

DHANALAKSHMI SRINIVASAN INSTITUTE OF RESEARCH AND TECHNOLOGY

**(Deemed to be University under section 3 of UGC Act, 1956.)
PERAMBALUR – 621 212, TAMIL NADU, INDIA.**

SCHOOL OF ARTS AND SCIENCE

CURRICULUM AND SYLLABUS

M.Sc., MICROBIOLOGY

REGULATION 2026

PROGRAMME:

Vision:

To establish as a premier center of advanced microbiological excellence, cultivating expert researchers, proficient microbiologists, and visionary scientists who explore microbial worlds to develop innovative solutions for healthcare, industry, agriculture, and environmental stewardship.

Mission:

- To deliver inclusive, flexible, and multidisciplinary postgraduate programs in microbiology that integrate advanced microbial genetics, immunology, biotechnology, and environmental sciences, equipping graduates with superior technical, analytical, and research competencies for diverse career opportunities and lifelong learning.
- To advance cutting-edge research and scholarly inquiry in medical microbiology, industrial microbiology, microbial ecology, and molecular techniques, addressing critical challenges in disease management, food safety, and ecosystem sustainability.
- To broaden access to advanced microbiology education for rural and underprivileged students by blending modern scientific expertise with indigenous microbial knowledge and traditional practices, fostering entrepreneurial skills for self-reliant professional growth.
- To instill ethical responsibility, social commitment, and global perspective through intensive laboratory research, industry collaborations, community initiatives, and experiential learning that bridges advanced theoretical knowledge with impactful real-world microbiological

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	PROGRAM EDUCATIONAL OBJECTIVES
PEO1	To provide graduates with in-depth knowledge of advanced microbiological concepts, sophisticated laboratory techniques, molecular methods, and research methodologies, preparing them for leadership roles in research institutions, industries, healthcare, and academia.
PEO2	To enhance critical thinking, experimental design, and problem-solving abilities so that graduates can independently conduct advanced research and develop microbiological solutions for complex issues in health, agriculture, and environment.
PEO3	To foster professional ethics, effective communication, teamwork, and leadership qualities that enable graduates to collaborate across disciplines and contribute responsibly to scientific and societal advancement.
PEO4	To promote continuous learning and adaptability, empowering graduates to stay abreast of emerging trends in microbiology and pursue higher research, innovation, or entrepreneurial ventures in the field.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	PROGRAM SPECIFIC OUTCOMES
PSO1	Graduates will be proficient in applying advanced microbiological techniques, molecular biology tools, microbial genomics, and bioprocess technology to investigate pathogens, develop antimicrobial strategies, and create industrial microbial products.
PSO2	Graduates will demonstrate expertise in research methodologies, data interpretation, biosafety protocols, and quality assurance practices, enabling them to contribute effectively to pharmaceutical industries, clinical diagnostics, environmental monitoring, and research organizations.

PROGRAM OUTCOMES (POs)

PO	PROGRAM OUTCOMES
PO1	Disciplinary Knowledge Demonstrate comprehensive knowledge and understanding of the fundamental concepts, theories, principles, and applications in the chosen discipline and allied fields.
PO2	Critical Thinking and Problem Solving Identify, analyze, and solve complex academic, professional, and societal problems using logical reasoning, analytical skills, and evidence-based approaches.
PO3	Research and Inquiry Apply scientific methods, research techniques, and investigative skills to conduct studies, analyze data, interpret results, and draw meaningful conclusions.
PO4	Creativity and Innovation Develop innovative ideas, creative solutions, and entrepreneurial approaches to address contemporary challenges in academic, professional, and social contexts.
PO5	Digital and Technological Competence Utilize appropriate digital technologies, software tools, and information resources effectively and ethically for learning, research, communication, and problem-solving.
PO6	Environment and Sustainability Understand environmental issues and sustainable development goals and apply this knowledge to promote ecological balance and responsible resource utilization.
PO7	Ethics and Social Responsibility Demonstrate ethical values, integrity, inclusiveness, and social responsibility while contributing positively to society and professional environments.
PO8	Teamwork and Leadership Work effectively as an individual and as a member or leader of diverse and multidisciplinary teams, demonstrating leadership, collaboration, and interpersonal skills.
PO9	Communication Skills Communicate effectively through oral, written, visual, and digital means with diverse audiences in academic, professional, and societal settings.
PO10	Employability and Entrepreneurship Develop professional competencies, managerial abilities, and entrepreneurial skills required for employment, higher education, and self-employment opportunities.
PO11	Lifelong Learning Recognize the need for continuous learning, adaptability, and self-development to meet evolving personal, professional, and societal demands in a dynamic global environment.

SEMESTER-I

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
I	Core	Microbiology and Microbial Physiology	PMB26101	4	0	0	4	40	60	100
		Practical - Microbiology and Microbial Physiology Laboratory	PMB26102	0	0	4	2	40	60	100
	SEC	Microbiological Techniques	PMB26S01	3	1	0	4	40	60	100
		Practical - Microbiological Techniques Laboratory	PMB26S02	0	0	4	2	40	60	100
	MDC	Multidisciplinary Course – 1		2	0	2	3	40	60	100
	DEC	Microbial Biochemistry	PMB26001	4	0	0	4	40	60	100
		Pharmaceutical Microbiology	PMB26002							
		Microbial Ecology	PMB26003							
	DEC	Computational Biology	PMB26004	3	0	2	4	40	60	100
		Cosmetic Microbiology	PMB26005							
		Bio-Entrepreneurship	PMB26006							
							23			700

SEMESTER-II

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
II	Core	Medical Microbiology	PMB26103	4	0	0	4	40	60	100
		Practical - Medical Microbiology	PMB26104	0	0	4	2	40	60	100
	SEC	Immunotechnology	PMB26S03	3	1	0	4	40	60	100
		Practical – Immunotechnology Laboratory	PMB26S04	0	0	4	2	40	60	100
	MDC	Multidisciplinary Course – 1		2	0	2	3	40	60	100
	DEC	Virology	PMB26007	4	0	0	4	40	60	100
		Mycology	PMB26008							
		Diagnostic Microbiology	PMB26009							
	DEC	Bio-Safety and IPR	PMB26010	3	0	2	4	40	60	100
		Antimicrobial Resistance	PMB26011							
		Epidemiology	PMB26012							
							23			700

SEMESTER-III

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
III	Core	Agriculture and Environmental Microbiology	PMB26105	4	0	0	4	40	60	100
		Food and Industrial Microbiology	PMB26106	4	0	0	4	40	60	100
		Practical - Agriculture and Environmental, Food and Industrial Microbiology	PMB26107	0	0	4	2	40	60	100
		Microbial Genetics and Molecular Biology	PMB26108	4	0	0	4	40	60	100
		Practical - Microbial Genetics and Molecular Biology	PMB26109	0	0	4	2	40	60	100
	DEC	Marine Microbiology	PMB26013	3	0	2	4	40	60	100
		Vermitechnology	PMB26014							
		Life Science Skill for Competitive Examination	PMB26015							
	EE	Experiential Elective	PMBEE01	*	*	*	2	*	*	100
IV	SEC	Communication and Soft Skill	-	1	0	0	1	40	60	100
							23			800

SEMESTER-IV

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
IV	Core	Genetic Engineering	PMB26010	3	1	0	4	40	60	100
		Research Methodology	PMB26011	3	1	0	4	40	60	100
		Project	PMB26012	0	0	24	12	40	60	100
							20			300

Multi-Disciplinary Courses (MDC) Offered to Other Departments:

Course Code	Title of the Course
PMB26901	Public Health Microbiology
PMB26902	Microbes in Human Health

Disciplinary Elective Course (DEC) Offered by the Department:

Course Code	Title of the Course
PMB26001	Microbial Biochemistry
PMB26002	Pharmaceutical Microbiology
PMB26003	Microbial Ecology
PMB26004	Computational Biology
PMB26005	Cosmetic Microbiology
PMB26006	Bio-Entrepreneurship
PMB26007	Virology
PMB26008	Mycology
PMB26009	Diagnostic Microbiology
PMB26010	Bio-Safety and IPR
PMB26011	Antimicrobial Resistance
PMB26012	Epidemiology
PMB26013	Marine Microbiology
PMB26014	Vermitechnology
PMB26015	Life Science Skill for Competitive Examination

Semester-wise Categorization of Courses

COURSE CATEGORY	Semester				No of Courses	Total Credits
	I	II	III	IV		
Core Courses (Theory & Practical)	2	2	5	3	12	48
SEC–Skill Enhancement Course (Theory & Practical)	2	2	-	-	4	12
MDC–Multi Disciplinary Course	1	1	-	-	2	6
DEC–Disciplinary Elective Course	2	2	1	-	5	20
EE–Experiential Elective	-	-	1	-	1	2
SEC– Communication and Soft Skill	-	-	1	-	1	1
Total Courses Per Semester	7	7	8	3	25(Courses)	
Total Credits	23	23	23	20	89(Credits)	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26101	MICROBIOLOGY AND MICROBIAL PHYSIOLOGY	Core	3	0	0	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Practical – Microbiology and Microbial Physiology Laboratory							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To understand the history, scope, classification, taxonomy, and modern developments in microbiology.							
2. To acquire knowledge of the structure, characteristics, classification, and significance of major groups of microorganisms.							
3. To explain microbial nutritional requirements, growth media, cultivation techniques, and culture preservation methods.							
4. To understand microbial cell structure, growth dynamics, transport mechanisms, photosynthesis, and adaptations to environmental conditions.							
5. To develop knowledge of carbon assimilation, microbial metabolism, cell division, sporulation, and morphogenesis.							
Course Outcomes:							
CO1: Recall the history, scope, major discoveries, and taxonomic classification systems of microorganisms, including contributions of pioneering microbiologists.(K1)							
CO2: Explain the structural characteristics, classification, reproduction, and economic importance of bacteria, algae, fungi, protozoa, and viruses.(K2)							
CO3: Apply the principles of microbial nutrition, cultivation, growth media preparation, and culture preservation techniques.(K3)							
CO4: Analyze microbial cell structures, growth patterns, environmental adaptations, and transport mechanisms in microorganisms.(K4)							
CO5: Illustrate and analyze the mechanisms of energy generation and cellular development, metabolic processes in microorganisms.(K2, K4)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	History and Classification of Microbiology					09Hrs.	
History and scope of Microbiology, Spontaneous generation vs. Biogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Paul Ehrlich, Elie Metchnikoff, Edward Jenner. Germ theory of disease. Modern Microbiology - Landmark achievements in 20th century. Microbial Taxonomy - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach - Woese domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Bergey's Classification of bacteria. Concepts of Microbiome, synthetic biology.							
Unit-II	Introduction and Characteristics of Microorganisms					09 Hrs.	

Bacteria: Morphological types, ultrastructure, cell wall and membrane organization, capsule, flagella, pili, specialized structures, reserve materials, endospores, Mycoplasma and Actinobacteria. Algae, Fungi, Lichens and Protozoa: General characteristics, classification, structure, reproduction and economic importance of major groups. Viruses: Discovery, morphology, classification, cultivation, bacteriophages, lytic and lysogenic cycles, viroids and prions.

Unit-III	Microbial Nutrition, Growth Media and Culture Preservation	09 Hrs.
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Microbial nutrient requirements: macronutrients, micronutrients and growth factors. Nutritional classification of microorganisms: phototrophs, chemotrophs, autotrophs and heterotrophs. Nutritional patterns of pathogens, saprophytes and auxotrophs. Types of growth media: natural, synthetic, complex, enriched and selective media.

Cultivation of aerobic, anaerobic and microaerophilic microorganisms. Preservation and maintenance of microbial cultures: routine methods, liquid nitrogen preservation and lyophilization.

