bioinformatics – Arthur M.ESK 2019 ISBN 9780198794141 6. Attwood, T.K. and Parry, D.J – Smith, D.J. 2005. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd.
E-references	1. https://www.ncbi.nlm.nih.gov/books/NBK20261/

Course Outcome

Upon completion of this course, the students will be able to		
CO1	Gain the knowledge about the history and developments of computers.	K1
CO2	Understand the sequencing methods, database searching tools and phylogenetic construction tools.	K2
CO3	Obtain knowledge on structure and classifications of proteins	K2
CO4	Perform evolutionary analysis by Pylogenetic methods	K3
CO5	Have a clear idea about the 3D structural analysis.	K3

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	M	S	S	S	S	S	S	S	M
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBE422	Choice II	L	T	P	C
Elective-II		PROTEOMICS & GENOMICS	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the various sequencing methods, • To obtain knowledge on different Marker system • To learn the proteomics and protein expression studies.					
Unit I	Genomics					
Introduction,definition, Genomics and its diversifications, Structural organization of prokaryotic and eukaryotic genomes;Genomics of yeast, *Arabidopsis thaliana, Escherichia coli* and Homo sapiens Metagenomics; Organelle genomes;Sequencingtechniques:Conventional techniques – Maxam Gilbert and Sanger Sequencing, Strategies for Whole Genome Sequencing –Hierarchical and Whole Genome Shotgun Sequencing, role of Genetic and Physical maps in Genome assembly, De novo and reference based assembly, Genome finishing –Gaps and their resolution, basic concepts of genome annotation –ORF, ab initio and homology based Gene prediction Second generation sequencing techniques –Pyrosequencing and Virtual terminator Sequencing.						
Unit II	Assessing genomic variations					
Dominant and codominant markers, Homoplasy concept, Identical by state vs Identical by descent markers, Hybridization based marker system – RFLP, PCR based marker systems – RAPD, AFLP, CAPS, SCAR, SSRs, Microarray based SNP detection techniques, Applications of DNA markers; C value paradox, types and significance of repeats in the genome; Expressed sequence tags: Differential and Display.						
Unit III	Proteomics					
Introduction, Branches of proteomics -Protein extraction Methods: Subcellular fractionation, Density gradients, Ultrafiltration, -Protein fractioation -Affinity purification -COFRADIC-Removal of interfering compounds; Protein solubilization methods, chaotropes and detergents -Preparation of Sample -Sample handling and storage -Protein detection and quantification methods –SILAC,Chemical tagging, fluorescence, negative staining, radio-labeling and Chemical modifications. Structural Proteomics: Protein Structure-function relationship –Disulfide bonds, Post translational modifications, Glycosylation, Phosphorylation and other modifications. Methods for detection of protein-protein interactions -Yeast 1, 2 and 3 hybrid systems –Phage display –Surface Plasmon Resonance-Fluorescence Resonance Energy Transfer -Algorithms for proteomics -OMSSA -SEQUEST -MASCOT.						
Unit IV	Protein expression					
Expression Systems –Plasmids, E coli, Yeast, Pitchiapastoris, Bacculovirus -Introduction, detection and purification of expressed transgenes -antibody capture –antibody generation and Engineering –Protein/peptide chemical synthesis –Reconstitution of proteins in lipid vesicles, -Liposomes -Proteinpolynucleotide interactions -Biotinylatedreactions -Signaling complex. Proteomic Techniques:2-D gel electrophoresis –Mass Spectrometry –Principles-MALDITOF -RP chromatography/Tandem mass 54spectrometry -Protein sequence analysis -N-terminal determinationmethods-Protein modification -Protein microarrays -Tissue microarray -Infra red Protein array with Quantitative Readout -X-ray crystallography -Nuclear Magnetic Resonance -X-ray						

Tomography -Data Analysis algorithms -Sequence Analysis algorithms.	
Unit V	**Proteomic approach for Clinical studies**
Protein Biomarker Discovery and Validation -Body fluid profiles, blood disease profiles, diabetes profiles, infectious diseases, stroke nd myocardial infarction, nervous system, Alzheimer, low abundance and hydrophobic proteins. High through put techniques to identify protein molecules in sample -Emerging echnologies: Proteomics in Biotechnology – Microfluidics	
Textbook	1. Primrose, S.B. and R.M. Twyman, 2009. Principles of Gene manipulation and Genomics, Seventh Edition, Blackwell publishing, UK. 2. Pevsner 2003. Bioinformatics and Functional Genomics. Wiley Dreamtech India Ltd., New Delhi
References	1. Brown, T.A. 2007. Gene Cloning & DNA Analysis: An introduction. VII edn. Blackwell publishing USA. 2. Genomics and proteomics, functional and computational aspect Edited by SandorSuhail, Springer (2000). 3. Introduction of proteomics, Daniel C .Liebler,Human Press, (2001) 4. Baxevanis, A.D. and Quellette,BF.. Bioinformatics A practical Guide to the analysis of Genes and protein .Wieyinter science Publication, New York(1998).
E-references	1. https://www.ncbi.nlm.nih.gov/books/NBK20261/

Course Outcome

Upon completion of this course, the students will be		
CO1	Understand the genomic concepts based on sequencing methods	K1
CO2	Assess genomic variations by molecular marker	K2
CO3	Gain the knowledge about the proteomic techniques	K2
CO4	Understand the protein expression profiles	K2
CO5	Perform clinical studies by proteomic approach	K3

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	M	S	S	S	S	S	S	S	M
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

VALUE ADDED PROGRAM

Course Code	P21MBV11	ADVANCED TECHNIQUES IN CLINICAL MICROBIOLOGY	Total Hours	C
Value Added Program I			30	2

