CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

Nationally Accredited with 'A' Grade by NAAC

ISO 9001:2015 Certified

TIRUCHIRAPPALLI

PG AND RESEARCH DEPARTMENT OF MICROBIOLOGY

M.Sc., MICROBIOLOGY

SYLLABUS

2022 -2023 and Onwards

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG AND RESEARCH DEPARTMENT OF MICROBIOLOGY

VISION

Our vision is to encourage eminent research work through the conception of an attractive and vibrant environment to achieve goals of our department.

MISSION

- To impart relevant, ultimate, principle-oriented education and practical expertise in the field of Microbiology.
- To strive to provide quality education conjugated with innovative technology so as to be able to gain technical and educational expertise locally, nationally, internationally.
- Our prime focus is to enrich the ambitions of our students, staff and steer with constructive collaboration towards excellence.

PROGRAMMEEDUCATIONALOBJECTIVES(PEOs)

PEOs	Statements
PEO1	**LEARNING ENVIRONMENT** To facilitate value-based holistic and comprehensive learning by integrating innovative learning practices to match the highest quality standards and train the students to be effective leaders in their chosen fields.
PEO2	**ACADEMIC EXCELLENCE** To provide a conducive environment to unleash their hidden talents and to nurture the spirit of critical thinking and encourage them to achieve their goal.
PEO3	**EMPLOYABILITY** To equip students with the required skills in order to adapt to the changing global scenario and gain access to versatile career opportunities in multidisciplinary domains.
PEO4	**PROFESSIONAL ETHICS AND SOCIAL RESPONSIBILITY** To develop a sense of social responsibility by formulating ethics and equity to transform students into committed professionals with a strong attitude towards the development of the nation.
PEO5	**GREEN SUSTAINABILITY** To understand the impact of professional solutions in societal and environmental contexts and demonstrate the knowledge for an overall sustainable development.

PROGRAMME OUTCOMES FOR M.Sc..Microbiology PROGRAMME

PO NO	On completion of M.Sc., Microbiology, the students will be able to
PO1	**Scientific Management and Career Opportunities:** Master the scientific and applied aspects of the subject for employment opportunities.
PO2	**Explore Creativity and Intelligence:** Employ novel ideas with conceptual thinking to secure self-discipline and independence to foster scientific attitude by exploration of Science.
PO3	**Team Building and Scientific Temperament:** Inculcate training, internships and team spirit with leadership skills through academic projects and transmit complex scientific and technical information and contribute to the scientific community.
PO4	**Innovative Learning and Technological Advancement:** Perceive research in the specialized areas and to engage in life-long learning to keep pace with emerging trends in academics, research and technology.
PO5	**Personality Development with Social Responsibility:** Achieve ethical, social and holistic values with social responsibility to develop a healthy life.

PROGRAMME SPECIFIC OUTCOMES FOR M.Sc., MICROBIOLOGY

PSO NO.	Students of M.Sc., Microbiology will be able to	POs Addressed
PSO 1	Understand the applied sciences to engage them life long learning to foster their successful carrier and educational goals.	**PO1 PO5**
PSO 2	Focus perceptive in the subject of Microbiology to apply its principles and its applications by adding broad range of scientific knowledge.	**PO2 PO3**
PSO 3	Acquire contextual knowledge on basis and modern concepts in current areas with contemporary technologies and multidisciplinary domains	**PO3 PO4**
PSO 4	Instill to work independently identify appropriate resources; enable individual, institutional and national values to understand the impact of innovation and applications.	**PO4 PO1**
PSO 5	Ability to imbibe moral and ethical values to formulate effective research grants and experimental designs	**PO5 PO2**

Cauvery College for Women (Autonomous), Trichy-18

PG & Research Department of Microbiology

M.Sc., Microbiology

Learning Outcome Based Curriculum Framework (CBCS-LOCF)

(For the Candidates admitted from the Academic year 2022-2023 onwards)

Semester	Course	Title	Course Code	Inst./ Hrs/Week	Credit	Hrs	Marks		Total
							Int.	Ext.	
I	Core Course– I (CC)	Essentials of Microbiology	22PMB1CC1	6	5	3	25	75	100
	Core Course– II (CC)	Biological Macromolecules	22PMB1CC2	6	5	3	25	75	100
	Core Course – III (CC)	Clinical Virology	22PMB1CC3	6	5	3	25	75	100
	Core Practical–I (CP)	Essentials of Microbiology, Biological Macromolecules and Clinical Virology (P)	22PMB1CC1P	6	5	3	40	60	100
	Discipline Specific Elective Course – I(DSE)	A. Biological Techniques	22PMB1DSE1A	6	3	3	25	75	100
		B. Organic Farming	22PMB1DSE1B						
		C. Microbial Cytology	22PMB1DSE1C						
		TOTAL		**30**	**23**	**-**	**-**	**-**	**500**
15 Days INTERNSHIP during Semester Holidays									
II	Core Course- IV (CC)	Bacteriology and Mycology	22PMB2CC4	6	5	3	25	75	100
	Core Course – V(CC)	Immunology and Immunotechnology	22PMB2CC5	6	5	3	25	75	100
	Core Choice Course – I (CCC)	A. Microbial Metabolism	22PMB2CCC1A	6	4	3	25	75	100
		B. Environmental and Agricultural Microbiology	22PMB2CCC1B						
		C. Microbial Ecology	22PMB2CCC1C						
	Core Practical–II (CP)	Bacteriology ,Mycology,Immunology and Immuno technology (P)	22PMB2CC2P	6	5	3	40	60	100
	Discipline Specific Elective Course – II (DSE)	A. Biofertilizer Technology	22PMB2DSE2A	6	3	3	25	75	100
		B. Public Health Microbiology	22PMB2DSE2B						
		C. Marine Microbiology	22PMB2DSE2C						

	Internship	Internship	22PMB2INT	-	2	-	-	100	100
	Extra Credits Course	SWAYAM	As Per UGC Recommendation						
	TOTAL			**30**	**24**	**-**	-	-	**600**
III	Core Course-VI (CC)	Molecular Biology and Microbial Genetics	22PMB3CC6	6	5	3	25	75	100
	Core Course-VII(CC)	Food and Dairy Microbiology	22PMB3CC7	6	5	3	25	75	100
	Chore Choice Course- II(CCC)	A. Cyber security	22PGCS3CCC2A	5	4	3	25	75	100
		B. Microbial Gene Technology	22PMB3CCC2B						
		C. Biosafety and Intellectual Property Rights	22PMB3CCC2C						
	Core Practical-III (CP)	Molecular Biology and Microbial Genetics (P)	22PMB3CC3P	6	5	3	40	60	100
	Discipline Specific Elective Course – III (DSE)	A. Microbiology for Competitive Examination	22PMB3DSE3A	4	3	2	-	100	100
		B. Food Adulteration	22PMB3DSE3B			3	25	75	
		C. Biomedical Laboratory Technology	22PMB3DSE3C						
	Generic Elective Course - I (GEC)	Food Quality Testing	22PMB3GEC1	3	2	3	25	75	100
	Extra Credit Course	SWAYAM	As per UGC Recommendation						
	TOTAL			**30**	**24**	**-**	**-**	**-**	**600**
IV	Core Course – VIII (CC)	Bioprocess Technology	22PMB4CC8	6	5	3	25	75	100
	Core Choice Course– III (CCC)	A. Bioinformatics and Biostatistics	22PMB4CCC3A	6	4	3	25	75	100
		B. Computational Biology	22PMB4CCC3B						
		C. Microbial Nanotechnology	22PMB4CCC3C						
	Core Practical-IV (CP)	Bioprocess Technology (P)	22PMB4CC4P	6	5	3	40	60	100
	Generic Elective Course -II (GEC)	Entrepreneurial Microbiology	22PMB4GEC2	3	2	3	25	75	100
	Project	Project Work	22PMB4PW	9	5	-	-	100	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**500**
	GRAND TOTAL			**120**	**92**	**-**	**-**	**-**	**2200**

Courses & Credits for PG Science Programmes

Sl. No	Courses	No of Courses	No of Credits	Marks
1.	Core Course – (CC)	08	40	800
2.	Core Choice Course– (CCC)	3	12	300
3.	Core Practical-(CP)	4	20	400
4.	Discipline Specific Elective- (DSE)	3	9	300
5.	Generic Elective Course - (GEC)	2	4	200
6.	Project	1	5	100
7.	Internship	1	2	100
	Total	22	92	2200

The internal and external marks for theory and practical papers are as follows:

Subject	Internal Marks	External Marks
Theory	25	75
Practical	40	60

Separate passing minimum is prescribed for Internal and External

For Theory:

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)

b) The passing minimum for End Semester Examinations shall be 40% out of 75marks (i.e. 30 mark

c) The passing minimum not less than 50% in the aggregate.

For Practical:

a) The passing minimum for CIA shall be 40% out of 40 marks (i.e. 16 marks)

b) The passing minimum for End Semester Examinations shall be 40% out of 60marks (i.e. 24 mark

c) The passing minimum not less than 50% in the aggregate.

For PROJECT:

Marks for Dissertation: 80 Marks

Marks for Viva Voce: 20 Marks

Total Marks: 100 Marks

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PG & Research Department of Microbiology

M.Sc., Microbiology

Learning Outcome Based Curriculum Framework (CBCS-LOCF)

(For the candidates admitted from the Academic year 2022-2023 and onwards)

Semester	Course	Title	Course Code	Inst./ Hrs/Week	Credits	Exam			Total
						Hrs	Marks		
							Int.	Ext.	
I	Core Course – I (CC)	Essentials of Microbiology	22PMB1CC1	6	5	3	25	75	100
	Core Course – II (CC)	Biological Macromolecules	22PMB1CC2	6	5	3	25	75	100
	Core Course – III(CC)	Clinical Virology	22PMB1CC3	6	5	3	25	75	100
	Core Practical –I (CP)	Essentials of Microbiology, Biological Macromolecules and Clinical Virology (P)	22PMB1CC1P	6	5	3	40	60	100
	Discipline Specific Elective Course – I (DSE)	A. Biological Techniques B. Organic Farming C. Microbial Cytology	22PMB1DSE1A 22PMB1DSE1B 22PMB1DSE1C	6	3	3	25	75	100
Total				**30**	**23**	**-**	**-**	**-**	**500**

Semester: I	Internal Marks: 25		External Marks: 75	
COURSE CODE	COURSE TITLE	CATEGORY	HRS./WEEK	CREDITS
22PMB1CC1	ESSENTIALS OF MICROBIOLOGY	CORE COURSE	6	5

Course Objective
To enable the students to understand the basic knowledge in Microbiology.