Unit-IV	Microbial Cell Structure, Growth and Photosynthesis	09 Hrs.
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Structure and functions of bacterial cell wall and peptidoglycan. Cytoplasmic membrane, pili, fimbriae and transport mechanisms (active and passive transport). Bacterial growth curve, growth rate, generation time and factors affecting growth (pH, temperature and osmotic conditions). Adaptation of microorganisms to extreme environments. Autotrophic and heterotrophic microorganisms. Photosynthetic pigments: chlorophyll, bacteriochlorophyll, carotenoids and phycobiliproteins. Basics of microbial photosynthesis and energy generation.

Unit-V	Carbon Assimilation, Respiration and Sporulation	09 Hrs.
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Carbon assimilation and autotrophy. Photosynthesis: oxygenic and anoxygenic photosynthesis; ATP generation and CO₂ fixation (Calvin cycle). Carbohydrate metabolism: glycolysis (EMP pathway), Krebs cycle and fermentation. Oxidative and substrate-level phosphorylation. Cell division and endospore structure, properties and germination. Microbial sporulation and morphogenesis in bacteria, fungi and algae.

Text Book(s):

1. Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6th Edition). McGraw - Hill Company, New York.
2. Dubey R.C. and Maheshwari D. K. (2009). Textbook of Microbiology. S. Chand, Limited.
3. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.
4. Caldwell DR. Microbial Physiology and Metabolism, Wm. C. Brown Publishers, USA 1995.
5. Moat AG, Foster JW and Spector MP. Microbial Physiology (4th edition). John Wiley and Sons, New York. 2002.

Reference Book(s):

1. Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12th Edition). Pearson, London, United Kingdom.
2. Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2nd Edition). Books / Cole Thomson Learning, UK.
3. Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3rd Edition). Cambridge University Press, Cambridge.
4. White D. The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York. 1995.
5. Robert Poole K. Advances in Microbial Physiology, Volume 53, Elsevier Science and Technology. 2007.

e Resources:

1. <http://sciencenetlinks.com/tools/microbeworld>
2. <https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404>
3. <https://www.asmscience.org/VisualLibrary>
4. <https://microbe.net/resources/microbiology-web-resources/>
5. <https://www.microbiologyresearch.org/resources>
6. <https://libguides.wccnet.edu/oer-subjects/microbiology>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credits
I	PMB26101		Microbiology and Microbial Physiology									3		3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	1	1	-	-	-	-	-	1	-	2	3	1	0.92
CO2	3	2	1	-	-	-	1	-	1	-	2	3	2	1.15
CO3	2	3	3	1	2	1	1	1	1	2	2	3	3	1.92
CO4	2	3	3	2	1	2	1	-	1	1	2	3	3	1.85
CO5	3	3	3	2	1	1	-	-	1	1	2	3	3	1.77
Mean Overall Score	2.6	2.4	2.2	1	0.8	0.8	0.6	0.2	1	0.8	2	3	2.4	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26102	PRACTICAL – MICROBIOLOGY AND MICROBIAL PHYSIOLOGY LABORATORY	Core	0	0	4	2
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To develop practical skills in basic microbiological laboratory techniques, aseptic handling, culture media preparation, and microbial isolation methods.							
2. To enable students to perform microscopic examination, staining procedures, and motility determination for the identification of microorganisms.							
3. To impart knowledge and hands-on experience in microbial preservation, enumeration, and biochemical characterization of bacteria.							
4. To understand microbial growth dynamics, physiological responses, and the influence of environmental factors on microbial growth.							
5. To evaluate microbial metabolic activities through carbohydrate fermentation and enzyme-based biochemical assays for microbial identification.							
Course Outcomes:							
CO1: Explain the principles of microbiological laboratory techniques, biosafety practices, culture media preparation, and pure culture methods used in microbial cultivation.(K2)							
CO2: Demonstrate microscopy, staining techniques, and motility determination methods for the identification and observation of microorganisms. (K3)							
CO3: Perform microbial preservation, enumeration, and biochemical characterization techniques for the study and identification of microorganisms.(K3)							
CO4: Analyze microbial growth patterns and the effects of environmental factors such as temperature, pH, and salinity on bacterial growth.(K4)							
CO5: Analyze microbial metabolic activities through carbohydrate fermentation and enzymatic assays to evaluate microbial physiological functions.(K4)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Basic Microbiological Techniques and Culture Methods						12Hrs.
1. Study of microbiology laboratory equipment and biosafety practices.							
2. Preparation of culture media (liquid & solid) for bacterial cultivation.							
3. Pure culture techniques: streak plate, spread plate and pour plate.							
Unit-II	Microscopy, Staining and Motility Studies						12Hrs.
4. Staining Techniques – Gram, acid-fast, capsule, endospore.							
5. Motility determination – Hanging drop method and soft agar method							
6. Observation of fungal structures using Lactophenol Cotton Blue staining.							
Unit-III	Microbial Preservation, Enumeration and Biochemical Characterization						12 Hrs.

7. Preservation of microbial cultures by slant, stab and glycerol stock methods.
8. Biochemical test - IMViC, TSI, Urease, Catalase, Oxidase, Hydrogen sulphide, coagulase, nitrate reduction tests
9. Enumeration of bacteria - viable count (plate count) and total count (Haemocytometer count)

Unit-IV	Microbial Growth and Physiology	12Hrs.
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10. Determination of bacterial growth curve by turbidometric method.
11. Estimation of generation time and growth rate of bacteria.
12. Effect of temperature, pH and salinity on bacterial growth.

Unit-V	Metabolic Activities of Microorganisms	08 Hrs.
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13. Carbohydrate fermentation tests.
14. Detection of enzymatic activities related to microbial metabolism (catalase, oxidase)

Text Book(s):

1. Aneja, K.N. (2018). Lab Manual of Microbiology and Biotechnology, Medtec Publisher.
2. Cappuccino, J.H. and Sherman, N. (2014). Microbiology – A Lab Manual (10thed). Singapore: The Benjamin Publishing Company.
3. Gunasekaran, P. (1995). Laboratory Manual in Microbiology. New Delhi: New Age International (P) Ltd. Publishers.
4. Gold man, E and Green, H.(2008). Practical handbook of microbiology. CRC press.
5. Trivedi, R. (2016). Practical Mannual in Microbial Physiology and Industrial Microbiology. New Delhi: SSDN Publishers.

Reference Book(s):

1. Kanika Sharma. (2009) Manual of Microbiology – Tools and Techniques. 2nd Edition, Ane Books Pvt. Ltd., New Delhi.
2. Keith Wilson and John Walker. (1995). Principles and Techniques of Practical Biochemistry. 4th edition. Cambridge University press, Britain.
3. Nizhny Novgorod. (2008) Laboratory manual on Biochemistry: Publishing House of Nizhny Novgorod State medical academy.
4. Rajan S and Selvi Christy R. (2015) Experiments in Microbiology. Anjana Books House, Chennai.
5. Merck (2010) Microbiology Manual 12th Edition.

e Resources:

1. <https://microbiologynote.com/hanging-dropmethod/>
2. [https://bio.libretexts.org/Courses/North_Carolina_State_University/MB352_General_Microbiology_Laboratory_2021_\(Lee\)/05%3A_Enumeration_of_Bacteria/5.01%3A_Introduction_to_Enumeration_of_Bacteria](https://bio.libretexts.org/Courses/North_Carolina_State_University/MB352_General_Microbiology_Laboratory_2021_(Lee)/05%3A_Enumeration_of_Bacteria/5.01%3A_Introduction_to_Enumeration_of_Bacteria)
3. <http://www.mgdcaua.org/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course											Hours	Credits
I	PMB26102	Microbiology and Microbial Physiology Laboratory											4	2
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	-	3	1	1	1	2	3	2	1.54
CO2	3	2	3	1	2	-	1	1	1	2	2	3	3	1.85
CO3	3	3	3	1	2	-	1	1	1	2	2	3	3	1.92
CO4	2	3	3	2	1	2	1	-	1	1	2	3	3	1.85
CO5	2	3	3	2	1	1	1	-	1	1	2	3	3	1.77
Mean Overall Score	2.6	2.6	2.6	1.2	1.4	0.6	1.4	0.6	1	1.4	2	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26S01	MICROBIOLOGICAL TECHNIQUES	SEC	3	1	0	4

Pre-Requisite: Bachelor's degree in Life Sciences or related discipline

Co- Requisite: Practical – Microbiological Techniques Laboratory

Progressive Course: Semester II – Medical Microbiology, Immunotechnology

Course Objectives:

1. To understand the principles and applications of microscopy and centrifugation techniques used in microbiological research.
2. To acquire knowledge of electrophoresis, blotting, radio-labelling, and flow cytometric techniques for biological analysis.
3. To understand the fundamentals of spectroscopy and mass spectrometry for qualitative and quantitative analysis of biomolecules.
4. To gain knowledge of chromatographic techniques and their applications in the separation and characterization of microbial products.
5. To understand classical and advanced DNA sequencing technologies and their applications in genomics and microbiology.

Course Outcomes:

CO1:Explain the principles, instrumentation, and applications of microscopy and centrifugation techniques used in biological and microbiological research.(K2)

CO2:Apply electrophoretic, blotting, radio-labelling, and flow cytometric techniques for the separation, detection, and analysis of biological molecules.(K3)

CO3:Analyze spectroscopic methods and their applications in the qualitative and quantitative characterization of biomolecules.(K4)

CO4:Examine the principles and applications of chromatographic techniques for the separation, purification, and identification of biological compounds.(K4)

CO5:Evaluate conventional and advanced DNA sequencing technologies for genomic analysis and molecular biology research.(K5)

K1-Remember

K2-Understand

K3-Apply

K4-Analyse

K5-Evaluate

K6-Create

Unit-I

Microscopy and Centrifugation Techniques

12 Hrs.

Principles and applications, simple, compound, dark, bright field, phase-contrast and fluorescent microscopes. Confocal laser scanning microscopy. Electron microscopy: SEM and TEM, Mechanism of image formation and contrast generation in SEM, Sample preparation methods for TEM. Principles, Swedberg unit, sedimentation coefficient, factors affecting sedimentation rate, clearing factor, rotors, their types and maintenance, determination of molecular weight by centrifugation, types of centrifuges, density gradient centrifugation, ultracentrifuges.

Unit-II

Electrophoresis and Blotting Techniques

12 Hrs.

Paper and gel electrophoresis, PAGE (native and SDS), Agarose gel electrophoresis, PFGE, Blotting- Southern, Western and Northern blotting, Immunoblotting, Labelling and Detection methods - Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry and data analysis. Safety measures in handling radioisotopes. RIA, non-radio-labelling.

Unit-III	Spectroscopic Techniques	12 Hrs.
Spectroscopy - Electromagnetic spectrum, Beer and Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic-absorption spectroscopy, ESR and H and C NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy, principle, instrumentation and application of MALDI-TOF.		
Unit-IV	Chromatographic Techniques	12 Hrs.
Chromatography - Introduction and types of chromatography, paper, thin layer, gas, partition, Gel permeation, ion-exchange, HP-TLC, HPLC, FPLC and affinity chromatography and instrumentation. Applications of chromatographic techniques in microbiology.		
Unit-V	DNA Sequencing Methods	12 Hrs.
Major landmarks in DNA sequencing - Maxam-Gilbert sequencing, Chain-termination methods, Advanced methods and de novo sequencing, Shotgun sequencing, Next-generation methods, Massively Parallel Signature Sequencing (MPSS), Polony sequencing, 454 pyrosequencing, Illumina (Solexa) sequencing, SOLiD sequencing, Ion semiconductor sequencing, DNA nanoball sequencing, Heliscope single molecule sequencing, Single molecule real time (SMRT) sequencing.		