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To understand the techniques on clinical microbiology • To evaluate the pathogens from the clinical specimens • To obtain the knowledge about the laboratory safety • To learn the basic and advanced techniques in clinical Laboratory
Unit I	**Laboratory Safety**
Organization of laboratory and safety precautions in laboratory – Personal hygiene and care – General health care – Vaccination Schedule for technicians – Laboratory care and cautions – Do's and Don'ts – lab accidents – Cuts and wounds – Fire Accidents (Chemical Gas, Flammable Chemicals, Electrical , Spirit Lamp, Gas) – Chemical burns.	
Unit II	**Sample Analysis**
Sample collection, processing, preservation and transportation of various clinical pathology samples. Pathological Analysis of clinical specimens.	
Unit III	**Microscopic Analysis**
Microscopic analysis of clinical specimens – Urine, Stool, Sputum, Pus, Blood, CSF and other body fluids.	
Unit IV	**Culture Methods**
Culture methods – Culturing and isolation of pathogens from clinical specimens. Culture media – General purpose media – special media – selective media – differential media – transport media.	
Unit V	**Advanced Techniques & Automation**
ELISA – PCR- Fluorescence Microscopy – Automated culture systems – automated Blood culture – Automated Urine culture – Automated Antibiotic Sensitivity testing.	
Textbook	1. Ananthanarayanan.R. and Paniker C.K.J Text Book of Microbiology, 9th Edition Orient Longman, (2013). 2. P. Chakraborthy, A Text Book of Microbiology 3 rdEdn, New Central book Agency (P) Ltd, Kolkata, India 2005. 3. PrafulGodkar, Darsan, 2014. Text book of Medical Laboratory Technology Vol I & II, Bhalani Publishing House. 4. James cappuccino, Natalie Sherman.(2004) Microbiology: A Laboratory manual. 7th Edition
References	1. Ochei.J and A. Kolhatkar, 2000. Medical laboratory science: Theory and Practice, McGraw Hill Education. 2. SoodRamnik. 2009. Medical Laboratory Technology: Methods and Interpretations. Jaypee Brothers, Medical Publishers Pvt. Limited. 3. Glick, B.J., Pasternak, J.J., Patten, C.L. 1994. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edition, ASM Press. 4. David Greenwood, Richard Slack and John Peutherer. (2000). Medical Microbiology.15th edition, Church Hill Living stone Publication.

E-references	1. https://mybooksfactory.com/wp-content/uploads/2021/04/sastry.jpg 2. https://lib-ebooks.com/manual-of-clinical-microbiology-2-volume-set-11th-edition/ 3. https://onlinelibrary.wiley.com/doi/book/10.1128/9781555817381

Course Outcome

Upon completion of this course, the students will be able to		
CO1	understand laboratory safety methods.	K2
CO2	understand pathological analysis of clinical specimens.	K2
CO3	acquire knowledge on microscopic analysis of clinical samples	K2
CO4	analyze the pathogens from the different cultures	K3
CO5	gain knowledge about automated techniques in Clinical Laboratory Technology.	K2

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	P21MBV41	PUBLIC HEALTH AND HYGIENE	Total Hours	C
Value Added Program - II			30	2
Cognitive Level	K2: Understand K3: Apply			
Learning objective	• To impart awareness on Public Health and Hygiene • To create knowledge on Health Education and hazards. • To identify the communicable diseases and their control measures • To learn about non-Communicable diseases and their preventive measures • To spot the health education in India			
Unit I	**Scope of Public health and Hygiene**			
Nutrition and health – classification of foods – Nutritional deficiencies - Vitamin deficiencies.				
Unit II	**Environment and Health hazards**			
Environmental degradation – Pollution and associated health hazards.				
Unit III	**Communicable diseases**			
Diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plauge, Leprosy, AIDS and Corona.				
Unit IV	**Non-Communicable diseases**			
Diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.				
Unit V	**Health Education in India**			
WHO Programmes – Government and Voluntary Organizations and their health services – Precautions, First Aid and awareness on sporadic diseases.				
Text Books	1. Park and Park,: Text Book of Preventive and Social Medicine – BanarsidasBhanot Publ. Jodhpur – India. 2010 2. Dubey, R.C and Maheswari, D.K.: Text Book of Microbiology – S. Chand & Co. Publ. New Delhi – India. 2007 3. Park, J.E. and Park, K. Textbook of Community Health for Nurses.2010			
Reference Books	1. Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation –Part I- IV .Murray, C. J. L. and A.D. Lopez. The Global Burden Of Disease. World Health Organization.1996. 2. Verma, S. Medical Zoology, Rastogi publ. – Meerut – India .1998 3. Singh, H.S. and Rastogi, P. : Parasitology, Rastogi Publ. India.2009			
E- Reference link	1. http://oms.bdu.ac.in/ec/admin/contents/316_16SNMEZO2_2020052104361175.pdf 2. http://keralamarinelife.in/Journals/Vol21/03%20Madhumita%20Mukherjee.pdf **3.** https://content.kopykitab.com/ebooks/2013/11/2328/sample/sample_2328.pdf			

Course Outcome

Upon completion of this course, the students will be able to		
CO1	communicate awareness on public health and Hygiene	K2
CO2	gather knowledge on health education and hazards.	K2
CO3	identify the communicable diseases and their control measures	K3
CO4	learn about non-Communicable diseases and their preventive measures	K2
CO5	Control communicable diseases by using appropriate disease control measures	K2

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S
CO3	S	S	S	S	S	S	S	M	S	M	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	M
CO5	S	S	S	S	S	M	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

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