Prerequisites
Basic knowledge and concepts of microbiology.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Remember and understand the scope, history and basics of microbiology	K1,K2
CO2	Analyze the principles of Microscopy and able to understand the characteristics of different microbes	K1,K2,K3
CO3	Locate and classify and bacteria, fungi, algae and virus	K2,K4
CO4	Explain Microbial growth and recall methods of reproduction	K1,K5
CO5	Construct and revise cultivation and preservation methods of microbes	K5,K6

Mapping of CO with PO and PSO

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

1- Slight (Low) correlation 2- Moderate(Medium) correlation
3- Substantial (High) correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	History and Scope of Microbiology, Classification systems– Phenetic, phylogenetic and numerical. Domain and	18	CO1, CO2, CO3	K1, K2, K3,

	kingdom concept - Haeckel's three kingdom concept, Whittaker's five kingdom concept, Carl Woes three domain system, Cavalier - smith eight kingdom concept. Bacterial classification(outline)according to Bergey's manual of systemic Bacteriology.			K4
II	Principles of microscopy. Compound microscope (Monocular and Binocular microscopes) – construction and function of parts, ray diagram of path of light, objectives, oculars, condensers, sources of illumination and uses. Dark field, Phase contrast and Fluorescence microscopes, Confocal microscopes, Atomic Force Microscope - principle, construction, ray diagram and applications - Electron microscopy – TEM and SEM – principle, construction, ray diagram and uses.	18	CO1, CO2	K1, K2, K3
III	Study of bacteria: Size, shape and arrangement of bacterial cells. Structures external to cell wall – capsule, slime layer, flagella, pili, fimbriae, stalks, prosthecae. Cell wall – gram positive and gram negative. Structures internal to cell wall – cell membrane , cytoplasm , cytoplasmic inclusions , genome, spores and cysts. Reproduction in bacteria: a) Binary fission *E coli* ,*Bacillus* and *Streptococcus* b) Other methods – Budding, Fragmentation, Prostheca, Multiple fission**.**	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
IV	General characteristics, Classification, Structure and Reproduction of Algae: *Chlorophyta* (Green algae), *Diatoms*, *Rhodophyta* (Red algae), Fungi: Cell wall – chemical composition and functions, membranes and their functions, nutritional strategies of fungi. Structure and life cycle of fungi *Ascomycetes* (*Aspergillus*), *Zygomycetes* (*Mucor*), *Basidiomycetes* (*Agaricus*). Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification of virus **.**	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
V	Microbial growth - culture media - isolation of pure culture. Growth curve: Diauxy - continuous culture – chemostat – turbidostat - synchronized growth. Measurement of microbial growth – Total cell count method - viable cell count method and biomass determination - dry weight – wet weight – protein – Kjeldhal nitrogen – chlorophyll. Growth phases – kinetics – asynchronous – synchronous - batch – continuous culture.	18	CO1, CO4, CO5	K1, K2, K4, K5

	Factors affecting growth (pH, salinity, temperature, light, etc). Microbial growth control - Physical and chemical methods – sterilization and disinfection. Maintenance and preservation of microorganism			
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Nomenclature and modern methods of Bacterial taxonomy, Micrometry, Gaint bacteria, Cultivation of virus and Protozoa, Bacterial nutrition.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Dave Wessner , Christine Dupont , Trevor Charles , Josh Neufeld.(2020).Microbiology.Wiley.
2. BhagwanRekadwad. (2020).Microbial Systematics: Taxonomy, Microbial Ecology, Diversity. CRC Press.
3. Joan L. Slonczewski , John W. Foster , Erik R. Zinser.(2020).Microbiology: An Evolving Science. W. W. Norton & Company.
4. Michael J. LeBoffe, Burton E. Pierce. (2019).Microbiology: Laboratory Theory & Application, 1st Edition. Morton Publishing Company.
5. Gerard Tortora , Berdell Funke , Christine Case. (2018).Microbiology: An Introduction, 4th Edition,Pearson.

Reference Books

1. Gerard Tortora , Berdell Funke , Christine Case, Derek Weber, Warner Bair . (2020).Microbiology: An Introduction, 12th Edition.Pearson.
2. Barry Chess.(2020).Talaro's Foundations in Microbiology: Basic Principles, 7th Edition.McGraw Hill.
3. Lourdes Norman-McKay .(2018).Microbiology: Basic and Clinical Principle, 1st Edition .Pearson.
4. Kathleen Park Talaro , Barry Chess. (2017).Foundations in Microbiology, 7th Edition. McGraw Hill.
5. PrescottL.M,Harley,J.P.andHelin,D.A. (2017).Microbiology, 5th Edition. McGraw Hill.

Web References

1. https://microbenotes.com/category/basic-microbiology/
2. https://microbiologyinfo.com/
3. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_1%3A_Introduction_to_Microbiology_and_Prokaryotic_Cell_Anatomy/1%3A_Fundamentals_of_Microbiology
4. https://www.biologydiscussion.com/notes/microbiology-notes/notes-microbiology-biology/34235
5. https://www.britannica.com/science/microbiology

Pedagogy

Chalk and talk, Quiz, Assignments, Group Discussion, Demo and PPT

Course Designer

Dr.P.F.Steffi

Semester: I	Internal Marks:25	External Marks:75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs/ Week**	**CREDITS**
22PMB1CC2	**BIOLOGICAL MACROMOLECULES**	**CORE COURSE**	**6**	**5**

Course objective

- To provide knowledge about cell, it's structure and function
- To understand the metabolicpathways of various macromolecules.
- To know about the basic concepts of thermodynamics, chemical reactions and buffers
- To illustrate the structure, function, kinetics and inhibition of enzymes

Prerequisite

Basic understanding of cell and its functions, biological macromolecules.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Remember and understand the basic structure of cell and it's various components	K1,K2
CO2	Analyze and understand the basic concepts of enzyme and it's catalysis	K2,K3
CO3	Categorize the Various types of Macro molecules examine their structure, properties & Function	K3,K4
CO4	Explain the basic concepts of thermodynamics and list out the various types of transport mechanisms	K4,K5
CO5	Discuss the various metabolic pathways and interpret the ATP Production and regulation	K5,K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation
"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Cell and it's function-Structural organization and functi of bacterial, animal and plant cell-Nucleus, Cytoplasm, Mitochondria, Golgi apparatus, Lysosomes, Ribosomes Endoplasmic reticulum. Various specialized component microorganisms-Pili,Fimbriae,Cilia,Flagella, S-layer,Magnetosomes-their structure and function. Cel division-Mitosis,Meiosis	18	CO1, CO2, CO3	K1, K2, K3
II	Enzymes-Definition –Classification –specificity-active site-Emil fischer and koshland Model for the mechanism of enzyme action, Enzyme kinetics:Michaelis–Menton equation for simple enzymes-Factors affecting enzyme activity. Enzyme inhibition- Competitive, Non competitive and Uncompetitive. Isozymes-coenzymes- Biological significance of enzymes	18	CO1,CO 2	K1, K2, K3, K4
III	Macromolecules. Nucleic acid - properties,biosynthesis of purines and pyrimidines - Structure of DNA and RNA.Types of RNA. Proteins -classification - primary-secondary-tertiary - quaternary and three dimensional structure of proteins.Synthesis of proteins.Aminoacids-Essential and Non Essential-Carbohydrates-mono,di,oligo and polysaccharides. Lipids and biomolecules: Fatty acids, properties, -oxidation	18	CO1,CO 2, CO3, CO4	K1, K2, K3, K4, K5
IV	Bioenergetics –Laws of thermodynamics,strategy of energy production in the cell. Oxidation -reduction reactions,coupled reactions and group transfer. Biological energy transducers-structural features of biomembranes, transport, free energy and spontaneity ofreaction,G,G°,G'and equilibrium.Basic concepts of acids,bases,pH and buffer	18	CO1, CO3, CO4	K1, K2, K3, K4, K5
V	Basic concepts of metabolism - catabolic principles and break down of carbohydrates-Glycolysis-EMP and Entnerdoudroff pathway,TCA cycle and HMP shunt. Lipids-Types of oxidation-proteins-Deamination,Transamination,Decarboxylation and Transmethylation- Nucleicacids – Purine and pyrimidine catabolism-significance	18	CO1, CO3, CO5	K1, K2, K3 ,K5
VI	**Self study for Enrichment** **(Not included for End Semester Examinations)** Cell cycle, Allosteric enzymes, Biosynthesis of cholesterol, Biological buffer system –Types and functions, ATP production	-	CO1, CO2, CO3, C04	K2, K3, K4, K5

Text Books

1. Amit Kumar Nayak, Amal Kumar Dhara, Dilipkumar Pal (2021) *Biological Macromolecules Bioactivity and Biomedical Applications*. 1st Edition.Elsevier Inc.
2. Rene Crester Kratz , (2020) *Molecular & Cell Biology* 2nd edition dummies
3. Jeremy MBerg, JohnLTymoczkoand Lubertstryer.,(2002*) Biochemistry*5th editionW.H.Freemanand company ,Newyork
4. FreifelderD (2004) *Molecular Biology*, 4thEdition Narosa Publishing House ,NewDelhi

Reference Books

1. David. E.Metzler and Carol.M Metzler(2001) *Biochemistry -Thechemical reactionsofliving cells-Vol1and2*.2ndedition Harcourt/Academic press ,Newyork
2. Lehninger,Albert L, David L Nelson and MichaelMCox.(2021) *Lehninger Principlesof Biochemistry.NewYork:* 8th Edition Worth Publishers.
3. StryerLBergJM and Tymoczko JL (2002) *Biochemistry* 5thedition.NewYorkW.H.Freeman.
4. Thomas M Devlin.A.(2002) *Textbook of Biochemistry with clinical correlations*,5thedition. JohnWileyandsons,Inc., publication,Newyork
5. Rafi MD (2014) *Textbook of Biochemistry for medical students*, 2ndeditionUniversitiesPress,(India) Pvt. Ltd,Hyderabad,India

Web References

1. https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/03%3A_
2. https://www.youtube.com/watch?v=h-z9-9OOWC4
3. https://www.youtube.com/watch?v=-FQmAnmLZtE
4. https://www.youtube.com/watch?v=ok9esggzN18
5. https://www.youtube.com/watch?v=PYH63o10iTE
6. https://www.youtube.com/watch?v=VigpwmH7E3M
7. https://www.youtube.com/watch?v=_zm_DyD6FJ0
8. https://www.youtube.com/watch?v=VGHD9e3yRIU
9. https://www.youtube.com/watch?v=2Jgb_DpaQhM
10. https://www.youtube.com/watch?v=NNASRkIU5Fw
11. https://www.youtube.com/watch?v=qVAvmieRM1E
12. https://www.youtube.com/watch?v=Gh2P5CmCC0M

Pedagogy

Chalk and talk, Quiz, Assignments, Group Discussion, Demo and PPT

Course Designer

Dr. N.Pushpa

Semester: I	InternalMarks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB1CC3	**CLINICAL VIROLOGY**	**CORE COURSE**	**6**	**5**

Course Objective

- To impart and explain the students with the advanced knowledge of the characteristics of Clinically important viruses with the focus on the General characters, Cultivation, Pathogenesis, Lab diagnosis, Prophylaxis, and Treatment of the disease.