Text Book(s):

1. Sharma B. K. (2014). Instrumental Method of Chemical Analysis. Krishna Prakashan Media (P) Ltd.
2. Chatwal G. R and Anand S. K. (2014.) Instrumental Methods of Chemical Analysis. Himalaya Publishing House.
3. Mitchell G. H. (2017). Gel Electrophoresis: Types, Applications and Research. Nova Science Publishers Inc.
4. Holme D. Peck H. (1998). Analytical Biochemistry. (3rd Edition). Prentice Hall.
5. Jayaraman J. (2011). Laboratory Manual in Biochemistry. (2nd Edition). Wiley Easton Ltd., New Delhi.

Reference Book(s):

1. Pavia D. L. (2012) Spectroscopy (4th Edition). Cengage.
2. Skoog A. and West M. (2014). Principles of Instrumental Analysis. (14th Edition). W.B.Saunders Co., Philadelphia.
3. Miller J. M. (2007). Chromatography: Concepts and Contrasts (2nd Edition) Wiley Black well.
4. Gurumani N. (2006). Research Methodology for Biological Sciences. (1st Edition). MJP Publishers.
5. Ponmurugan P. and Gangathara P. B. (2012). Biotechniques. (1st Edition). MJP Publishers.

e Resources:

1. <https://www.biologydiscussion.com/micro-biology/chromatography/thinlayer-chromatography-with-diagram/18037>
2. <https://microbiologynotes.org/gel-electrophoresis-types-principlesinstrumentation-and-applications/>
3. <http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge-introduction- types-uses-and-other-details-with-diagram/12489>
4. <https://www.watelectrical.com/biosensors-types-its-working-and-applications> .
5. <http://www.wikiscales.com/articles/electronic-analytical-balance/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									Hours		Credits
I	PMB26S01		Microbiological Techniques									4		4
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes(P SOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	2	1	2	-	1	-	1	1	2	3	2	1.54
CO2	3	3	3	1	3	-	1	1	1	2	2	3	3	2.00
CO3	3	3	3	2	2	-	1	-	1	1	2	3	3	1.85
CO4	3	3	3	2	2	-	1	-	1	1	2	3	3	1.85
CO5	3	3	3	3	3	-	1	-	2	2	3	3	3	2.23
Mean Overall Score	3	2.8	2.8	1.8	2.4	0	1	0.2	1.2	1.4	2.2	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26S02	PRACTICAL – MICROBIOLOGICAL TECHNIQUES LABORATORY	SEC	0	0	4	2
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To provide hands-on training in the operation, calibration, and maintenance of advanced microbiological laboratory instruments.							
2. To develop practical skills in microscopy, centrifugation, electrophoresis, and blotting techniques for the analysis of microbial cells and biomolecules.							
3. To enable students to apply spectroscopic and chromatographic methods for the qualitative and quantitative analysis of biological samples.							
4. To familiarize students with molecular biology techniques, including nucleic acid analysis, protein characterization, and sequencing-based approaches.							
5. To train students in bioinformatics tools for sequence analysis, microbial identification, NGS data interpretation, and phylogenetic studies.							
Course Outcomes:							
CO1: Demonstrate the calibration and operation of laboratory instruments, microscopy techniques, and centrifugation methods for the analysis of microbial cells and cellular components.(K3)							
CO2: Perform electrophoretic and blotting techniques for the separation, detection, and characterization of nucleic acids and proteins while following laboratory safety practices.(K3)							
CO3: Analyze spectrophotometric data for the quantification and estimation of biomolecules in biological samples.(K4)							
CO4: Examine chromatographic techniques for the separation, identification, and characterization of amino acids and proteins.(K4)							
CO5: Evaluate microbial sequence data using 16S rRNA gene analysis, next-generation sequencing tools, and phylogenetic approaches for microbial identification and classification.(K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Microscopy and Centrifugation Techniques						12 Hrs.
1. Calibration and handling of common laboratory instruments.							
2. Measurement of microbial cell size using ocular and stage micrometers.							
3. Separation and Characterization of Cellular Components by Differential and Density Gradient Centrifugation							
Unit-II	Electrophoresis and Blotting Techniques						12 Hrs.
4. Separation of DNA fragments by agarose gel electrophoresis.							
5. Demonstration of Blotting Techniques – SDS-PAGEfor protein detection.							
6. Safety procedures in handling radioactive materials.							
Unit-III	Spectroscopic Techniques						08 Hrs.
7. Quantification of Biomolecules Using UV-Visible Spectrophotometry.							
8. Estimation of Protein Concentration by Spectrophotometric Methods.							
Unit-IV	ChromatographicTechniques						08 Hrs.

9. Separation amino acids using paper and thin-layer chromatography, Determination of R_f values.
10. Separation of proteins using gel filtration chromatography

Unit-V	DNA Sequencing Methods	08 Hrs.
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11. Sequence Alignment and Microbial Identification Using 16S rRNA Gene Analysis
12. Bioinformatics Analysis of NGS Data and Phylogenetic Tree Construction

Text Book(s):

1. Wilson K. & Walker. J. (2010). Principles and Techniques in Practical Biochemistry. 7thed. Cambridge Univ. Press, UK
2. Dryer, R. L. and Lata G. F. (1989) Experimental Biochemistry. Oxford University Press, UK.
3. Boyer, R. (2000) Modern Experimental Biochemistry, Third edition, Benjamin Cummings, San Francisco.
4. Mikkelsen, S. R. and Corton, E. (2004) Bioanalytical Chemistry. John Wiley & Sons, U.S.A.
5. Pattabhi, V. and Gautham, N. (2002) Biophysics. Second Edition. Kluwer Academic Publishers, Narosa Publishing House, India
6. Slater, R. J. (2002) Radioisotopes in Biology: A Practical Approach. Oxford University Press, UK.

Reference Book(s):

1. Evans, J. N.S. (1995). Biomolecular NMR Spectroscopy. Oxford University Press, UK.
2. Wahid, P.A. (2001) An Introduction to Isotopes and Radiations: Allied Publishers Ltd., India
3. Rouessac, F and Rouessac, A. (2007) Chemical Analysis: Modern instrumentation methods and techniques. Second edition., John Wiley and Sons, U.S.A.
4. Simpson, R.J., Adams, P. D. and Golemis, E.A. (2009) Basic methods in Protein purification and analysis; Laboratory Manual. Cold Spring Harbor Laboratory Press, U.S.A.

e Resources:

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf
2. <https://www.scribd.com/document/870289026/Micrometry-experiement-2>
3. <https://www.jru.edu.in/studentcorner/lab-manual/bpharm/7thsem/INSTRUMENTAL%20METHODS%20OF%20ANALYSIS.pdf>
4. <https://blast.ncbi.nlm.nih.gov/Blast.cgi>
5. <https://www.megasoftware.net/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26S02			Practical – Microbiological Techniques Laboratory								4		2
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	3	1	2	-	1	1	1	1	2	3	3	1.77
CO2	3	3	3	1	2	-	2	1	1	2	2	3	3	2
CO3	2	3	3	2	2	-	1	-	1	1	2	3	3	1.77
CO4	2	3	3	2	2	-	1	-	1	1	2	3	3	1.77
CO5	3	3	3	3	3	-	1	1	2	2	3	3	3	2.31
Mean Overall Score	2.6	2.8	3	1.8	2.2	0	1.2	0.6	1.2	1.4	2.2	3	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26001	MICROBIAL BIOCHEMISTRY	DEC	3	0	0	3
Pre-Requisite: Bachelor’s degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To understand the chemical basis of life, molecular interactions, biological buffers, and the structure of microbial cell components.							
2. To explain the principles of bioenergetics, thermodynamics, ATP generation, and energy transfer in biological systems.							
3. To acquire knowledge of the structure, classification, metabolism, and regulation of carbohydrates, lipids, and fatty acids in microorganisms.							
4. To understand the classification, structure, properties, biosynthesis, degradation, and functional significance of amino acids and proteins.							
5. To comprehend the structure, metabolism, and functions of nucleic acids, enzymes, and vitamins, including their roles in microbial physiology.							
Course Outcomes:							
CO1: Explain the principles of chemical bonding, water chemistry, biological buffers, bioenergetics, and the structure of microbial biomolecules relevant to microbial systems.(K2)							
CO2: Illustrate the structure, classification, properties, biosynthesis, degradation, and metabolic pathways of carbohydrates, lipids, proteins, nucleic acids, enzymes, and vitamins.(K2)							
CO3: Apply the concepts of thermodynamics, enzyme kinetics, metabolic pathways, and biomolecular interactions to solve biological and microbiological problems.(K3)							
CO4: Analyze the relationship between biomolecular structure, metabolic regulation, enzyme inhibition, and microbial adaptation under different physiological and environmental conditions.(K4)							
CO5: Evaluate biochemical processes and integrate knowledge of microbial biomolecules, metabolism, enzymes, and vitamins to interpret biological functions and solve microbiological problems.(K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Chemistry of Life and Microbial Molecules						09Hrs.
Bonds: ionic bonding, Ion-dipole.Covalent bond, H-bonds, Van der Wall’s interaction, Hydrophobic and hydrophilic interactions.Water as a biological solvent and its role in biological processes pH, Henderson-Hassel-balchequation, concept of buffer, strength of buffer, range of buffer, important biological buffers.Structure of Microbial Molecules: Peptidoglycan, bacteriorhodopsin, biphytanyl chains and lipidsin archaeal cell membranes and their significance in adaptation in extreme conditions.							
Unit-II	Bioenergetics						09Hrs.

Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds.

Unit-III	Carbohydrates, Lipids and fatty acids	09Hrs.
Carbohydrates: Classification, Structure and properties of monosaccharides and disaccharides. Polysaccharides - starch, cellulose, agar- agar and peptidoglycan. Metabolism and its regulation: Gluconeogenesis, glycolysis, kreb's cycle, pentose phosphate pathway or hexose monophosphate shunt, glyoxylate cycle and Entner Doudroff pathway. Lipids and fatty acids: Classification, structure, properties and functions. Phospholipid and cholesterol synthesis in <i>E. coli</i> . Metabolism - α , β and γ oxidation of fatty acids and lipid peroxidation.		
Unit-IV	Amino acids and Protein	09Hrs.
Amino acids and protein: Classification based on structure, polarity, biological importance and reactivity. Physical properties and chemical reactions. Biosynthesis and degradation of amino acids – an overall view. Protein: Classification, physical and chemical properties. Structure – Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary (α -helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins.		
Unit-V	Nucleic acids, Enzymes and Vitamins	09Hrs.
Nucleic acids: Structure, synthesis (de novo and salvage) and degradation of purines and pyrimidines. Enzymes and Vitamins: Classification, chemical nature and properties. Factors affecting enzyme activity, Active site, Enzyme inhibition- Reversible, irreversible, allosteric inhibition, enzyme specificity, co-enzymes, Mechanism of enzyme action- Lock and key model, induced fit theory. Isozyme, ribozyme and abzyme. Vitamins – Properties of Vitamins. Vitamins as Co –factors and Co – enzymes.		

Text Book(s):

1. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd edition, Wiley publisher. 2010.
2. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition Wiley publisher. 2013.
3. Deb AC. Edition. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) ltd, London. 2011.
4. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014.
5. Rajagopal G. Concise textbook of biochemistry, 2nd edition. Ahuja Publishing House. 2010.
6. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013.