Prerequisites
Basic Understanding of Etiology and Diagnostic Management of Animal Viruses.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Describe General Characters and Classification of viruses	K1,K2,K3
CO2	Aware different Diagnostic methods adopted for viruses	K2,K3,K4
CO3	Understand the replicative cycles of Viruses	K2,K3, K4,K5
CO4	Analyze the pathogenesis and symptoms of Viruses	K3,K4, K5,K6
CO5	Examine and Categorize different types of preventive measures Of Viruses	K3,K4, K5,K6

Mapping of CO with PO and PSO

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

"1"–Slight(Low) Correlation "2" – Moderate (Medium) correlation
"3"–Substantial(High) Correlation "-"indicates there is no correlation

Syllabus

UNIT	CONTENTS	HOURS	COs	COGNITIVE LEVEL
I	GeneralVirology-IntroductionandHistoricalperspectiveofclinicalvirology.Nomenclature,GeneralPropertiesandUltrastructureofviruses.viralreplication,classificationofViruses–BaltimoreandICTVmethods.Samplecollection,TransportandexaminationsofviralSpecimens.Incompleteviruses- Prions, Satellite Viruses,Viroids and Virusoids.	18	CO1, CO2,CO3	K1, K2,K3
II	General Methods of Diagnosis and Serology-Cultivation of clinically important viruses in embryonated eggs, experimental animals, cell cultures, cell lines and transgenic systems. Serological methods–Haem agglutination & HAI; complement fixation, Immuno fluorescence methods, PCR,ELISA and Radio immuno assays, Immuno blotting-Western Blot. Assay of viruses – physical, chemical and Infective assay. Antiviral agents and viral vaccines.	18	CO1, CO2,CO5	K1, K2,K3, K4
III	Air borne Viruses-Clinical Course, Disease burden, risk factor, Epidemiology, Prevention and Treatment of following Air borne viruses-Rhinovirus, Influenza Virus (A,BandH1N1),Varicella virus- Chicken pox, Mumps virus, Measles virus, MERS-Co V and SARS-Cov-2.	18	CO1, CO2,CO3,CO4	K1,K2,K3, K4,K5
IV	Food borne Viruses-Causative agent, Pathogenesis, Lab Diagnosis, Treatment and Prophylaxis of following Food borne Viruses- Adenovirus, Rotavirus, Hepatitis virus, Enteroviruses-Poliomyelitis, Calcivirus, Polio virus and Coxsackie viruses.	18	CO1, CO2,CO3, CO4,CO5	K1,K2,K3, K4,K5

V	Vector borne Viruses-Morphology of Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following Vector borne viral diseases-Chikungunya, Dengue, Yellow fever, Rabies and Ebola Viruses. Oncogenic Viruses - Pathogenesis, Diagnosis and Prevention of Oncogenic viruses- Human Papiloma virus, HIV, HTLV, Herpes and Epstein Barr Virus.	18	CO1, CO2,CO3, CO4,CO5	K1, K2,K3, K4K5, K6
VI	**Self Study Enrichment(Not included for End Semester Examinations)** Cultural Characters of Viruses, Qualitative and Quantitative estimation of Viruses, Structure and life cycle of viruses, Etiology and Classification of viruses and Viral Prophylaxis.	-	CO1, CO2,CO3, CO4,CO5	K1, K2,K3, K4K5, K6

Text Books

1. Ananthanarayan and Jayaram Panike r(2020).*Text book of Microbiology*.11thEdition,London:OxfordUniversity press.
2. GeoBrooks,KarenCCarroll,JanetButelandStephenMorse(2020).*MedicalMicrobiology*.26th Edition, McGraw Hill Publication.
3. Jawetz,MelnickandAdelberg's(2019).*MedicalMicrobiology*.24thEdition,HillMedicalPublication division.
4. KennethJRyan,NafeesAhmadandAndrewAlspaughJ(2018).*SherrisMedicalMicrobiology*.7thEdition, McGraw Hill Education.
5. Mishra B(2018).*Text BookofMedicaVirology*.1st Edition, CBS Publishers.
6. GreenwoodD,SlackRC,BarerMRandIrvingWL(2018).*MedicalMicrobiology:AGuide to Medical Infections*.19thEdition,Churchill Livingstone Publishers.

Reference book

1. AejazIqbalandZafarNowshad(2020).Medicalmicrobiology:MillenniumEdition. Notion Press.
2. AlanJ.Cann(2015).PrinciplesofMolecularVirology.4thEdition,California:AcademicPress.
3. DimmockNJandPrimeroseSB(2016).Introductiontomodernvirology.4thEdition,London:OxfordBlackwell scientific publication.
4. SinghR.P(2015).ImmunologyandMedicalMicrobiology.1stEdition,NewDelhi:KalyaniPublishers.

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1. https://www.youtube.com/watch?v=SAbYEYs-_ak
2. https://www.youtube.com/watch?v=6RDofkmG1yo
3. https://www.youtube.com/watch?v=dGKeq7DH91c
4. https://www.youtube.com/watch?v=xEp-Sdgl9AU
5. https://www.youtube.com/watch?v=Kweu6hjWV9w

Pedagogy

Chalk and talk, Quiz, Assignments, Group Discussion, Demo and PPT

Course Designer

Dr.S.Jeyabharathi

Semester : I	Internal Marks: 40		External Marks : 60	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS./WEEK**	**CREDITS**
22PMB1CC1P	**ESSENTIALS OF MICROBIOLOGY, BIOLOGICAL MACROMOLECULES AND CLINICAL VIROLOGY (P)**	**CORE PRACTICAL**	**6**	**5**

Course objective

To impart knowledge about bacterial morphology, phage identification and estimation of nucleic acids

Prerequisites

Imparting practical skills of microbiology

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Learn and recall basic microbiological methods	K1
CO2	Understand fundamental techniques involving staining, Micrometry, sterilization, disinfection, culturing etc.	K2
CO3	Demonstrate various methods to study viruses and bacteria	K3
CO4	Evaluate and quantify the biological macromolecules	K5
CO5	Create and apply various standard operating procedures for handling microbes	K6

Mapping of CO with PO and PSO

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

"1"-Slight (Low) correlation "2"- Moderate(Medium) correlation
"3"- Substantial (High) correlation "-" indicates there is no correlation

Syllabus

I. Essentials of Microbiology

1. Safety measures to be followed in the laboratory
2. Study of compound microscope: use of monocular, binocular microscopes, use of oil immersion lens
3. Micrometry – measurement of cell dimensions
4. Study of instruments – autoclave, hot air oven, inoculation chamber (LAFU), Incubator, pH meter
5. Cleaning and sterilization of glassware and preparation of cleaning solutions
6. Enumeration of bacteria from environmental sample – Spread and Pour plate
7. Purification of bacteria by different streaking methods
8. Study of microbial behavior – motility of bacteria by hanging drop technique
9. Staining of bacteria - Monochrome staining, Preparation of Gram staining solutions, Gram staining, Negative staining, Structural staining – endospore, cell wall, capsule staining
10. Fungal slide culture

II. Biological Macromolecules

1. Preparation of buffer (Tris, Phosphate, Acetate buffer)
2. Determination of (H+) ion concentration
3. Verification of Beer-Lambert's law using coloured solution
4. Preparation of standard graph for the following and estimating the concentration in a microbial sample
    - Glucose-Anthrone method,
    - Bovine serum albumin (Lowry's method) and
    - Nucleic acid -DNA (diphenyl amine method),RNA(Orcinol method).
5. Separation of amino acids by paper chromatography and identification of amino acid. Separation of proteins by PAGE, SDS-PAGE-Demonstration.

III. Clinical Virology

1. Animal tissue culture - Demo
2. Embryonated egg inoculation
3. Cell lines studies - Demo

Reference Books

1. Saha R. (2022). *Microbiology Practical Manual,2nd edition***.** CBS Publishers & Distributors.
2. Apurba S Sastry , Sandhya Bhat.(2021).*Essentials of Practical Microbiology, 1st edition.* Jaypee Brothers Medical Publishers.
3. Baveja C. P, BavejaV. (2021).*Text and Practical Microbiology for MLT,3rd edition.* Arya Publications.
4. Das S.(2020).*Microbiology Practical Manual,1st edition* CBS Publishers.
5. Bharti Arora, AroraD.R. (2020).*Practical Microbiology, 2nd edition*. CBS Publishers & Distributors.
6. Sinha K P.(2020).*Manual of Practical Biochemistry,1st edition.* Scientific Book Company.
7. Rafi Mohammed.(2020).*Manual of Practical Biochemistry,3rd edition.* Orient

Blackswan Pvt Ltd.
8. SoundravallyRajendiran , Pooja Dhiman.(2019).*Biochemistry Practical Manual, 1st edition.*Elsevier.
9. Amita Jain , Jyotsna Agarwal , Vimala Venkatesh.(2018).*Microbiology Practical Manual, 1st edition* Elsevier.
10. Gunasekaran P.(2018). *Laboratory Manual In Microbiology,2nd edition*NewAge International Pvt. Ltd. Publisher.

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1. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
2. https://ttk.elte.hu/dstore/document/893/book.pdf
3. https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC103J-lab-manual.pdf
4. https://profiles.uonbi.ac.ke/jamesmuthomi/files/acp101_microbiology_practical_exercises.pdf
5. https://www.slideshare.net/PatriciaCosta17/practical-handbook-of-microbiology

Pedagogy

Chalk and talk, Quiz, Assignments, Group Discussions, Demo and PPT

Course Designer

Dr.P.F.Steffi

Semester : I	Internal Marks :25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB1DSE1A	**BIOLOGICAL TECHNIQUES**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objective

To educate the students with the basic principles of microbial techniques so as to develop their research aptitude and career prospects.