Reference Book(s):

1. D.L. Nelson, Michael M. Cox Lehninger's Principle of Biochemistry. 6th ed. W. H. Freeman, 2012.
2. J.M. Willey, Lansing M. Prescott Microbiology. 7th Ed. McGraw-Hill Higher Education, 2008.
3. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr., Lubert Stryer Biochemistry. 8th Ed. W.H. Freeman, 2015.
4. White David. Physiology and Biochemistry of Prokaryotes. 3rd Ed. Oxford University Press, New York, 2007.

e Resources:

1. <https://www.ncbi.nlm.nih.gov/>
2. <https://www.genome.jp/kegg>
3. <https://www.expasy.org/>
4. <https://www.rcsb.org/>
5. <https://iubmb.qmul.ac.uk/enzyme/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26001			Microbial Biochemistry								3		3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	-	-	-	1	-	2	3	2	1.15
CO2	3	2	2	-	1	-	-	-	1	-	2	3	3	1.31
CO3	3	3	3	1	2	1	1	-	1	2	2	3	3	1.92
CO4	3	3	3	2	1	1	1	-	1	1	2	3	3	1.85
CO5	3	3	3	3	2	1	1	-	2	2	3	3	3	2.23
Mean Overall Score	3	2.6	2.4	1.2	1.4	0.6	0.6	0	1.2	1	2.2	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26002	PHARMACEUTICAL MICROBIOLOGY	DEC	3	0	0	3
Pre-Requisite: Bachelor’s degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To understand the classification, mechanisms of action, and clinical applications of antibiotics, synthetic antimicrobial agents, disinfectants, antiseptics, and preservatives.							
2. To explain the principles of drug targeting, drug delivery systems, pharmacokinetics, bioavailability, and mechanisms of antimicrobial resistance.							
3. To describe the microbial production of pharmaceutical products, causes of pharmaceutical spoilage, sterilization methods, and recent advances in vaccine technology.							
4. To interpret pharmaceutical regulatory requirements, intellectual property, rational drug design, biosensors, and the applications of microbial enzymes in the pharmaceutical industry.							
5. To understand quality assurance, validation, Good Manufacturing Practices, Good Laboratory Practices, sterility testing, and the design of sterile pharmaceutical manufacturing and microbiology laboratories.							
Course Outcomes:							
CO1: Explain the principles, classification, mechanisms of action, and therapeutic applications of antibiotics, synthetic antimicrobial agents, disinfectants, antiseptics, and preservatives.(K2)							
CO2: Apply the concepts of drug targeting, drug delivery systems, pharmacokinetics, and antimicrobial resistance in pharmaceutical and clinical applications.(K3)							
CO3: Analyze the microbial production, spoilage, quality control, and manufacturing processes of pharmaceutical products, including vaccine technologies and fermentation-derived therapeutics.(K4)							
CO4: Evaluate pharmaceutical regulations, rational drug design, biosensors, microbial enzyme applications, and regulatory standards in pharmaceutical product development.(K5)							
CO5: Design quality assurance principles, GMP, GLP, sterility testing, and regulatory guidelines in the manufacture and quality control of pharmaceutical products.(K3, K6)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate		K6-Create
Unit-I	Antibiotics and Antimicrobial Agents						09Hrs.
Antibiotics and synthetic antimicrobial agents, Antibiotics and synthetic antimicrobial agents, (Aminoglycosides, β lactams, tetracyclines, ansamycins, macrolid antibiotics), Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.							
Unit-II	Drug Targeting, Drug Delivery and Pharmacokinetics						09 Hrs.
Molecular principles of drug targeting. Drug delivery system in gene therapy- Bacterial resistance to antibiotics. Mode of action of non-antibiotic antimicrobial agents. Delivery systems – formulations, targeted drug delivery, Sustained release of drugs. Drug distribution in body, bio-availability and pharmacokinetic studies.							
Unit-III	Pharma Products and Vaccine Technology						09 Hrs.

Microbial production and Spoilage of pharmaceutical Products Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non-injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

Unit-IV	Pharmaceutical Regulations, Drug Design and Biosensors	09 Hrs.
Regulatory practices, biosensors and applications in Pharmaceuticals Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.		

Unit-V	Quality Assurance, Validation and Sterile Pharmaceutical Manufacturing	09 Hrs.
Quality Assurance and Validation Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators. Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory) Safety in microbiology laboratory.		

Text Book(s):

1. Vyas SP and Dixit VK (2010). Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi.
2. Joseph D Nally (2016). Good Manufacturing Practices for Pharmaceuticals, CRC Press, 6th edn.
3. Stephen P Denyer, Norman A Hodges, Sean P Gorman, Brendan F Gilmore (2011). Hugo and Russell's Pharmaceutical Microbiology, John Wiley and Sons, 8th edn.
4. Chakrabarty AM, Omenn and Gilbert S (1990). Biopharmaceuticals in Transition: Advances in Applied Biotechnology, Portfolio publisher, Vol. 10.
5. Hill RG (2012). Drug Discovery and Development-E-Book: Technology in Transition, Elsevier Health Sciences.

Reference Book(s):

1. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
2. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
3. Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial
4. Biotechnology Association by Paine Webber. Gulf Publishing Company Houston.
5. Drug Carriers in biology & Medicine Edt. by Gregory Gregoriadis. Academic Press New York.
6. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan LalIhhpunjani. CBS Publishers & Distributors, New Delhi.

e Resources:

1. <https://medicine.wustl.edu/news/why-chikungunya-other-arthritis-causing-viruses-target-the-joints/>
2. <https://www.news-medical.net/news/20180511/Addressing-Antimicrobial-Resistance-Through-Industry.aspx>
3. https://www.eurekalert.org/pub_releases/2018-05/uon-nlb050918.php
4. <https://pubs.acs.org/stoken/presspac/presspac/full/10.1021/acsami.8b04433>
5. [https://www.cell.com/cell-host-microbe/fulltext/S1931-3128\(18\)30198-7](https://www.cell.com/cell-host-microbe/fulltext/S1931-3128(18)30198-7)

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26002			Pharmaceutical Microbiology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	-	1	-	1	1	2	3	2	1.31
CO2	3	3	2	1	2	-	1	1	1	2	2	3	3	1.85
CO3	3	3	3	2	2	1	1	-	1	2	2	3	3	2.00
CO4	3	3	3	3	3	-	2	1	1	2	3	3	3	2.31
CO5	3	3	3	3	3	1	3	2	2	3	3	3	3	2.69
Mean Overall Score	3	2.8	2.4	1.8	2.2	0.4	1.6	0.8	1.2	2	2.4	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26003	MICROBIAL ECOLOGY	DEC	3	0	0	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To understand the chemical basis of life, molecular interactions, biological buffers, and the structure of microbial cell components.							
2. To explain the principles of bioenergetics, thermodynamics, ATP generation, and energy transfer in biological systems.							
3. To acquire knowledge of the structure, classification, metabolism, and regulation of carbohydrates, lipids, and fatty acids in microorganisms.							
4. To understand the classification, structure, properties, biosynthesis, degradation, and functional significance of amino acids and proteins.							
5. To comprehend the structure, metabolism, and functions of nucleic acids, enzymes, and vitamins, including their roles in microbial physiology.							
Course Outcomes:							
CO1: Explain the principles of chemical bonding, water chemistry, biological buffers, bioenergetics, and the structure of microbial biomolecules relevant to microbial systems. (K2)							
CO2: Illustrate the structure, classification, properties, biosynthesis, degradation, and metabolic pathways of carbohydrates, lipids, proteins, nucleic acids, enzymes, and vitamins. (K2)							
CO3: Apply the concepts of thermodynamics, enzyme kinetics, metabolic pathways, and biomolecular interactions to solve biological and microbiological problems. (K3)							
CO4: Analyze the relationship between biomolecular structure, metabolic regulation, enzyme inhibition, and microbial adaptation under different physiological and environmental conditions. (K4)							
CO5: Evaluate biochemical processes and integrate knowledge of microbial biomolecules, metabolism, enzymes, and vitamins to interpret biological functions and solve microbiological problems. (K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Introduction to Ecology					09 Hrs.	
Soil Microbiology-Ecology: Humus, Microflora of soil, Nitrogen cycle - Nitrogen fixation, nitrification, denitrification. Rhizosphere - Rhizosphere microorganisms. Fecal pollution of water - waterborne diseases, indicator organisms. Microbiological examination of water.							
Unit-II	Water, Sewage and Air Microbiology					09 Hrs.	
Water purification- aeration, sedimentation, coagulation, flocculation, sand filtration. Disinfection of drinking water, Sewage treatment. Dispersal of airborne microorganisms. Indoor and outdoor air Droplet nuclei, aerosol, Air borne diseases.							
Unit-III	Global Environmental Problems					09 Hrs.	
Ozone depletion, green-house effect and acid rain, their impacts and biotechnological approaches for management. Definition of xenobiotics and biomagnification. Composting, vermicomposting and biogas production.							

Unit-IV	Ecosystem Conservation	09 Hrs.
Ecosystem structure and function – components of ecosystems, food chains, food webs, ecological pyramids, and energy flow. Ecological succession – primary and secondary succession. Biodiversity – levels, importance, threats, and conservation (in situ and ex situ). Ecological interactions – mutualism, commensalism, parasitism, predation, and competition.		
Unit-V	Ecological Impacts of Environmental Pollution	09 Hrs.
Microbial ecology – role of microorganisms in decomposition, nutrient recycling, and maintenance of ecosystem balance. Environmental pollution – ecological impacts on terrestrial and aquatic ecosystems. Bioremediation and phytoremediation as ecological approaches for ecosystem restoration. Wetland ecosystems, ecological restoration, and sustainable management of natural resources.		

Text Book(s):

1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. Latest Edition. McGraw-Hill Education.
2. Mitchell, R., Gu, J. D., & Laskin, A. I. Environmental Microbiology. Wiley-Blackwell.
3. Maier, R. M., Pepper, I. L., & Gerba, C. P. Environmental Microbiology. Academic Press, Elsevier.
4. Molles, M. C. Ecology: Concepts and Applications. McGraw-Hill Education.
5. Microbial Ecology by Ronald M. Atlas, Richard Bartha.

Reference Book(s):

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK.
2. David T Plummer, Tata McGraw- Hill publishing company limited; McGraw office, New Delhi.
3. C.R. Kothari, 2 nd Edition, 2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. Biophysical chemistry - Upadhyay, Upadhyay and Nath 6. A Biologist's guide to principle and techniques of practical biochemistry - Brigan L. Williams.
5. Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill.

e Resources:

1. https://www.ncbi.nlm.nih.gov/books/?utm_source=chatgpt.com
2. https://www.epa.gov/environmental-topics?utm_source=chatgpt.com
3. https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health?utm_source=chatgpt.com
4. https://pubmed.ncbi.nlm.nih.gov/?utm_source=chatgpt.com

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26003			Microbial Ecology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	–	1	2	1	–	1	–	2	3	2	1.54
CO2	3	3	2	1	2	3	2	1	2	2	2	3	2	2.15
CO3	3	3	3	2	2	3	2	1	2	2	3	3	3	2.46
CO4	3	3	2	2	1	3	3	2	2	2	3	3	3	2.46
CO5	3	3	3	2	2	3	3	2	2	3	3	3	3	2.69
Mean Overall Score	3	2.8	2.2	1.4	1.6	2.8	2.2	1.2	1.8	1.8	2.6	3	2.6	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26004	COMPUTATIONAL BIOLOGY	DEC	2	0	2	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To introduce the fundamental concepts of bioinformatics, computer systems, operating systems, internet resources, and their applications in biological sciences.							
2. To develop an understanding of biological databases, data retrieval methods, and the organization of genomic, proteomic, and structural information.							
3. To provide knowledge of bioinformatics tools for sequence analysis, alignment, similarity searching, structure prediction, and phylogenetic analysis.							
4. To explain the principles and applications of genomics, including genome sequencing strategies, metagenomics, SNP analysis, and DNA microarray technology.							
5. To familiarize students with proteomics, protein engineering, protein microarrays, and the emerging field of infectomics and its applications in biomedical research.							
Course Outcomes:							
CO1: Describe the fundamentals of bioinformatics, computer systems, operating systems, programming language types, internet resources, and scientific literature databases used in biological research. (K2)							
CO2: Demonstrate the retrieval, organization, and application of biological data from public databases and bioinformatics resources for genomics, proteomics, biotechnology, and biomedical research. (K3)							
CO3: Analyze biological sequences using bioinformatics tools such as FASTA, BLAST, sequence alignment methods, and phylogenetic analysis to interpret evolutionary relationships. (K4)							
CO4: Evaluate genomic technologies, including whole genome sequencing strategies, metagenomics, SNPs, ESTs, genome assembly methods, and DNA microarray applications in biological research. (K5)							
CO5: Design approaches for proteomic analysis and infectomics studies by integrating protein sequencing, protein engineering, protein microarrays, and computational bioinformatics tools to solve biological problems. (K6)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate		K6-Create
Unit-I	Biology and Computer Fundamentals						09 Hrs.
Introduction to Bioinformatics: definition, history, scope, and applications in biology and medicine. Basics of computers, types of computers, servers, operating systems (UNIX and Linux), programming language types, internet basics, web browsers, URL, and searching scientific literature using PubMed and scientific search engines. Practice: Linux basic commands, PubMed literature search.							
Unit-II	Biological Databases						09 Hrs.
Introduction to biological databases: sequence, structural, and specialized databases. Public biological databases, data retrieval using SRS and Entrez, sequence retrieval from online databases, and applications of biological databases in genomics, proteomics, biotechnology, and biomedical research. Practice: DNA and protein sequence retrieval from NCBI, UniProt, PDB.							
Unit-III	Tools in Bioinformatics						09 Hrs.

Tools in Bioinformatics: Structure prediction –similarity and database structure tools, FASTA, BLAST - Sequence and similarity – sequence alignment – local, global pairwise and multiple sequence, introduction to phylogenetic trees.

Practice: Sequence analysis and Phylogenetic Tree Construction Using BLAST and MEGA.

Unit-IV	Genomics	09 Hrs.
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Genomics: Types of genomics-structural, functional, comparative and environmental genomics. Metagenomics–study on Uncultivable microbes. SNPs-EST- Strategies for Whole Genome Sequencing – Hierarchical and Whole Genome Shotgun Sequencing- De novo and reference-based assembly. DNA microarray.

Practice: Genome assembly (Demonstration).

Unit-V	Proteomics	09 Hrs.
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Proteomics: Protein sequencing; Protein modifications, Protein engineering; Protein chips, Types of proteomics - expression proteomics, structural proteomics and functional proteomics. Protein microarrays. Infectomics: Introduction and definitions of Infectomics. Types of Infectomics - ecological, immuno-and chemical Infectomics. Future of Infectomics.

Practice: Protein structure visualization using PyMOL.

Text Book(s):

1. Chavali LN. Bioinformatics and Bioprogramming in C, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2009.
2. Ruchi Singh and Richa Sharma. Bioinformatics: Basics, algorithms and applications, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2010.
3. MolecBryan Bergeron. Bioinformatics Computing First Indian Edition, Prentice Hall.2003.
4. Genes and Genomes. University Science Books. 6 Lewin B. (2005). Genes IX. Oxford University press.
5. A. Pandey and M. Mann. (2000). Proteomics to study genes and genomes Nature.

Reference Book(s):

1. Rashidi HH and Buehler LK. Bioinformatics Basics: Applications in Biological Science and Medicine, Second Edition CRC Press, London. 2005.
2. Baxeavanis AD and Ouellette BEF, Bioinformatics: A practical guide to the analysis of genes and proteins, First Edition Wiley Interscience – New York (2001).
3. Des Higgins and Willie Taylor Bioinformatics: Sequence, structure and databanks, Oxford University Press (2002).
4. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
5. Proteins and Proteomics. 2002. R.J. Simpson. Cold Spring Harbor Lab. Press. New York.

e Resources:

1. www.bioinformaticssoftwareandtools.co.in.
2. www.bioinformaticsweb.net/datalink.html.
3. Evolution.genetics.washington.edu/phylip.html.
4. <https://www.cs.cmu.edu/~durand/Phylogenetics/Readings/Pagebook.pdf>
5. <https://www.ncbi.nlm.nih.gov/books/NBK21122/>
6. <https://www.nhbs.com/an-introduction-to-molecular-evolution-and-phylogenetics-book>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26004			Computational Biology								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	3	-	1	-	1	1	2	2	2	1.38
CO2	3	3	3	1	3	-	1	1	1	2	2	3	3	2.00
CO3	3	3	3	2	3	-	1	-	1	1	2	3	3	1.92
CO4	3	3	3	3	3	1	1	-	1	2	3	3	3	2.23
CO5	3	3	3	3	3	1	1	1	2	3	3	3	3	2.46
Mean Overall Score	3	2.8	2.6	1.8	3	0.4	1	0.4	1.2	1.8	2.4	2.8	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26005	COSMETIC MICROBIOLOGY	DEC	2	0	2	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To impart knowledge of Cosmetic Microbiology.							
2. To promote the technical skills involved in Cosmetic Microbiology test methods.							
3. To explain methods to analyze Health care products.							
4. To acquire knowledge on cosmetic microbiology and role of microorganisms in cosmetics.							
5. To gain insight into pharmacopeial microbial assays and biosafety.							
Course Outcomes:							
CO1: Explain the concepts of cosmetic microbiology, the role of microorganisms in cosmetics, preservation methods, natural antimicrobial agents, sanitary practices, and HACCP protocols in cosmetic manufacturing. (K2)							
CO2: Apply cosmetic microbiology test methods, including antimicrobial preservative efficacy testing, microbial content testing, validation methods, bioburden analysis, pharmacopeial microbial assays, and preservative regulations. (K3)							
CO3: Analyze the formulation, applications, advantages, disadvantages, and microbiological aspects of skin and hair care products and the causes of common cosmetic-related skin and scalp disorders. (K4)							
CO4: Evaluate cosmetic preservation strategies, sterility assurance systems, environmental monitoring, sampling methods, and global regulatory and toxicological aspects of cosmetic preservation. (K5)							
CO5: Design clinical trial protocols for cosmetic products by incorporating appropriate trial designs, ethical principles, ethics committee requirements, blinding methods, and crossover study designs. (K6)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate		K6-Create
Unit-I	Cosmetic Microbiology						09Hrs.
History of Cosmetic Microbiology – Need for cosmetic microbiology, Scope of cosmetic microbiology, - Role of microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing - HACCP protocols in cosmetic microbiology.							
Practice: Demonstration of HACCP principles in cosmetic manufacturing.							
Unit-II	Cosmetic Microbiology Methods						09 Hrs.
Cosmetic microbiology test methods - Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods - bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives.							
Practice: Microbial Limit Test of cosmetic products							
Unit-III	Skin Care Products						09 Hrs.

Face wash, Moisturizing cream, Cold Cream, Vanishing cream and their advantages and disadvantages. Cosmetic problems associated with skin: blemishes, wrinkles, acne, prickly heat and body odor Anti-perspirants & deodorants– Actives & mechanism of action. Hair care products- advantages and disadvantages. Cosmetic problems associated with Hair and scalp: Dandruff, Hair fall causes.

Practice: Preparation of different types of creams.

Unit-IV	Preservation of Cosmetics	09 Hrs.
Preservation of cosmetics -Antimicrobial preservative efficacy & microbial content testing -Microbiology Laboratory methods in support of sterility Assurance System. Environmental monitoring -Sampling: Principles and Practice - Global regulations & toxicological aspects.		
Practice: Sterility assurance demonstrations.		

Unit-V	Clinical Trials	09 Hrs.
Introduction to clinical trials -Types of clinical trials – single blinding, double blinding, open access, randomised trials with examples-Interventional study -Ethics committee and its members – Institution ethics/independent ethics-Cross over designs.		
Practice: Design of a cosmetic clinical trial with informed consent and randomization.		

Text Book(s):

1. Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.
2. Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN:8178330911.
3. Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.
4. Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3rd Edition). CRC Press. ISBN:9780429113697.
5. Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press.ISBN-10:0849337135.

Reference Book(s):

1. Indian Herbal Pharmacopoeia (2002). Vol. I &II Indian Drug Manufacturers Association, Mumbai.
2. British Herbal Pharmacopoeia. (1990). Vol.I. British Herbal Medicine Association.ISBN: 0903032090.
3. Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (2nd edition). Saujanya Books, Delhi.ISBN-10:81-900788-5- 2/8190078852. ISBN-13:978-81-900788-5-6/9788190078856.
4. Turner R. (2013). Screening methods in Pharmacology. Elsevier. ISBN: 9781483264233.
5. Cupp M. J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp. 85- 93). M. J. Cupp. Humana Press.Totowa, NJ, USA. ISBN-10:1617371904.

e Resources:

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

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26005			Cosmetic Microbiology								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	2	2	-	1	1	2	3	2	1.54
CO2	3	3	3	1	2	1	2	1	1	2	2	3	3	2.08
CO3	3	3	2	2	1	1	1	-	1	2	2	3	3	1.85
CO4	3	3	3	2	2	2	2	1	1	2	3	3	3	2.31
CO5	3	3	3	3	2	1	3	2	2	3	3	3	3	2.62
Mean Overall Score	3	2.8	2.4	1.6	1.6	1.4	2	0.8	1.2	2	2.4	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26006	BIO-ENTREPRENEURSHIP	DEC	2	0	2	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Microbiology and Microbial Physiology, Microbiological Techniques							
Progressive Course: Semester II – Medical Microbiology, Immunotechnology							
Course Objectives:							
1. To project the development role of government and non-government schemes for entrepreneurship programme.							
2. To know the role of skills of entrepreneurs.							
3. To acquire a basic understanding on biological entrepreneurial programs.							
4. To learn about different types of bio-fertilizer and its market potentials.							
5. To know about the techno-economical assessment.							
Course Outcomes:							
CO1: Explain the basic concepts and frameworks of entrepreneurship programme. (K2)							
CO2: Identify and describe government and non-government schemes supporting entrepreneurship. (K1,K2)							
CO3: Describe the structure and principles of bio-based technology and its applications in entrepreneurship. (K2)							
CO4: Develop and initiate a start-up in bio-based technology and bio-based business development. (K6)							
CO5: Evaluate the impact of bio-entrepreneurship initiatives on societal development in rural and underprivileged sectors. (K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Concept of Entrepreneur and Entrepreneurship						09Hrs.
Definitions-concept of entrepreneurship, development. Structure of a bio-based technology, start-up of bio-based technology company and bio-based business development. Government and non-Govt. Schemes for entrepreneurship programmes. Funding agency and opportunity.							
Practice: Study of biotechnology start-ups and entrepreneurship models.							
Unit-II	Skills for Entrepreneurs						09 Hrs.
communication skills, problem solving skills; Business plan development; Market need-distribution, price, promotion and market goal setting, Develop the business at Global level. Financial plan-Financial support for business, business insurance.							
Practice: Preparation of a business planfor a biotechnology product., Market survey and SWOT analysis.							
Unit-III	Project and Bio-Product Development						09 Hrs.
Project: identification, classification, formulation, appraisal. Small, large-scale production and cost benefit analysis and marketing of edible and medicinal mushroom cultivation-button, Oyster, Ganoderma. Single cell protein - Production of Yeast and <i>Spirulina</i> .							
Practice: Demonstration of mushroom spawn preparation.							
Unit-IV	Biofertilizer Productions						09 Hrs.

Mass multiplication, production cost analysis and marketing of Cyanobacterial biofertilizer, Bacterial biofertilizer-*Rhizobium*, *Azospirillum*, Fungal biofertilizers-AMF, Actinobacterial biofertilizer-*Frankia* sp. Seaweed liquid biofertilizer, Biopesticides - *Bacillus*, *Bacillus thuringiensis*, *Bacillus sphaericus*, etc.

Practice: Preparation of Bacillus-based biopesticide.

Unit-V	Dairy and Food Product	09 Hrs.
Small, large-scale production and cost benefit analysis and marketing of agar, Gelidium and fermented foods- cheese, pickles and other probiotic food. Mass production and marketing of compost- Vermicomposting and microbial compost - types of compost pits- Laboratory and field application; cost-benefit analysis.		
Practice: Preparation of yogurt, paneer, or fermented pickles.		