Prerequisite

Basic understanding of experimental protocols on biological research.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO 1	Describe and compare various instrumentation protocols.	K1,K2
CO 2	Illustrate the working principles of biological techniques	K3
CO 3	Analyze the results of biological techniques.	K4
CO 4	Summarize the advantages of assorted techniques	K6
CO 5	Formulate the applications of instrumentation biology.	K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation
"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Microscopic Techniques-Basic principles, mechanisms and application of Bright Field, Dark field, Phase contrast, Polarization, Confocal laser scanning microscope, Fluorescence, Scanning Electron microscope & Transmission Electron Microscope (SEM & TEM) and Radio- frequency scanning tunneling microscopy, Atomic force microscopy. Preparation of microbial, animal and plant samples for microscopy.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K6
II	Spectroscopy & Spectrometry- Basic	18	CO1, CO2,	K1, K2,

	concepts and applications ofCircular Dichroism (CD) and Optical Rotatory Dispersion (ORD), Fluorescence spectroscopy, UV/Visible spectrophotometry, Infrared spectroscopy, Fourier-transform infrared spectroscopy (FTIR), Nuclear Magnetic Resonance spectroscopy (NMR).		CO3, CO4, CO5	K3, K4, K6
III	Chromatographic Techniques-Basic Principles and application of Thin-layer chromatography, Paper chromatography, Gel filtration chromatography, Ion- exchange chromatography, Affinity chromatography, Gas chromatography and High Performance Liquid chromatography.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K6
IV	Centrifugation & Electrophoresis- Basic principles and applications of Centrifuges - Preparative, analytical, high speed, low speed, ultracentrifuge, differential and density gradient. Basic concepts and applications of Gel Electrophoresis- Agarose and acrylamide (native, denaturing and gradient), Isoelectric focusing, 2D Electrophoresis, Immuno-electrophoresis and Pulse field Electrophoresis.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K6
V	Radiography & Molecular Techniques- Basic principles and application of Autoradiography. Liquid scintillation counting, phosphor imaging, Imatinib Resistance Mutation Analysis. Types of PCR- Real time PCR, Reverse Transcriptase PCR, Multiplex PCR, Nested PCR and In-situ PCR. Blotting (Southern, Western, Northern) Techniques, DNA Finger printing, RFLP, RAPD and AFLP application.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K6
VI	**Self Study for Enrichment(Not included for End Semester Examination)** Differentiate the functions of Microscope, Interpret the results of FTIR, Separation of the compounds using chromatography and centrifugation, Working principles of DNA Amplification.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K6

Text Books

1. Rao, D. M. (2020). *Instrumental Methods of Analysis.* 1st Edition.CBS publishers and distributors pvt ltd.
2. Gurdeep R. Chatwal. (2019).*Instrumental Methods of Chemical Analysis*. 3rd Edition. Himalaya publishing house.
3. Bhawana Pandey M.H. Fulekar. (2019).*Bioinstrumentation.* 5th Edition. Dream tech Press.
4. Gilbert HMitchell.(2017). *Gel Electrophoresis: Types, Applications & Research*. 1st Edition. Nova Science Publishers .
5. Jessica carol. (2016).*Textbook of Analytical Biochemistry.* 1st Edition. Syrawood Publishing House.

Reference Books

1. Ankita Jain, Haresh Kalasariya, Varsha Tailor,Nikunj Patel. (2020).*Bioinstrumentation techniques-Basics and applications.*1st Edition. Notion Press.
2. Gakhar, Monika Miglani, Ashwani Kumar.(2019).*Molecular Biology: A Laboratory Manual.*1stEdition .Dreamtech Press.
3. AlmrothE.,Wright.(2018). *Principles of Microscopy: Being a Handbook to the Microscope.*1stEdition .Forgotten Books.
4. *Andreas Hofmann and Samuel Clokie. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology.8th Edition. Cambridge University Press.*
5. *Sanjay B Bari.(2017). Theory and Practice of Chromatographic Techniques. 1st Edition. Pharma Med Press.*

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1**.** http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf
2. https://research.ipmu.jp/seminar/sysimg/seminar/574.pdf
3. http://www-keeler.ch.cam.ac.uk/lectures/Irvine/
4. https://www.ccamp.res.in/sites/default/files/Basics%20of%20Chromatography_KR_C-CAMP.pdf
5. http://www.bdu.ac.in/schools/biotechnology-and-genetic-engineering/biomedical-science/docs/course_materials/Biotechniques/Electrophoresis.pdf
6.https://ehs.psu.edu/sites/ehs/files/lsc_theory_of_operation_part_1.pdf
7.https://www.youtube.com/watch?v=kOCcmJ3nVQ4

Pedagogy

Power point presentations, Group Discussion, Seminar, Quiz, Assignment, Brain Storming Activity.

Course Designer

Dr.N.Sathammai Priya

Semester : I	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS./WEEK**	**CREDITS**
22PMB1DSE1B	**ORGANIC FARMING**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objective

- This course aims at sensitizing the need and generating knowledge and skills on various organic farming practices, so as to equip the learners carrying out organic agricultural production and management.

Prerequisites

Basic knowledge and concepts of organic farming

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Define and understand the origin and importance of organic farming	K1, K2
CO2	Analyze and apply the methods in Organic Crop Production	K3, K4
CO3	Determine and Explain the methodology practiced in organic farming	K3, K4
CO4	Evaluate and categorize various organic farming system and crop protection practices	K4, K5
CO5	Criticize and manage the commercialization of organic products	K5, K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Introduction - Different concepts of organic farming – Natural farming, Biodynamic farming, and Zero Budget Farming. Principles of organic farming- Conventional farming v/s Organic farming. Benefits and Need for organic farming.	18	CO1, CO2, CO3,	K1, K2, K3, K4,
II	Development and Scope of organic farming; Requirements for organic farming-Soil fertility, Crop Nutrition & Nutrients inputs. Organic Crop Production Systems. Benefits of Integrated organic farming system.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4, K5,
III	Green manuring- Composting- principles, stages, types and factors, Composting methods –Vermicomposting- and Preparation of Vermi wash, Organic amendments and sludges. Biofertilizers and their types- methods of application-advantages and disadvantages. Seed Propagation-planting materials and seed treatments, Water management -drip irrigation -rain water harvesting.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4, K5,
IV	Plant protection- Integrated Pest Management- bio pesticides and Herbal pesticides- production at household/ farm level, Agniastra, Neemastra - mode of application-advantages. Biocontrol agents. Weed management- preventive practices, biological control of weeds, mechanical control, Standards for organic inputs, crop rotation-intercropping- Mulching-Pruning.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2, K3, K4, K5, K6,
V	Seed conservation- techniques- seed bank. Farm inspection and Process of Certification. Quality analysis of organic foods-Standards of organic foods- Organic Trademark-Marketing of Organic products. Economics of Organic Farming and Government schemes related to organic farming.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2, K3, K4, K5, K6,
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Farming components and preparation of organic nutrients. Preparation of Bio	-	CO1, CO2, CO3, CO4,	K1, K2, K3, K4,

	fertilizers - Bio pesticides and formulations. Study on crop rotation and mixed cropping techniques.		CO5,	K5, K6,

Text Books

1. Joanne MWilley,KathleenMSandmanand Dorothy H Wood. (2019). *Prescotts Microbiology*, McGraw-Hill, 11th Education.
2. Unni M Rand SabuThomas. (2018). *Organic Farming Global Perspectives and Methods*. 1st Edition. Wood head Publishing.
3. AmitavaRakshitand H B Singh. (2018). *ABC of Organic Farming*. 1st Edition. Jain Brothers.
4. Maliwal P.L. (2019). *Principles of Organic Farming.* 1st Edition. Scientific Publishers.
5. Govind Mishra Munish Kumar Verma, Ajeet Singh. (2019). *Organic farming.*1st Edition. Sankalp Publication.

Reference Books

1. Bansal M. (2020). *Basics of Organic Farming*. 1st Edition. CBS publishers and Distributors Pvt. Ltd.
2. Janet Wilson. (2020). *Composting: Sustainable and Low- Cost Techniques for Beginners.* 1st Edition, Drip Digital Publisher.
3. Debabrata Biswas, Shirley A. Micallef. (2019). *Safety and Practice for Organic Food.*1st Edition. Academic press Elsevie rScience.
4. Vinaya Kumar Sethi. (2018*). Organic farming and bio-fertilizers.* 1st Edition. Discovery Publishing House Pvt. Ltd.

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1.https://www.24mantra.com/blogs/organic-farming-vs-conventional-farming-which-method-is-better/
2.https://www.onlinebiologynotes.com/biofertilizer-advantages-types-methods-of-application-and-disadvantages/
3. https://www.britannica.com/topic/seed-propagation
4.https://content.ces.ncsu.edu/extension-gardener-handbook/8-integrated-pest-management-ipm
5.https://www.agric.wa.gov.au/small-landholders-western-australia/marketing-organic-produce
6.https://youmatter.world/en/definition/organic-farming-definition-standards-benefits/
7.https://vikaspedia.in/agriculture/national-schemes-for-farmers/schemes-for-organic-farming

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion.

Course Designer

Dr. S. Jenny

Semester: I	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB1DSE1C	**MICROBIAL CYTOLOGY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objective

To introduce basics in prokaryotic and eukaryotic cell structures and its functions

Prerequisites

Microscopic and submicroscopic details of microorganisms.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Remember and analyze the main principles of cells theory	K1 K4
CO2	Outline view of cells	K2
CO3	Identify the Structural and functions of cells	K3
CO4	Analyze and compare the cell division and its functions	K4, K5
CO5	Discuss about the Microbial cell Communication	K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation
"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	History of microbial cytology, Cell-definition and general concepts, Main principles of the cell theory, cell as basic unit of life, broad classification of cell types-Prokaryotic and eukaryotic cells and their similarities and differences.	18	CO1, CO2, CO3	K1, K2, K3, K4
II	Structure and function of prokaryotic cell-outer flagella, surface layers, cell wall, cytosol and other organelles, chromosome and extra chromosomal DNA.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4
III	Structure and function of eukaryotic cell-cytosol, nucleus, chloroplast, organelles of Vesicular trafficking system, endoplasmic reticulum(rough and smooth), golgibodies, lysosomes and microbodies.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5, K6.
IV	Role of cell cycle and control of cell cycle, cell division- Mitosis and Meiosis.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5
V	Overview- types of cell signaling- signal molecules – signal amplification – receptor types-quorum sensing.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5, K6
VI	**Self study for Enrichment(Not included for End Semester Examination)** State the cell theory of organisms, Difference between prokaryotic and eukaryotic cell, Cell cycle control mechanism, Role of signal transduction.	-	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5

Text Books

1. Verma P.S. and Agarwal V.K. (2016) *Cell Biology (Cytology, Biomolecules, Molecular Biology)*, Paperback.S.Chand and Company Ltd.
2. Kumar P. and Mina U. (2018) *Life Sciences: Fundamentals and Practice, Part-I, 6th Edition.*Pathfinder Publication.
3. Hardin J. and Bertoni G. (2017) *Becker's World of the Cell. 9th Edition (Global Edition).* Pearson Education Ltd.
4. Karp G., Iwasa J. and Masall W. (2015) *Karp's Cell and Molecular Biology – Concepts and Experiments. 8th Edition*. John Wiley and Sons.

5. Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014) *Campbell Biology in Focus*. Pearson Education.

Reference Books

1. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) *Essential Cell Biology 5th Edition*. W.W. Norton & Company.
2. Cooper G.M. and Hausman R.E. (2016) The Cell – *A Molecular Approach, 7th Edition.*Sinauer Associates Inc.
3. Mason K.A., Losos J.B. and Singer S.R. (2011) *Raven and Johnson's Biology. 9th Edition*. Mc Graw Hill publications.
4. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. (2015) *Molecular biology of cell, 6th Edition.*Garland Science, Taylor and Francis.
5. Challoner J. (2015) *The Cell: A visual tour of the building block of* life.The University of Chicago Press and Ivy Press Ltd.

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1. https://repository.embuni.ac.ke/bitstream/handle/123456789/1246/CYTOLOGY%20CHAPTER%201.pdf?sequence=1&isAllowed=y
2. https://biologydictionary.net/prokaryotic-cell/
3. https://opentextbc.ca/biology2eopenstax/chapter/eukaryotic-cells/#:~:text=Like%20a%20prokaryotic%20cell%2C%20a,that%20allow%20for%20compartmentalizing%20functions.
4. https://ncert.nic.in/textbook/pdf/kebo110.pdf
5. https://www.mdpi.com/2079-6382/9/11/779/pdf

Pedagogy

Chalk and talk Quiz, Assignments, Group Discussions, Demo and PPT

Course Designer

Dr.E.Priya

Cauvery College for Women (Autonomous),Trichy

PG & Research Department of Microbiology

M.Sc., Microbiology

Learning Outcome Based Curriculum Framework (CBCS-LOCF)

(For the candidates admitted from the Academic year 2022-2023 and onwards)

Semester	Course	Title	Course Code	Inst./ Hrs/Week	Credits	Exam			Total
						Hrs	Marks		
							Int.	Ext.	
II	Core Course- IV (CC)	Bacteriology and Mycology	22PMB2CC4	6	5	3	25	75	100
	Core Course– V (CC)	Immunology and Immunotechnology	22PMB2CC5	6	5	3	25	75	100
	Core Choice Course – I (CCC)	A. Microbial Metabolism	22PMB2CCC1A	6	4	3	25	75	100
		B. Environmental and Agricultural Microbiology	22PMB2CCC1B						
		C.Microbial Ecology	22PMB2CCC1C						
	Core Practical–II (CP)	Bacteriology, Mycology, Immunology and Immunotechnology (P)	22PMB2CC2P	6	5	3	40	60	100
	Discipline Specific Elective Course – II (DSE)	A. Biofertilizer Technology	22PMB2DSE2A	6	3	3	25	75	100
		B. Public Health Microbiology	22PMB2DSE2B						
		C. Marine Microbiology	22PMB2DSE2C						
	Internship	Internship	22PMB2INT	-	2	-	-	100	100
	Extra Credit Course	Swayam Online Course		As Per UGC Recommendation					
Total				**30**	**24**	**-**	**-**	**-**	**600**

Semester: II	Internal Marks: 25	External Marks: 75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2CC4	**BACTERIOLOGY AND MYCOLOGY**	**CORE COURSE**	**6**	**5**

Course Objectives

The course aims to impart the knowledge of structural, physiological, genetic, and growth characteristics of bacteria and fungi.

Prerequisites

Salient Cognizance on Bacteria and Fungi.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Understand the principles of microbial growth kinetics and methods to measure growth	K2
CO2	Analyze the archaebacterial domain on the basis of cell content and phylogeny	K3
CO3	Categorize the cell wall composition for the classification of bacteria	K4
CO4	Determine Fungal Classification and culture media preparation	K5
CO5	Assess the criteria used for classification of fungi	K6

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5

CO1	3	3	3	2	2	3	2	2	3	2
CO2	3	3	2	2	2	3	3	2	3	3
CO3	3	3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	2

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-"indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Microbial Growth and Reproduction in bacteria: Prokaryotic cell cycle, chromosome replication and partitioning, growth cycle and mathematics of growth, phases of growth, calculation of generation time, measurement of microbial growth, measurement of cell mass, influence of environmental factors on growth, cultivation of anaerobic bacteria and accessing non-culturable.	18	CO1, CO2, CO3 CO4	K2, K3, K4, K5
II	Archaebacteria : General characteristics and phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum, Crenarchaeota (Sulfolobus, Thermoproteus), Korarchaeota, Euryarchaeota-Methanogens, Thermophiles, Halophiles and rhodopsin based phototrophy.	18	CO1, CO2, CO3, CO4	K2, K3, K4, K5

III	Classification of Eubacteria : morphology, metabolism, ecological significance and economic importance of eubacterial groups, Gram negative non proteobacteria, Gram negative Alpha proteobacteria, Beta proteobacteria, Gamma proteobacteria, Delta proteobacteria, Epsilon proteobacteria.	18	CO1, CO2, CO3, CO4	K2, K3, K4, K5
IV	General features of fungi- Various systems of classification of fungi. a. Ainsworth (1973) and b. Webstor (1980). Micrometry : Study of micrometry and its significance in fungal taxonomy. Culture: Types of culture media and their preparation, special culture media.	18	CO1, CO4, CO5	K2, K5, K6
V	Criteria used in the classification of fungi: a. Morphology: External and Internal, b. Vegetative and Reproductive, c. Cytological and Genetics, d. Serological and Nutritional. e. Physiological and Biochemical, f. Host specificity, g. Ultrastructural and cultural.	18	CO1, CO4 , CO5	K2, K5, K6
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Classification of Eubacteria II : Gram positive: low G+ C (Firmicutes): general characteristics with suitable examples, Gram positive: high G+C (Actinobacteria), Cyanobacteria: an Introduction	-	CO1, CO2, CO3,	K2, K3, K4

Text Books

1. Michael T. Madigan,John M. Martinko,Kelly S. Bender, Daniel H. Buckley And David A. Stahl, Pearson.(2015).Brock Biology Of Microorganisms, Fourteenth Edition,

Pearson, Boston.

2. Joanne, M. Willey, Linda,M. Sherwood, Christopher,J. Woolverton And Chris Woolverton, Mc Graw Hill. (2011). Prescott, Harley, And Klein's Microbiology, Eighth edition.
3. De Vos P.(2012). Bergey's Manual of Systematic Bacteriology: Volume 3: The Firmicutes, Springer, Second Edition, Newdelhi
4. Alexopoulos,C.J, Mims, C.W, Blackwell, M.(2007).Introductory Mycology, Fourth Edition, Wiley & Sons.
5. Aneja, K.R and Mehrotra, R.S.(2018). An Introduction to Mycology, New Age International (P) Ltd., Publishers.

Reference Books

1. Griffiths, A. B.(2019). A Manual of Bacteriology, Forgotten Books.
2. Edgar M Crookshank,(2018). Manual of Bacteriology, Forgotten Books.
3. Arora and Brij Bala Arora. (2019).Medical Mycology, Second Edition, CBS.
4. Hait.(2017). A Textbook of Mycology, New Central Book Agency (NCBA); 1st edition, India.

Web References

1. http://www.rvskvv.net/images/General-Bacteriology_23.04.2020.pdf
2. https://www.eolss.net/sample-chapters/C03/E5-25-48.pdf
3. https://www.vnmu.edu.ua/downloads/microbiology/20131218-135731.pdf
4. https://www.uobabylon.edu.iq/eprints/publication_1_13183_803.pdf
5. https://www.microrao.com/micronotes/mycology.pdf

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion and Quiz.

Course Designer

Dr.N.Sathammai Priya

Semester : II	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2CC5	**IMMUNOLOGY AND IMMUNOTECHNOLOGY**	**CORE COURSE**	**6**	**5**

Course Objective

The students will acquire the competency to serve as future teachers, trainers and researchers in the field.

Prerequisites

Understand and critically analyze the literature in the field of Immunology and its technical aspects in the field of Immunology.

Course Outcome and Cognitive Level Mapping.

CO Number	CO Statement	Cognitive Level
CO1	Explain the basics of immunology	K2
CO2	Illustrate the hypersensitivity reaction	K3
CO3	Categorize auto immunity and auto immune disease	K4
CO4	Interpret transplantation and tumor immunology	K5
CO5	Discuss molecular immunology and immuno diagnosis	K6

Mapping of CO with PO and PSO

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

1- Slight (Low) correlation 2- Moderate (Medium) correlation

3- Substantial (High) correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	**Basic Immunology:** History of Immunology, Types of Immunity, Cells and organs involved in immune system (T-cells, B-cells, lymphoid organ, spleen and bone marrow), immune responses – cell mediated and humoral, Antigens, Cytokine, Haptens, adjuvants, Antibodies: their structure and functions, Complement system, Antigen processing cells, Classes of Immunoglobulin (IgA, IgG, IgD, IgM and IgE).	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4
II	**Hypersensitivity reaction:** IgE-mediated (type-I), Ab-mediated cytotoxic (type-II), Immune complex mediated (type-III) and Delayed type hypersensitivity (type-IV).	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Auto immunity and auto immune disease:** (a) Organs specific autoimmune disease – Hashimoto's thyroiditis, Good pastures syndrome, Insulin dependent diabetes mellitus, Grave's disease, Myasthenia gravis. (b) Systemic autoimmune disease – systemic lupus erythematosus (SLE), Multiple sclerosis, Rheumatoid arthritis.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Transplantation and Tumor immunology:** Transplantation and its classification, Immunologic basis of graft rejection and its	18	CO1, CO2, CO3,	K1, K2, K3,

	mechanism, Transplantation antigens, tissue typing role of MHC molecules in allograft rejection and immune suppressive therapy. Tumors of the immune system, tumor antigens and immune response to tumors, detection of tumor markers and tumor immunotherapy.		CO4, CO5	K4, K5, K6
V	**Molecular Immunology and Immuno diagnosis** Antigen antibody interaction – Precipitation reactions, Agglutination reactions, ABO Blood typing principles. Principles and applications of ELISA, Radio Immuno Assay, western blot analysis, immune electrophoresis, Immunofluorescence and chemiluminescence assay.	18	CO1, CO2, CO3, CO4, CO5	K1 K2, K3, K4, K5, K6
VI	**UNIT VI – Self study for Enrichment (Not included for End Semester Examination)** Immunological memory, Non-allergic hypersensitivity, Nutrition and autoimmunity, Advances in tumor immunology and fluorescence activated cell sorting (FACS) analysis.	-	CO1, CO2, CO3, CO4, CO5	K1 K2, K3, K4, K5, K6

Text Books

1. Coico R. and Geoffrey S. (2015) *Immunology: A Short Course*. *7th Edition.* Wiley-Blackwell.
2. Singh R.P. (2015) *Immunology and Medical Microbiology. 2nd Edition*. Kalyani Publishers, New Delhi.
3. Talwar C.P. and Gupta S. K. (2017) *Hand Book of Practical and Clinical Immunology*. CBS Publishers & Distributors.
4. Shyamasree G. (2021) *Immunology and Immunotechnology. 2nd Edition.* Books & Allied Pvt.Ltd.
5. Gupta. S. K. and Goswani. B. (2021) *Immunology for MBBS.* APC Books.
6. Misbah S.A., Spickett G.P. and Dalm V.A.S.H. (2022) *Chapel and Haeney's Essentials of Clinical Immunology. 7th Edition.* Wiley-Blackwell.

Reference Books

1. Sudha G. and Shubhangi S. (2013) *Textbook of Basic and Clinical Immunology*. Universties Press (India) Pvt. Ltd.
2. Rich R., Fleisher T., Shearer W., Schroeder H., Frew A. and Weyand C. (2018) *Clinical Immunology: Principles and Practice.* Elsevier.
3. Abbas A.K., Lichtman A.H. and Pillai S. (2019) *Basic Immunology (Functions and Disorders of the Immune System). 6th Edition.* Elsevier.
4. Punt J. (2019) *Kuby Immunology. 8th Edition*. Macmillan Learning.
5. Ian C Clift. (2020) *Clinical Immunodiagnostics: Laboratory Principles and Practices*. Jones & Bartlett Publishers.
6. Chakravarty A.K. (2021) *Immunology and Immunotechnology.* Oxford University Press.

Web References

1. https://www.medicosrepublic.com/kuby-immunology-8th-edition-pdf-free-download/
2. https://muhammad1988adeel.files.wordpress.com/2011/04/kuby-immunology-6th-edition.pdf
3. https://med-mu.com/wp-content/uploads/2018/06/Essentials-of-Clinical-Immunology-6E-Chapel-Haeney-Misbah-_-Snowden.pdf
4. https://www.wiley.com/en-us/Essentials+of+Clinical+Immunology%2C+Includes+Wiley+E+Text%2C+6th+Edition-p-9781118472958
5. https://www.flipkart.com/essential-clinical-immunology/p/itmczzkduhtrf52d

Pedagogy

Chalk and talk, Power Point Presentation, Quiz, Assignments, Group Discussions, Seminar, Assignment.

Course Designer

Dr. N. Jeenathunisa

Semester: II	Internal Marks: 25	External Marks: 75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2CCC1A	**MICROBIAL METABOLISM**	**CORE CHOICE COURSE**	**6**	**4**

Course Objectives

This course deals with how to make microbes differentiate based on the metabolism and describe how microbes do catabolism to get energy and metabolism to build structure.

Prerequisites

Basic knowledge on Physiological processes of Microbes.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Define and understand the basic concepts of metabolism	K1,K2
CO2	Explain and analyze about the growth phases of Microbial populations	K3, K4
CO3	Analyze about Microbial respiration	K3, K4
CO4	Criticize about bacterial photosynthesis	K5, K6
CO5	Assess about microbial biosynthesis	K5, K6

Mapping of CO with PO and PSO

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

CO5	2	3	2	2	3	3	3	3	3	2

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-"indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Metabolism-Definition - specific functions and types- Anabolism versus Catabolism. Metabolic pathways – Linear, irreversible and branched metabolic pathways. Mechanisms of enzyme reaction – the role of ATP, reducing power and precursor metabolites in metabolism. Biochemical mechanisms of generating ATP. Components of electron transport chains - NAD, NADP, FAD, FMN, Coenzyme-Q, Cytochromes..	18	CO1, CO2, CO3	K1, K2, K3, K4,
II	Microbial Growth- 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. Nutritional types and metabolic diversity - types based on carbon, energy and electron sources. Measurement of cell numbers,cell mass and metabolic activity.	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
III	Respiration- Aerobic respiration: glycolysis, Pentose Phosphate pathway,TCA cycle. Glyoxylate cycle. Respiratory electron	18	CO1, CO2, CO3, CO4	K1, K2, K3,

	transport in mitochondria and bacteria. Anaerobic respirations: sulfate, nitrate, carbonate respirations and their ecological significance.Intracellular location and reactions, Amphibolic reactions.			K4, K5
IV	Bacterial Photosynthesis - Brief account of photosynthesis – oxygenic and anoxygenic photosynthesis. fixation of C02- Calvin cycle - C3-C4 pathway. Chemolithotrophic oxidations - Sulfur, Iron, Hydrogen and Nitrogen oxidations. Methanogenesis, Basic aspects of bioenergetics – entropy, enthalpy, equilibrium constant, electron carriers, artificial electron donors, inhibitors, uncouplers, energy bond, phosphorylation.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	Microbial Biosynthesis-Biosynthesis of Peptidoglycan, Biopolymers, Amino acids, Fatty acids, Vitamins and their regulations. Assimilation of Nitrogen, Sulfur, Phosphorus.	18	CO1, CO2, CO3, CO4 , CO5	K1, K2, K3, K4, K5,K6
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Bioluminescence: Bioluminescent bacteria and its importance. Biochemistry of Luciferin- Luciferase along with the lux operon (genes).	-	CO1, CO2, CO3, CO4 , CO5	K1, K2, K3, K4, K5,K6

Text Books

1.Satyanarayana, U. and Chakrapani, U. (2013) Biochemistry, Fourth Edition. Book and Allied Pvt, Kolkata.

2.Stryer L. (2010) Biochemistry Seventh Edition. W.H. Freeman and Company, New York.

3. Monika Rustugi (2016).Bacterial Metabolism . Meditech.

4. Anadhi, D. (2014). Introduction to Biochemistry and Metabolism. Pearson Education India

Reference Books

1. Tyrrell Conway,Paul S. Cohen. (2015) Metabolism and Bacterial Pathogensis. ASM Press.
2. Rabus, R. (Oldenburg) Saier Jr., M.H. (La Jolla, CA. (2022). Microbial Physiology. Karger Publication.
3. Walid EI Sharoud. (2011). Bacterial Physiology: A Molecular Approach. Springer.
4. G.N.Cohen.(2011). Microbial Biochemistry.Springer.

Web References

1. https://download.e-bookshelf.de/download/0000/5838/44/L-G-0000583844-0002360696.pdf
2. https://www.perlego.com/book/2771785/microbial-physiology-pdf
3. https://www.slideshare.net/cavoyc/physiology-of-microorganism-1
4. https://byjus.com/biology/metabolism/
5. https://www.britannica.com/science/metabolism

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion,Quiz.

Course Designer

Ms.S.Sathya

Semester : II	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2CCC1B	**ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**	**CORE CHOICE COURSE**	**6**	**4**

Course Objective

To enable the students to get exposure on relationship between microbes and nature, its roles and its utilization for the creation of sustainable environment and their concepts, Biofertilizer role, Biogeochemical cycles and Plant diseases.

Prerequisites

Basic knowledge about Environment and Agricultural systems.

Course Outcomes and Cognitive Level Mapping

COs	CO Statement	Cognitive level
CO1	Define the basic view of air Microorganisms	K1
CO2	Explain the Microbial association in water	K2
CO3	Discuss about water pollution and water quality	K6
CO4	Understand the production of Biofertilizer	K4
CO5	Discuss about Plant diseases & Control measures	K6

Mapping of CO with PO and PSO

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

"1"- Slight (Low) correlation "2"- Moderate (Medium) correlation

"3"- Substantial (High) correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Air microbiology: Significance of air microflora-Microbial air pollution-sources, biological indicators and effects on plants and human beings. Enumeration of bacteria from air. Air borne diseases. Role of microbes in biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur.	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4
II	Microbes in marine and fresh water environment – eutrophication – Biodegradation and bioaccumulation – bioremediation concepts, microbial and phytoremediation – composting – solid waste treatment – saccarification and pyrolisis.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4
III	Water pollution – sources and nature of pollutants in water – sewage – treatment of liquid waste – primary, secondary and tertiary treatment – water borne diseases – Assessment of water quality – BOD and COD determinations.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5, K6.
IV	Microbial association – beneficial – nitrogen fixing organism – symbiosis, asymbiosis, associate symbiosis – bacteria, Actinomycetes, cyanobacteria – mycorrhiza – ecto, endo and ectendo mycorrhiza – phosphate solubilizers – application of biofertilizers in agriculture. Biology of nitrogen fixation – genes and regulations in Rhizobium.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5

V	Plant pathogens – bacterial – viral – fungal pathogens. Morphological, physiological changes with reference to disease establishment in plants – plant protection – phenolics – phytoalexins and related compounds. Bioinsecticides – viral, bacterial and fungal.	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5, K6
VI	**Self Study for Enrichment (Not included for End Semester Examination)** Soil microbes and fertility of soil. Bioaugmentation, Xenobiotics degradation. Plant growth promoting rhizobacteria (PGPR). Role of biofertilizer in integrated nutrient management.	-	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5

Text Books

1. Bibhuti Bhusan Mishra, Suraja Kumar Nayak, Swati Mohapatra, Deviprasad Samantaray (2021). *Environmental and Agricultural Microbiology: Applications for Sustainability*. Wiley-Scrivener; 1st edition.
2. Robert L.Tate (2020). *Soil Microbiology*. John Wiley & Sons 3rd edition.
3. Subba Rao (2020) Soil Microbiology. Oxford Publishing.
4. Mangesh Y Dudhe (2020). *Agriculture- Microbiology*. New Vishal Publications.
5. Krishnendu Acharya, Surjit Sen and Manjula Rai (2019) *Biofertilizers and Biopesticides*. Techno World.
6. Aneja (2017) *Fundamental- Agricultural Microbiology*. New Age International (P) Ltd Publishers.