Text Book(s):

1. Nagendra S. (2008). Entrepreneurship and management Sanguine technical publishers
2. Bhatia, B.S. and G.S. Batra. (2003). Entrepreneurship and small business management. Deep and deep publications
3. Naidu, N.V.R. (2008). Management and entrepreneurship. I.K. International Pvt.Ltd.
4. Greene. (2000). Entrepreneurship ideas in action. Thomson learning.
5. Sandera, F.E., B.Mosse and P.B.Tinke. (1975). Endomycorrhizae, Academic Press, London.
6. Rao, N.S. (1980). Biofertilizers in Agriculture. Oxford & IBH Publishing Co. Pvt. Ltd., Bombay.
7. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies Shimasaki, CD. (2014). Amsterdam: Elsevier. Academic Press is an imprint of Elsevier, ISBN: 0124047300.

Reference Book(s):

1. P. Saravanelu, "Entrepreneurship Development", Eskapee Publications.
2. N.P. Srinivasan & G.P. Gupta, "Entrepreneurship Development", Sultanchand & Sons.
3. Satish Taneja, "Entrepreneur Development", New Venture Creation.
4. Barringer M.J. "Entrepreneurship", Prentice-Hall, 1999.
5. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship Development", Tata McGraw Hill.
6. Vasanth Desai, "Dynamics of Entrepreneurial Development and Management", Himalayas Publishing House.

e Resources:

1. <https://study.com/academy/lesson/what-is-an-entrepreneur-definitioncharacteristics examples.html>
2. <https://study.com/academy/lesson/institutional-entrepreneurship-theoryexamples.html>
3. https://study.com/articles/Fermentation_Microbiologist_Job_Description_Salary_and_Career_Outlook.html

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26006			Bio-Entrepreneurship								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	2	1	1	2	1	1	1	1	2	3	2	1	2	1.54
CO2	2	1	1	1	1	1	1	-	2	3	2	1	2	1.38
CO3	3	2	2	2	2	2	1	1	2	3	2	3	3	2.15
CO4	3	3	3	3	2	2	2	3	3	3	2	3	3	2.69
CO5	2	3	2	2	1	3	3	1	2	2	3	2	2	2.15
Mean Overall Score	2.4	2	1.8	2	1.4	1.8	1.6	1.2	2.2	2.8	2.2	2	2.4	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26103	MEDICAL MICROBIOLOGY	Core	3	0	0	3
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Medical Microbiology Laboratory							
Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology							
Course Objectives:							
1. To provide a comprehensive understanding of infectious diseases, host - pathogen interactions, virulence factors, and mechanisms of microbial pathogenicity.							
2. To develop knowledge of the morphology, pathogenicity, epidemiology, laboratory diagnosis, and treatment of medically important bacteria, viruses, fungi, and parasites.							
3. To familiarize students with the principles and applications of clinical microbiology, specimen handling, and diagnostic procedures used in disease identification.							
4. To introduce conventional and molecular diagnostic techniques for the detection and characterization of microbial pathogens.							
5. To enhance understanding of antimicrobial agents, mechanisms of drug resistance, and strategies for controlling infectious diseases.							
Course Outcomes:							
CO1: Explain the principles of infectious diseases, host-parasite interactions, virulence factors, normal microbiota, nosocomial infections, pathogenicity measures, biofilms, quorum sensing, and mechanisms of antimicrobial drug resistance. (K2)							
CO2: Apply microbiological methods for the identification, laboratory diagnosis, and antibiotic susceptibility testing of medically important bacterial pathogens. (K3)							
CO3: Analyze the epidemiology, pathogenesis, laboratory diagnosis, prevention, and treatment of medically important viral diseases and evaluate the role of antiviral drugs and vaccines. (K4)							
CO4: Evaluate the morphological characteristics, pathogenesis, laboratory diagnosis, antifungal susceptibility testing, and treatment of medically important fungal pathogens. (K5)							
CO5: Design appropriate diagnostic approaches for medically important parasitic infections using clinical samples and molecular diagnostic tools, including nucleic acid probes. (K6)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Introduction to infectious Diseases					09 Hrs.	
Introduction to infectious Diseases-Milestones in Medical Microbiology - Infectious Diseasesprocess –Virulence factors of bacteria – Host parasite relationship. Normal microbiota of human body and their significance, opportunistic infections, Nosocomial infections and their control. CDC Blood and body fluid guidelines. Quantitative measures of pathogenicity:minimal lethal dose (MLD), LD50, ID50, TCID50.Type three secretion system (TTSS, T3SS), Role of biofilms and quorumsensing in microbial pathogenicity.AntimicrobialAgents: Mechanisms of drug resistance, Multi-drug Resistance: Target modification, Antibiotic inactivation, Bypass pathway, Drug efflux.							
Unit-II	Medical Bacteriology					09 Hrs.	
Gram positive organisms - Morphology, cultural characteristics, pathogenicity andlaboratory diagnosis of <i>Staphylococcus aureus</i> , <i>Streptococcus pyogenes</i> , <i>Pneumococcus</i> , <i>Bacillus anthracis</i> , <i>Corynebacterium diphtheriae</i> ,							

Mycobacterium tuberculosis, *Mycobacterium leprae*. Spirochaetes – *Treponema pallidum*, *Leptospira*. Gram negative organisms - Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *E. coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, *Bordetella pertussis*, *Neisseria gonorrhoeae*, and *Neisseria meningitidis*. Zoonotic bacterial pathogens, Antibiotic susceptibility test: Kirby – Bauer disk diffusion method. General methods of Bacterial diagnosis.

Unit-III	Medical Virology	09 Hrs.
General properties of and epidemiology, pathogenesis, lab diagnosis and treatment of medically important viral diseases - Influenza, Measles, Mumps, Rubella, monkey pox, Chicken Pox, Poliomyelitis, HIV, Rabies, Yellow fever, Dengue, Covid-19 and Japanese Encephalitis. Brief note on oncogenic viruses. Emerging viral diseases - Antiviral drugs, antiviral vaccines.		

Unit-IV	Medical Mycology	09 Hrs.
Morphological and cultural characteristics of and epidemiology, mechanism of fungal pathogenesis, lab diagnosis and treatment of medically important diseases caused by: Superficial mycosis – <i>Tinea versicolor</i> . Cutaneous mycoses: <i>Microsporum</i> , <i>Trichophyton</i> , <i>Epidermophyton</i> . Subcutaneous mycoses: Sporotrichosis, Chromoblastomycosis, Zygomycosis. Systemic Mycoses – <i>Histoplasma capsulatum</i> , <i>Blastomyces dermatitidis</i> , <i>Cryptococcus neoformans</i> , <i>Coccidioides immitis</i> , <i>Paracoccidioides brasiliensis</i> . Opportunistic mycoses: Candidiasis, Cryptococcosis and Aspergillosis. Antifungal susceptibility testing.		

Unit-V	Medical Parasitology	09 Hrs.
Morphology, pathogenesis, laboratory diagnosis and treatment of medically important protozoan diseases caused by: <i>Entamoeba histolytica</i> , <i>Giardia lamblia</i> , <i>Trichomonas vaginalis</i> , <i>Plasmodium vivax</i> , <i>Leishmania donovani</i> , <i>Taenia solium</i> , <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i> . Diagnosis of parasitic infection using clinical samples. Role of Nucleic acid probes in diagnostic microbiology.		

Text Book(s):

1. Prescott, Harley and Klein's. Microbiology, 7th edition McGraw Hill Medical Publication division. 2007.
2. Monica Cheesbrough 2006. District Laboratory Practice in Tropical Countries - Part I and II 2nd edition. Cambridge University Press, New Delhi.
3. Rajan S. 2012. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
4. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. 2007. Bailey and Scott's Diagnostic Microbiology, Mosby Elsevier. 12th edition.
5. Mackie and McCartney. 2006. Practical Medical Microbiology, South Asia Edition. 14th edition.
6. Rajan S and Selvi Christy R. 2018. Experimental Procedures in Life Sciences. CBS Publishers, New Delhi.
7. Lenette E, Balows HA, Hausler WJ and Shadomy J. Manual of Clinical Microbiology. Bethesda, American Society of Microbiology. 1985.
8. Jawetz, Melnick and Adelberg's Medical Microbiology, 22nd edition McGraw Hill Medical Publication division. 2001.
9. David Greenwood, Richard CB Slack and John Peutherer Medical Microbiology, 16th edition, Church Hill Living Stone Publication. 2002.
10. 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.

e Resources:

1. <http://textbookofbacteriology.net/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26103			Medical Microbiology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	1	2	-	1	1	2	3	2	1.46
CO2	3	3	3	1	2	-	2	1	1	2	2	3	3	2.00
CO3	3	3	3	2	2	2	2	-	1	2	2	3	3	2.15
CO4	3	3	3	2	2	1	2	-	1	2	3	3	3	2.15
CO5	3	3	3	3	3	1	2	1	2	3	3	3	3	2.54
Mean Overall Score	3	2.8	2.6	1.6	2	1	2	0.4	1.2	2	2.4	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26104	PRACTICAL – MEDICAL MICROBIOLOGY LABORATORY	Core	0	0	4	2
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Medical Microbiology							
Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology							
Course Objectives:							
1. To provide practical training in staining techniques and the identification of pathogenic microorganisms from clinical specimens.							
2. To develop skills in microbial characterization, antimicrobial susceptibility testing, and screening of antibiotic-producing microorganisms.							
3. To familiarize students with virological techniques including bacteriophage isolation, viral quantification, and virus cultivation.							
4. To impart knowledge of serological methods used in the diagnosis of viral infections.							
5. To train students in the laboratory identification of medically important fungi and parasitic organisms.							
Course Outcomes:							
CO1: Perform differential and cytological staining techniques and identify clinically important microorganisms using biochemical characterization of clinical specimens. (K3)							
CO2: Apply antimicrobial susceptibility testing, electrophoretic separation of serum proteins, and screening methods for antibiotic-producing microorganisms. (K3)							
CO3: Analyze bacteriophage isolation techniques and estimate viral yield using plaque assay methods. (K4)							
CO4: Evaluate viral identification methods using embryonated egg inoculation techniques and hemagglutination inhibition assays. (K5)							
CO5: Identify medically important fungi and parasites from clinical samples using standard staining and microscopic techniques. (K3)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Staining methods and Biochemical Characterization						12Hrs.
1. Differential stains – Gram stain, Ziehl Neelsen's stain for AFB							
2. Cytological stains – i) Endospore stain, ii) Capsule stain							
3. Isolation, biochemical characterization and identification of the clinical pathogen from urine, pus, throat swab and sputum.							
Unit-II	Antimicrobial Testing						12 Hrs.
4. Kirby – Bauer disc diffusion technique.							
5. Electrophoretic separation of serum proteins.							
6. Screening of antibiotic-producing microbes.							
Unit-III	Bacteriophage Isolation						08Hrs.
7. Isolation of bacteriophages from sewage							
8. Estimation of virus yields - plaque assay.							

Unit-IV	Virus Identification	08 Hrs.
9. Routes of inoculations in embryonated eggs 10. Hemagglutination inhibition assay.		
Unit-V	Mycology and Parasitology	08 Hrs.
13. Identification of dermatophytes from clinical samples. 12. Stain for Amoeba / Intestinal protozoa / Malarial parasites – Iron haematoxylin stain, Leishman's stain, Giemsa stain.		