Reference Books

1. Pareek and Navneet Pareek (2019). *Agricultural Microbiology*. Scientific Publishers.

2.Paul (2015). *Soil Microbiology, Ecology and Biochemistry*. Academic Press.

3. Trivedi (2015).*Agriculture Microbiology and Microbial Applications*. Pointer Publishers.

4.Gupta, S.K.(2014) *Approaches and trends in plant disease management*. Scientific publishers.

5. Jamaluddin (2013) Microbes and sustainable plant productivity. Scientific Publishers.

Web References

1. https://www.tandfonline.com/doi/abs/10.1080/10643387409381619?journalCode=best18
2. https://forages.oregonstate.edu/nfgc/eo/onlineforagecurriculum/instructormaterials/availabletopics/nitrogenfixation/definition
3. https://cropwatch.unl.edu/soybean-management/plant-disease
4. https://www.biologydiscussion.com/biotechnology/biodegradation/biodegradation-and-bioremediation-with-diagram/11043
5. https://thebiologynotes.com/biopesticides/

Pedagogy

Chalk and talk ,Power point presentation, Group Discussion, Seminar, Quiz, Assignment.

Course Designer

Ms.K.Sangeetha

Semester: II	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs/WEEK**	**CREDITS**
22PMB2CCC1C	**MICROBIAL ECOLOGY**	**CORE CHOICE COURSE**	**6**	**4**

Course Objective

To create awareness on evolutionary relationship of ecosystem and its interactions. To understand the concepts of community ecology and strategies for biodiversity conservation.

Prerequisite

Basic Knowledge of Ecological concepts

Course Outcomes and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Examine basic concept of ecosystem	K4
CO2	Determine the microorganisms and their natural habitats	K4
CO3	Evaluate the environmental pollution	K5
CO4	Diagnose waste management system	K5
CO5	Extend the biodiversity and its conservation	K6

Mapping of CO with PO and PSO

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

" 1"- Slight (Low) correlation "2"- Moderate (Medium) correlation

" 3"- Substantial (High) correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	History, significance, principle, scope and development of microbial ecology. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation. Biological Interactions: Microbe–Microbe Interactions, Microbe–Plant Interactions, Microbe–Animal Interactions. Ecological succession: mechanisms; concept of climax.	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4
II	Ecosystem – structure and functions. Abiotic and biotic components. Energy flow, food chain, food web, ecological pyramids and types. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats. Atmosphere: Stratification of the Atmosphere.	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4
III	Environmental pollution-Air pollution: Sources and classification of major air pollutants; Noise pollution- concept and effects. Soil pollution: sources and types of soil and water pollutants; effect of pollutants on soil health and productivity; Radioactive pollutants, their lifetime and disposal; Water pollution: major sources and types of water pollutants; pollution in fresh and sea water bodies. Efficient	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6.

	microbes in Pollution control. Climate change: Global warming and green house effects.			
IV	Waste management- Solid and liquid wastes. Physical, chemical and biological properties of wastes; Effluent treatment- sewage and other agro-industrial wastes; Biomagnification and its impact on loss of biodiversity. Biodegradation and Bioconversion of organic wastes; Microbiological and public health aspects of waste disposal; heavy metal contamination of environments. Source and sinks of heavy metals	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5
V	Biodiversity- concepts, levels and types; strategies for biodiversity conservation. Biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Principles of conservation- *in-situ* and *ex-situ*. Major approaches to management. Miyawaki forest.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
VI	**Self study for Enrichment (Not included for End Semester Examination)** Ecological succession-types, Aero microflora, dispersal of microbes. Sources and sinks of greenhouse gases, Acid rain. E.- waste management. Biodiversity hot spots in India and world.	-	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

Text Books

1. Joseph C Daniel(1999). *Environment Aspects of Microbiology1st Edition.* Bright sun Publications, Chennai.
2. Vaun Mc Arthur (2009). *Microbial Ecology – An Evolutionary approach*. Elsievierpublications, Academic press.
3. Saha, T.K (2010). *Ecology and Environmental Biology*. Books and Allied Pvt. Ltd.

Kolkata.

4. Edward J Kormandy (2017). *Concepts of Ecology*. Pearson India
5. P.D.Sharma (2018). *Fundamentals of Ecology*. Rastogi Publications.
6. Vaishali Anand (2020). *Environment and Ecology*. Mc Graw Hill.

Reference Books

1. Atlas, R.A and Bartha, R (2000). *Microbial Ecology, Fundamentals and Application*. Benjamin Cummings, New York.
2. Nduka Okafor. (2011). *Environmental Microbiology of Aquatic and Waste Systems*. Springer Dordrecht Heidelberg London New York
3. Ian Pepper Charles Gerba Terry Gentry (2014). *Environmental Microbiology 3rd Edition*. Academic press. USA.
4. Prescott, L.M., Harley, J.P. and Helin D.A. (2017). *Microbiology 10th Edition*. McGraw Hill, New York.

Web References

1. https://study.com/learn/lesson/metapopulation-concept-model.html
2. https://study.com/academy/lesson/what-is-a-terrestrial-ecosystem-definition-examples-types.html
3. https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html#:~:text=Currently%2C%20microbes%20are%20used%20to,processes%20known%20as%20'bioremediation'.&text=Bioremediation%20uses%20micro%2Dorganisms%20to,pollutants%20into%20non%2Dtoxic%20substances.
4. https://www.biologydiscussion.com/biodiversity/biodiversity-concept-types-and-other-details-with-diagram/7132
5. https://www.intechopen.com/chapters/45093

Pedagogy

Chalk and talk, Power point presentation, Group Discussion, Seminar, Quiz, Assignment.

Course Designer

Ms.K.Sangeetha

Semester: II	Internal Marks: 40	External Marks: 60		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS./WEEK**	**CREDITS**
22PMB2CC2P	**BACTERIOLOGY, MYCOLOGY, IMMUNOLOGY AND IMMUNOTECHNOLOGY (P)**	**CORE PRACTICAL**	**6**	**5**

Course Objective

To impart knowledge about pure culture, staining & immuno techniques.

Prerequisites

Basic knowledge and concepts of bacteriological, mycological and immunological techniques.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Analyze the Growth nature of organisms	K4
CO2	Assess the staining techniques	K5
CO3	Evaluate on bacterial motility	K5
CO4	Determine ABO blood grouping	K5
CO5	Compiled view of immune techniques	K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-"indicates there is no correlation

Syllabus

BACTERIOLOGY

1. Preparation of culture media for cultivation of bacteria from air, water & soil
2. Pure culture techniques – dilution-plating, Streak-plate, Spread-plate, Pour-Plate
3. Staining Techniques –Simple and Differential (Gram Staining and Spore Staining)
4. Hanging drop method

MYCOLOGY

1. Preparation of culture media for cultivation of fungi
2. Isolation and identification of major classes of fungi
3. KOH Mount, LCB Mount

IMMUNOLOGY & IMMUNOTECHNOLOGY

1. ABO blood grouping.
2. Perform Total Leukocyte Count of the given blood sample.

4. Separation of serum from the blood sample.
5. Perform immunodiffusion by Ouchterlony method.
6. Perform single radient immunodiffusion
7. Perform DOT ELISA.
3. Perform Differential Leukocyte Count of the given blood sample
8. Perform immuno electrophoresis.

Reference Books

1. Arora. D. R and Brij Bala Arora. (2019). Medical Mycology. Second Edition. CBS Publisher.
2. Punt J. (2019) *Kuby Immunology. 8th Edition*. Macmillan Learning.
3. Ian C Clift. (2020) *Clinical Immunodiagnostics: Laboratory Principles and Practices*.

Jones & Bartlett Publishers

4. Elsa Cooper, (2018). Microbial Physiology: A Practical Approach. Callisto Reference.

5. Gerhard Gottschalk, (2020). Bacterial Metabolism. Springer.

Web References

1. https://fccljohnson.files.wordpress.com/2012/10/kim-and-gadd-bacterial-physiology-and-metabolism-b-h-kim-g-m-gadd-cambridge-university-press-2008.pdf
2. https://medicine.yale.edu/labmed/sections/immunology/
3. https://aacijournal.biomedcentral.com/articles/supplements/volume-14-supplement-2
4. https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=6

Pedagogy

Chalk and Talk, demo and hands-on.

Course Designer

Dr. R. Nithyatharani

Semester: II	Internal Marks: 25	External Marks: 75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2DSE2A	**BIOFERTILIZER TECHNOLOGY**	**DISCIPLINE SPECIFIC ELECTIVE COURSE**	**6**	**3**

Course Objective

The aim of the course is to make the student to know the importance of biofertilizers in agriculture and about the field applications and mass production technologies.

Prerequisites

Basic knowledge and concepts of bio-fertilizer production methods.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Explain and state the concept of biofertilizers, characteristics, advantages	K1, K5
CO2	Perceive and analyze the knowledge about bacterial biofertilizer production methods	K4, K5
CO3	Elaborate and discuss the production methods of fungal biofertilizer	K2, K6
CO4	Discuss and summarize about the production and application of algal biofertilizer	K2, K6
CO5	Create and summarize the knowledge about biocontrol agents and its applications	K5, K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation
"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Biofertilizers–characteristics-types-Bacterial, Fungal, Algal and Actinorhizal, Plant Growth Promoting Rhizobacteria (PGPR). Advantages and limitations of biofertilizers.	18	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5,K6
II	Bacterial biofertilizer-production and application of *Rhizobium,Azospirillum, Azotobacter*and *Glucano acetobacter*. *Rhizobium* nodule formation-Mechanism-biochemistry of Nitrogen fixation. Phosphate solubilizing bacteria- phosphate solubilizers, phosphate mobilizers-mechanism of phosphate solubilization.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4, K5, K6
III	Fungal biofertilizer - Mycorrhizae- AM and VAM fungi and its types-production. Actinorhizal biofertilizer-Frankia-*Casuarina* symbiosis- Frankia characters and their importance.	18	CO1, CO2, CO3, CO4,	K1, K2, K3, K4, K5, K6
IV	Algal biofertilizer -Blue green algae-characteristics, production and application. Azolla –cultivation and application.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2, K3, K4, K5,K6,
V	Biocontrol agents- characteristics - *Pseudomonas,Trichoderma.* Bioinsecticides-*Bacillus thuringiensis, Verticillium, Beauveria, Metarhizium.* Biopesticides.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2, K3, K4, K5,K6,
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Liquid biofertilizer production-application methods. Field visits	-	CO1, CO2, CO3, CO4, CO5,	K1, K2, K3, K4, K5, K6,

Text Books

1. ReetaKoshla, (2017). Biofertilizers and biocontrol agents for organic farming. Kojo Press.
2. Hyma. P, (2017). Biofertilizers: Commercial production Technology and Quality Control. Random Publications.
3. Bikas. R. Pati, (2016). Recent Trends in Bio-fertilizers. I.K. International.
4. Dr. K. Kumar, K. Govindarajan, S.Kumarkannaiyan (2010) Biofertilizer Technology Scientific Publisher (India).