Text Book(s):

1. Mackie and McCartney. 2006. Practical Medical Microbiology, South Asia Edition. 14th edition.
2. Rajan S and Selvi Christy R. 2018. Experimental Procedures in Life Sciences. CBS Publishers, New Delhi.
3. Monica Cheesbrough 2006. District Laboratory Practice in Tropical Countries - Part I and II 2nd edition. Cambridge University Press, New Delhi.
4. Rajan S. 2012. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
5. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. 2007. Bailey and Scott's Diagnostic Microbiology, Mosby Elsevier. 12th edition.
6. Lenette E, Balows HA, Hausler WJ and Shadomy J. Manual of Clinical Microbiology. Bethesda, American Society of Microbiology. 1985.

e Resources:

1. <https://www.aspergillus.org.uk/mycology-courses?page=514>.
2. <https://www.mooc-list.com/tags/human-parasitology>
3. <https://www.mooc-list.com/tags/tropical-parasitology>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26104			Practical – Medical Microbiology Laboratory								4		2
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	3	3	1	2	-	2	1	1	2	2	3	3	2.00
CO2	3	3	3	1	2	-	2	1	1	2	2	3	3	2.00
CO3	3	3	3	2	2	-	1	-	1	1	2	3	3	1.85
CO4	3	3	3	2	2	-	1	-	1	2	3	3	3	2.00
CO5	3	2	3	1	1	-	1	-	1	1	2	3	3	1.62
Mean Overall Score	3	2.8	3	1.4	1.8	-	1.4	0.4	1	1.6	2.2	3	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26S03	IMMUNOTECHNOLOGY	SEC	3	1	0	4
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Practical – Immunotechnology Laboratory							
Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology							
Course Objectives:							
1. To provide a comprehensive understanding of the principles, components, and mechanisms of innate and adaptive immunity.							
2. To explain the structure, functions, diversity, and production of antigens and antibodies in immune responses.							
3. To develop knowledge of T-cell and B-cell biology, antigen presentation, and the molecular basis of immune recognition.							
4. To familiarize students with immune responses in health and disease, including hypersensitivity, immunodeficiency, autoimmunity, and immunotherapy.							
5. To introduce modern immunological techniques, vaccine development strategies, and their applications in diagnosis, research, and clinical practice.							
Course Outcomes:							
CO1: Explain the organization, components, and functions of the immune system, including innate and adaptive immune mechanisms. (K2)							
CO2: Describe the structure, generation, and functional roles of antigens, antibodies, and immune receptors in host defense. (K2)							
CO3: Analyze the development, activation, and interactions of T cells, B cells, and MHC molecules during immune responses. (K4)							
CO4: Evaluate the immunological basis of infectious diseases, hypersensitivity, immunodeficiency, autoimmune disorders, and immunotherapeutic interventions. (K5)							
CO5: Apply immunological techniques and immunodiagnostic methods, including ELISA, flow cytometry, immunoblotting, and monoclonal antibody technology, in research and healthcare settings. (K3)							
K1-Remember	K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create		
Unit-I	Basics of Immunology						12 Hrs.
Historic perspective, Discovery of humoral and cellular immunity, Types of Immunity (Innate & Acquired immunity), Innate immunity components-physical, physiological defenses; – complement, acute phase proteins. Acquired immunity: (specific) natural, artificial, active and passive immunity. Inflammatory response, Hematopoiesis, Cells (T cell, B cell, macrophages, neutrophils, Natural killer cells, mast cells, basophils, and eosinophils, etc) & organs of Immune system (Thymus, Bone marrow, lymph node, spleen, MALT, GALT, BALT).							
Unit-II	Antigens and Antibodies						12 Hrs.
Immunogenicity versus Antigenicity, Nature of antigens; Antibody-structure and functions-subtypes; structural basis of Antibody diversity; Theories of Antibody formation., Genetic basis of antibody diversity-somatic hyper mutation recombination, class switching and clonal selection, Recent advances in the production of monoclonal antibodies and their applications, Antibody engineering.							

Unit-III	T Cell & B cell Biology	12 Hrs.
Detailed structure and development of B cell and T cell – receptors - Structure of CD4,CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, selectins,integrins). Activation of T and B cells- Maturation of T cell and B cell. Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2). Peptide loading and expression of MHC-I and MHC-II molecules.		
Unit-IV	Immunity in Health & Diseases	12 Hrs.
Infection-Immunity & signal transduction pathways (antibacterial, antiviral and anti-fungal immune responses), Immune system Disorders (Hypersensitivity Type I to TypeIV), Immunodeficiency diseases (Primary and secondary immunodeficiencies), Auto immune diseases (organ specific and systemic), Prevention & therapy (Vaccine, cell therapy, cytokine and antibody therapy).		
Unit-V	Immunotechniques and Immunodiagnosis	12 Hrs.
Production of polyclonal, monoclonal antibodies and phage display - techniques and applications. Immunization practices- active and passive immunization. Vaccines - killed and attenuated, recombinant vaccines, DNA and peptide vaccines. Applications of immunotechniques – Immune cell culture, ELISA, Flow cytometry, Immunoelectron microscopy, Immunohistochemistry, Immunoprecipitation & Immuno Blotting, CHIP assay, Nanopro Immunoassay, Whole animal imaging, Bioplex array.		

Text Book(s):

1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.
2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.
3. Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10th Edition). Elsevier.
4. David F. Keren., Jeffrey S. Warren Diagnostic Immunology, Lippincott Williams and Wilkins Publishers, USA
5. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Roitt's essential immunology. John Wiley & Sons.

Reference Book(s):

1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.
2. Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell
3. Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4th Edition). WileyBlackwell.
4. Kenneth Murphy., Casey Weaver and Leslie Berg (2022). Janeway's Immunobiology, (10TH Edition). W W Norton & Co Inc.
5. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan.

e Resources:

1. <https://www.khanacademy.org/science/health-and-medicine/immunology>
2. <https://ocw.mit.edu>
3. <https://nptel.ac.in>
4. <https://swayam.gov.in>
5. <https://www.edx.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26S03			Immunotechnology								4		4
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	1	1	-	1	-	2	3	2	1.31
CO2	3	2	2	-	1	-	1	-	1	-	2	3	3	1.38
CO3	3	3	3	2	1	-	1	-	1	1	2	3	3	1.77
CO4	3	3	3	2	2	1	2	-	1	2	3	3	3	2.15
CO5	3	3	3	1	3	-	1	1	2	2	2	3	3	2.08
Mean Overall Score	3	2.6	2.4	1	1.6	0.4	1.2	0.2	1.2	1	2.2	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26S04	PRACTICAL – IMMUNOTECHNOLOGY LABORATORY	SEC	0	0	4	2
Pre-Requisite: Bachelor's degree in Life Sciences or related discipline							
Co- Requisite: Immunotechnology							
Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology							
Course Objectives:							
1. To provide practical knowledge of antigen–antibody reactions and blood grouping techniques used in immunological diagnosis.							
2. To develop skills in hematological procedures for the enumeration and analysis of blood cells.							
3. To familiarize students with the isolation and identification of immune cells involved in immune responses.							
4. To train students in immunodiffusion and immunoelectrophoretic techniques for antigen and antibody detection.							
5. To introduce advanced immunodiagnostic methods such as ELISA and Western blotting and their applications in disease diagnosis.							
Course Outcomes:							
CO1: Perform blood grouping and agglutination-based serological tests for clinical diagnosis. (K3)							
CO2: Determine and interpret hematological parameters, including RBC and leukocyte counts, for clinical assessment. (K3)							
CO3: Isolate peripheral blood mononuclear cells and identify T- and B-lymphocyte populations using appropriate laboratory techniques. (K3)							
CO4: Apply immunodiffusion and immunoelectrophoretic techniques to analyze antigen-antibody interactions. (K4)							
CO5: Interpret the diagnostic significance of advanced immunodiagnostic techniques, including ELISA and Western blotting, based on experimental outcomes. (K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Agglutination Techniques						12 Hrs.
1. Direct agglutination to determine ABO and Rh typing.							
2. Latex agglutination test – RA- test, CRP- test, ASO- test.							
3. Widal slide and tube agglutination test.							
Unit-II	Hematological Techniques						12 Hrs.
4. Determination of differential leukocyte count using a hemocytometer.							
5. Isolation and enumeration of RBC from human blood.							
6. Dissection of Laboratory Animal and Sample Collection.							
Unit-III	Isolation and Identification of Immune Cells						08 Hrs.
7. Isolation of peripheral blood mononuclear cells (PBMCs) by density gradient centrifugation.							
8. Identification of T and B lymphocytes using immunological markers (demonstration).							

Unit-IV	Precipitation Techniques	08 Hrs.
9. Precipitation reactions: Single and Double immune diffusion 10. Immuno electrophoresis: Counter current and Rocket Immuno electrophoresis		
Unit-V	Immunodiagnostic Techniques	08 Hrs.
11. Western blotting – Demonstration. 12. Enzyme Linked Immunosorbent Assay – Demonstration.		

Text Book(s):

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2nd Edition. Publisher- Taylor and Francis.
2. Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.
3. Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.
4. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.
5. Morag C. and Timbury M.C. (1994). Medical Virology. 4th edn. Blackwell Scientific Publishers.

Reference Book(s):

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
2. Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.
3. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
4. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries. Part 22nd Edition. Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders.

e Resources:

1. <http://textbookofbacteriology.net/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26S04			Practical – Immunotechnology Laboratory								4		2
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	3	1	2	-	2	1	1	2	2	3	3	1.92
CO2	3	3	3	1	2	-	1	1	1	2	2	3	3	1.92
CO3	3	3	3	1	2	-	1	1	1	2	2	3	3	1.92
CO4	3	3	3	2	2	-	1	-	1	1	2	3	3	1.85
CO5	3	3	3	2	3	-	1	-	2	2	3	3	3	2.15
Mean Overall Score	3	2.8	3	1.4	2.2	-	1.2	0.6	1.2	1.8	2.2	3	3	

infected cells. Isolation and purification of viruses.

Unit-III	Study of Virus	10 Hrs.
Morphology, ultra-structure, chemical composition and replication of: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV-TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – HBV. Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite virus, Virusoids, Viroids and Prions. Cellular interactions - clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Oncogenesis: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways.		
Unit-IV	Applied Virology	10 Hrs.
General aspects of plant and animal viral diseases. Introduction to viral vaccines, preparation of vaccines, new vaccine technology; antiviral drugs, Monoclonal Antibodies, antiviral gene therapy, antiviral libraries, antiretrovirals- mechanism of action and drug resistance. Modern approaches of virus control: Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing. T-phages, Cyanophages, Baculovirus. Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.		
Unit-V	Emerging Virus and Challenges	07 Hrs.
Mechanism of host cell damage- Host cell 'shut off', apoptosis, necrosis, alteration of signaling pathways. Viruses and the future: Promise and problems. Emerging diseases, sources and causes of emergent virus diseases. Prospectus using medical technology to eliminate specific viral and other infectious diseases (Ebola, Nephra, Hendra, SARS, etc).		

Text Book(s):

1. Knipe D.M. and Howley P.M. (2013). Fields Virology, 6th Edition 2 Vol. Wolters Kluwer Health/Lippincott Williams & Wilkins, Philadelphia.
2. Martinez J. Hewlett (2018). Basic Virology, 4th Edition. Wiley, USA.
3. Carter J. and Saunders V. (2013). Virology: Principles and Applications, 2nd Edition. Wiley, USA.
4. Flint S.J., Racaniello V.R., Enquist L.W., Racaniello V.R., Skalka. A.M. (2015) Principles of Virology, 4th Edition, 2 Vol. American Society for Microbiology, USA.
5. Black J.G. and Black L.J. (2017) Microbiology-Principles and Explorations, 10th Edition. John Wiley & Sons Inc. New York, USA.
6. Dimmock, N.J., Easton, A.J., and Leppard, K.N. (2016). Introduction to Modern Virology. 7th Edition. Blackwell publishing, USA.