Reference Books

1. Dinesh K Maheswari, (2012). Bacteria in agrobiology. Springer Heildelberg, New York.
2. Mahendra K Rai, (2015). The Handbook Microbial Biofertilizers 9th edition. Haworth Press, Inc. New York.
3. BoopanderGiri, Ram Prasad, Qiang-Sheng Wu, Ajit Varma, (2019). Bio-fertilizers of sustainable agriculture and environment. Springer.
4. AmitavaRakshit, Vijay Meena, Manoj Parihar, H.B. Singh, A.K.Singh, (2021). Bio-fertilizers. Elsevier

Web References

1..https://www.researchgate.net/publication/323185331_Role_of_Biofertilizers_in_Agriculture

2..https://www.researchgate.net/publication/225980699_Bacterial_Biofertilizers

3..https://www.fungaldiversity.org/fdp/sfdp/FD38-2.pdf

4.https://annamalaiuniversity.ac.in/studport/download/VAC%20Syllabus/VAAG%20011.pdf

5.https://www.apsnet.org/edcenter/disimpactmngmnt/topc/Documents/PHI-BiologicalControl.pdf6.https://www.fehd.gov.hk/english/pestcontrol/images/Pestnews_45e(text).pdf

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion.

Course Designer

Dr. R. Nithyatharani

Semester : II	Internal Marks: 25	External Marks: 75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS/WEEK**	**CREDITS**
22PMB2DSE2B	**PUBLIC HEALTH MICROBIOLOGY**	**DISCIPLINE SPECIFIC ELECTIVE COURSE**	**6**	**3**

Course Objectives

This course deals with the microbes related to public health and to gain knowledge about the medically important human microbial pathogens with focus on the diseases caused by them, disease pathogenesis, lab diagnosis, prophylaxis, control measures.

Prerequisites

Basic knowledge about diagnosis and treatment methods for various microbial infections.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Define and examine the basic ideas about microbial association	K1,K4
CO2	Diagnose and analyze various airborne disease	K3,K4
CO3	Determine the water borne diseases and its control	K1,K4
CO4	Evaluate and discuss about the role of microorganisms in food	K3,K5
CO5	Extend the diagnosis hospital acquired Infections	K2,K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation
"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Introduction to public health:Definition, scope, concept and importance of public health microbiology – roles of microbiologist in public health – microbial association of water, air and soil. Basic concept on pollution and its types.	18	CO1, CO2, CO3	K1, K3, K4
II	Air borne infections: Air and its composition – indoor air and outdoor air. Air borne diseases- (bacterial, fungal and viral), Sources of infection. Methods of enumeration of microorganisms in air – air sanitation.	18	CO1, CO2, CO3, CO4	K1, K3, K4, K5
III	Water borne infections:Kinds of water – water borne diseases (viral, bacterial, protozoan) – methods of enumeration of microorganisms in water – indicator organisms – water treatment control of water borne diseases.	18	CO1, CO2, CO3, CO4	K1, K3, K4, K5
IV	Food borne diseases: Definition and importance of food hygiene – types (spoilage of meat and its products, milk and dairy products, fish and fish products and eggs) – Role of microorganisms in food spoilage and poisoning – food borne diseases – types of food borne diseases – food poisoning – food borne infection. Principles of Food microbiological analysis.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	Nosocomial infection: Introduction and its types, pathogenicity of nosocomial infection, prevention and control of nosocomial infections. Prophylactic immunization – disposal of infective hospital and laboratory materials – monitoring of sanitation in the community – techniques used	18	CO1, CO2, CO3, CO4 CO5	K1, K2, K3, K4, K5, K6

	for the diagnosis of hospital acquired infection.			
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Classification of Medically important Microbes.	-	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

Text Books

1. Patrick R. Murray, Ken S. Rosenthal, and. Michael A. Pfalle.(2012).Medical Microbiology. Elsevier Health Sciences.
2. Keith Struthers.J.(2017).Clinical Microbiology. Taylor& Francis Group.
3. Sastry Apurba.S.(2021).Essentials of Microbiology. Jaypee Brothers Medical Publishers
4. Gerard Tortora (Author), Berdell Funke (Author), Christine Case.(2022).Microbiology An Introduction. Pearson Mastering.

Reference Books

1. Joanne Willey, Christopher J. Woolverton, Linda Sherwood (2011).Prescott's Microbiology. McGraw Hill
2. Park.K.(2017).Parks Text Book of Preventive and Social Medicine.
3. Goering, Hazel Dockrell, Mark Zuckerman, Peter Chiodini.(2018).Mim's Medical Microbiology and Immunlogy
4. Engelkirk.P.K. and Duben-Engelkirk.J.(2015).Burton's Microbiology for the Health Sciences,10th Edn.Wolters Kluwer Health.

Web References

1. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/env_occupational_health_students/medicalbacteriology.pdf
2. https://ysmubooks.am/uploads/Microbiology.pdf
3. https://www.slideshare.net/MMASSY/intro-to-medical-microbiology-lecture-notes
4. http://samples.jbpub.com/9781284032314/9781284032314_ch01_001_016.pdf

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion, Quiz.

Course Designer

Ms.S.Sathya

Semester: II	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRS./WEEK**	**CREDITS**
22PMB2DSE2C	**MARINE MICROBIOLOGY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objective

This course deals with the study of microorganisms in sea environment including their biodiversity, ecology and biogeochemistry, so as to equip the learners to understand the microbial diversity in marine environment.

Prerequisites

Basic knowledge and concepts of Marine microbial diversity.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement	Cognitive Level
CO1	Define and understand the marine microbes and kingdom concepts	K1, K2
CO2	Analyze and apply the role of microbes in seawater habitats	K3, K4
CO3	Determine and Explain the Biogeo chemical processes in marine systems	K3, K4
CO4	Evaluate and categorize various application of marine microbial products	K4, K5
CO5	Criticize and manage the Biodegradation methods for marine pollutants	K5, K6

Mapping of CO with PO and PSO

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

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" indicates there is no correlation

Syllabus

UNIT	CONTENT	HOURS	COS	COGNITIVE LEVEL
I	Marine Microbes- Classification-Haeckel'sthree kingdom,Whittaker's five kingdom, Carl Woese three domain concepts. Marine bacteria and Archaea, Marine fungi, and Marine viruses.	18	CO1, CO2, CO3**,**	K1, K2**,** K3, K4**,**
II	MarineHabitats-Role of microbes in sea water habitats- coastal, intertidal, estuaries, shores, salt marsh,mangrove, lagoon, coral reef, deepsea, hydrothermal vents. Sea weeds, Sea grasses, Kelp forest and uses. Marine Microbial food web.	18	CO1, CO2, CO3, CO4,	K1, K2**,** K3, K4**,** K5,
III	Marine Biogeochemistry- Chemical and physical factors in the marine environment- Properties of seawater. Biogeochemical processes in marine systems- carbon, nitrogen, oxygen, sulfur and phosphorous cycle.	18	CO1, CO2, CO3, CO4,	K1, K2**,** K3, K4**,** K5,
IV	Marine Microbial Products-Marine microbesof Biotechnological importance; Marine hydrocolloids(Agar,Agarose,CarrageenanandAlginate),Marinedrugs-bioactivecompounds,Marine Nutraceutical–functional foods.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2**,** K3, K4**,** K5**,** K6**,**
V	Marine Pollution- Sources-domestic, industrial and agricultural discharges- oil pollution-thermal and radioactivepollution.Biodegradation andbioremediationofmarinepollutants.Biofouling-biofilm formation-relatedmicrobes-control &prevention methods.	18	CO1, CO2, CO3, CO4, CO5,	K1, K2**,** K3, K4**,** K5**,** K6**,**
VI	**Self Study for Enrichment (Not included for End Semester Examinations)** Extremophiles-biotechnological applications. Marine flora & fauna. Composition of sea water and brackish water. Antifouling coating-production.	-	CO1, CO2, CO3, CO4, CO5,	K1, K2**,** K3, K4**,** K5**,** K6**,**

Text Books

1. Verma Divya, (2022). Marine Microbiology Ecology and Application. 1st Edition. Bio-Green Publishers
2. Colin B. Munn. (2019). Marine Microbiology. 3rd Edition. CRC PressPublishers.
3. Steffi P. F. Rajeswari Anburtaj. (2020) A Textbook on Marine Microbiology. 1st Edition. Ryan Publishers.
4. Se-Kwon Kim. (2013). Marine Microbiology Bioactive Compounds and Biotechnological Applications. 1st Edition. John Wiley Publishers.

Reference Books

1. Anjana K. Vala, Bharti P. Dave, Dushyant R. Dudhagara. (2021).Marine Microbial Bioremediation. 1st Edition. CRC PressPublishers.
2. Lucas J. Stal, Mariana Silvia Cretoiu. (2022). The Marine Microbiome. 1st Edition. Springer Nature.
3. Aparna Gunjal, Sonali Shinde. (2021). Microbial Diversity and Ecology in Hotspots.1st Edition. Elsevier Science.
4. Milton Fingerman.(2020). Recent Advances in Marine Biotechnology. 1st Edition. CRC Press Publishers.

Web References

1. https://ocean.si.edu/ocean-life/microbes/marine-microbes
2. https://www.slideshare.net/LeiramSejram/marine-habitats
3. https://byjus.com/biology/biogeochemical-cycles/
4. https://www.slideshare.net/SudheerKandibanda/marine-drugs-56601492
5. https://www.slideshare.net/ShaikhMuzahim/marine-nutraceuticals
6. https://byjus.com/free-ias-prep/marine-pollution/
7. http://www.marinebiotech.eu/wiki/Bioremediation_of_marine_ecosystems

Pedagogy

Chalk and Talk, Assignment, Seminar and Group Discussion.

Course Designer

Dr. S. Jenny