Reference Book(s):

1. Jane Flint S. (2015). Principles of virology. 2, Pathogenesis and control. ASM Press, Washington, DC.
2. Alan J. Cann. Principles of Molecular Virology. 6th edition, Academic press, California. 2015.
3. Ann Giudici Fettner. The science of viruses. 2nd edition, Quill, William Marrow, New York. 1990.
4. Baishali C, Sumanta K Dutta, Patra Lekha RC and Ranjita S. Topley and Wilson's: Principles of bacteriology, Virology and immunity. 11th edition, vol 4, Edward Arnold, London. 2005.
5. John Carter and Venetia Saunders. Virology: Principles and applications, 2nd Edition, John Wiley and son's publishers, USA. 2013.

e Resources:

1. <https://ictv.global>
2. <https://www.cdc.gov>
3. <https://www.who.int>
4. <https://nptel.ac.in>
5. <https://www.biointeractive.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26007			Virology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	1	1	-	1	-	2	3	2	1.31
CO2	3	3	3	1	3	-	1	1	1	2	2	3	3	2.00
CO3	3	2	2	-	1	1	1	-	1	1	2	3	3	1.54
CO4	3	3	3	3	3	1	2	-	1	2	3	3	3	2.31
CO5	3	3	3	2	2	2	2	-	1	2	3	3	3	2.23
Mean Overall Score	3	2.6	2.4	1.2	2	1	1.4	0.2	1	1.4	2.4	3	2.8	

Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis.

Unit-IV	Antifungal Agents and Laboratory Identification of Fungi	09 Hrs.
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Principles of antifungal therapy, classification of antifungal drugs. Laboratory identification of medically important fungi using direct microscopy, fungal culture techniques, colony morphology, microscopic identification, biochemical tests, serological methods, antigen and antibody detection, molecular diagnostic techniques such as PCR, quality control in mycology laboratories, biosafety practices, and interpretation of laboratory results.

Unit-V	Prevention, Control, Epidemiology and Emerging Fungal Infections	09 Hrs.
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Epidemiology, transmission, prevention, and control of fungal infections in community and hospital settings. Infection control measures- sterilization and disinfection, personal protective equipment, environmental control of fungal contamination, surveillance of healthcare-associated fungal infections, and public health importance of mycoses. Emerging and re-emerging fungal pathogens, antifungal resistance, recent advances in diagnosis and treatment, and current research trends in medical mycology.

Text Book(s):

1. Chander, J. Medical Mycology. 5th Edition. New Delhi: Jaypee Brothers Medical Publishers.
2. Tille, P. Bailey & Scott's Diagnostic Microbiology. 15th Edition. Elsevier.
3. Procop, G. W., Church, D. L., Hall, G. S., et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 7th Edition. Wolters Kluwer.
4. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. Medical Microbiology. 10th Edition. Elsevier.
5. Carroll, K. C., et al. Jawetz, Melnick & Adelberg's Medical Microbiology. 29th Edition. McGraw-Hill Education.

Reference Book(s):

1. Larone, D. H. Larone's Medically Important Fungi: A Guide to Identification. 6th Edition. ASM Press.
2. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2024). Medical Microbiology (10th ed). Elsevier.
3. Procop, G. W., Church, D. L., Hall, G. S., & Janda, W. M. (2017). Koneman's Color Atlas and Textbook of Diagnostic Microbiology (7th ed). Wolters Kluwer.
4. Tille, P. (2022). Bailey & Scott's Diagnostic Microbiology (15th ed). Elsevier.
5. Ananthanarayan, R., & Paniker, C. K. J. (2023). Ananthanarayan and Paniker's Textbook of Microbiology (12th ed). Universities Press.

e Resources:

1. https://www.cdc.gov/fungal/index.html?utm_source=chatgpt.com
2. https://www.ecmm.info/?utm_source=chatgpt.com
3. https://clsi.org/?utm_source=chatgpt.com
4. https://www.merckmanuals.com/professional?utm_source=chatgpt.com
5. https://www.adelaide.edu.au/mycology/?utm_source=chatgpt.com

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26008			Mycology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	–	–	1	–	1	–	1	–	2	3	2	1.15
CO2	3	3	3	–	3	–	2	2	2	2	2	3	3	2.15
CO3	3	3	2	1	2	1	2	–	2	1	2	3	3	1.92
CO4	3	3	3	2	3	1	3	1	2	2	2	3	3	2.38
CO5	2	3	2	2	2	3	3	2	2	2	3	3	3	2.46
Mean Overall Score	2.8	2.8	2.5	1.25	2.2	1.33	2.2	1.5	1.8	1.75	2.2	3	2.8	

Unit-III	Diseases of Nervous System & Reticulo endothelial System	09 Hrs.
Diseases of Nervous System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of <i>Clostridium tetani</i> , <i>Clostridium botulinum</i> , <i>Mycobacterium leprae</i> , Rabies virus, <i>Neisseria meningitidis</i> . Diseases of Reticulo endothelial System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of <i>Brucella</i> , <i>Plasmodium</i> , Bacterial Septicemia.		
Unit-IV	Diseases of Gastrointestinal tract & Urogenital System	09 Hrs.
Diseases of Gastrointestinal tract (GIT) system: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of GIT diseases caused by: <i>Salmonella typhi</i> , <i>Shigella dysenteriae</i> , <i>Escherichia coli</i> : ETEC, EHEC, EPEC, EAEC; viral Hepatitis: Hepatitis A, Hepatitis B, Hepatitis C; <i>Entamoeba histolytica</i> . Diseases of Urogenital System: Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of HIV, <i>Neisseria gonorrhoeae</i> , <i>Chlamydia trachomatis</i> .		
Unit-V	Diagnosis Methods	09 Hrs.
Diagnosis – Process of sample collection, transport, examinations and discarding of clinical specimens. Antibigram and serological test. Diagnostic methods- non-cultured: PCR based microbial typing; Eubacterial identification based on 16s rRNA sequences-Amplified ribosomal DNA Restriction analysis (ARDRA)-Culture independent analysis of bacteria-DGGE and TRFLP; Molecular diagnosis of fungal pathogens based on 18s rRNA sequences; Detection of viral pathogens through PCR.		

Text Book(s):

1. Brooks, G.F., Carroll, K. C., Butel, J. S. and Morse, S. A. (2007) Jawetz, Melnick, & Adelberg's Medical Microbiology, Twenty-Fourth Edition. McGraw-Hill Companies, UK
2. Murray P.R., Tenover F.C., and Tenover F.C., and Tenover F.C. (2007). Medical Microbiology 6 th Edn., ASM Press, U.S.A.
3. Bauman, R.W. (2005). 4th Edition. Microbiology: with diseases by body system; Pearson Education, Inc., U.S.A.
4. Ryan K. J. and Ryan C.G. (2004) Sherris Medical Microbiology: an Introduction to infectious diseases. 2nd edition. McGraw-Hill, U.S.A.
5. Nester E. W., Anderson D. G. and Nester M. T. 2006. Microbiology: A Human Perspective, McGraw-Hill, U.S.A.

Reference Book(s):

1. Murray P. R., Baron E. J., Tenover J. H., Tenover F.C. and Tenover F.C. (2003). Manual of Clinical Microbiology. (8th Edition). American Society for Microbiology, Washington, DC. ISBN:1-555810255-4.
2. Bennett J. E., Dolin R. and Blaser M. J. (2019). Principles and Practice of Infectious Diseases. (9th Edition). Elsevier. EBook ISBN: 9780323550277. Hardcover ISBN: 9780323482554.
3. Brogden, K. A., Minion, C., Roth, J.A., Bolin, C.A. and Stanton, T. B. (2000) Virulence Mechanisms of Bacterial Pathogens 2nd Edition. ASM Press, U.S.A.
4. Salyers, A. A. and Whitt, D.D. (2002) Bacterial Pathogenesis: A molecular Approach –2ndEdn. ASM Press, U.S.A.
5. Koneman E.W., Allen S. D., Schreckenbach P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378
6. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1

e Resources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK20370/>
2. <https://journals.asm.org/doi/10.1128/JCM.02592-20>
3. <https://www.sciencedirect.com/science/article/pii/S2221169116309509>
4. http://www.textbookofbacteriology.net/normalflora_3.html

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26009			Diagnostic Microbiology								3		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	-	1	2	2	-	1	1	2	3	2	1.54
CO2	3	2	2	-	1	2	2	-	1	1	2	3	3	1.69
CO3	3	3	3	2	1	1	2	-	1	1	2	3	3	1.92
CO4	3	3	3	1	2	-	2	1	1	2	2	3	3	2.00
CO5	3	3	3	1	3	-	1	1	1	2	2	3	3	2.00
Mean Overall Score	3	2.6	2.4	0.8	1.6	1	1.8	0.4	1	1.4	2	3	2.8	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26010	BIO-SAFETY AND IPR	DEC	2	0	2	3

Pre-Requisite: Bachelor's degree in Life Sciences or related discipline

Co- Requisite: Medical Microbiology, Immunotechnology

Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology

Course Objectives:

1. To provide knowledge of laboratory biosafety practices, hazard management, and safe handling of biological materials.
2. To familiarize students with biosafety regulations, GMO policies, risk assessment, and recombinant DNA safety guidelines.
3. To develop an understanding of biomedical ethics and ethical issues associated with modern biotechnological advancements.
4. To examine ethical and legal aspects of human embryo research, public health regulations, and governmental oversight agencies.
5. To introduce intellectual property rights, patent laws, and regulatory frameworks governing biotechnology innovations.

Course Outcomes:

CO1: Apply laboratory biosafety principles, standard precautions, and hazard control measures in biological laboratories. **(K3)**

CO2: Evaluate biosafety concerns, risk assessment strategies, and regulatory policies related to GMOs and recombinant DNA technology. **(K5)**

CO3: Analyze ethical issues in healthcare, biomedical research, genetic engineering, cloning, and stem cell technology. **(K4)**

CO4: Assess ethical and legal considerations associated with embryo research and understand the roles of regulatory agencies in biotechnology governance. **(K5)**

CO5: Explain intellectual property rights, patent procedures, biotechnology regulations, and their significance in research, innovation, and commercialization. **(K2)**

K1-Remember	K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create
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Unit-I	Laboratory Biosafety and Hazard Management	09Hrs.
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Good laboratory practices, Chemical safety, Fire safety, Electrical safety, Exposure control plan, Employee education and orientation, Disposal of hazardous waste, Standard precautions, Engineering controls: Lab environment, biosafety cabinet, personal protective equipment, post-exposure control, post-exposure control, Classification of biologic agents based on hazard, Handling bio-hazardous material.

Practice: Demonstration of laboratory rules and safety procedures.

Unit-II	Biosafety, GMO Regulations and Risk Assessment	09 Hrs.
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Legal, socioeconomic, public elucidation of process of biotechnology in generating new forms of life. Biosafety in general, Food and feed products containing GMOs, Risk assessment/analysis, Risk management, Ethical aspects of GMOs, policy on the storage of GMOs, Gene technology act, Precautionary principle, Potential environmental risks & benefits, Potential socio-economical risks & benefits. Recombinant DNA safety guidelines and regulations.

Practice: GMO risk assessment and management exercise.		
Unit-III	Biomedical Ethics	09 Hrs.
Ethical theories, contemporary approaches to medical ethics, physician-patient relationship, confidentiality, truth telling, autonomy, paternalism & informed consent, abortion, medical experimentation, justice and health care system, the nature of bioethics, Genetic modification/research on plants and animals, therapeutic cloning, human cloning, stem cell research.		
Practice: Informed consent preparation and ethical case analysis.		
Unit-IV	Embryo Research	09 Hrs.
Human Embryonic Development; Ethics through Embryo Development: Fertilization, The Fetus and feeling pain; Scientific Research on Human Embryos and its Experimental goals - Ethical issues in Embryo Research. Federal Laws and the roles of: The Food and Drug Administration, The Centers for Disease Control and Prevention, The United States Department of Agriculture, The Environmental Protection Agency, State and Local Agencies.		
Practice: Study of human embryonic development and embryo research ethics.		
Unit-V	Intellectual Property Rights (IPR)	09 Hrs.
Patents - copy right and neighboring rights, patents for invention, trademarks, trade names - Conditions for patentability - Drafting and filing a patent application, infringement, copyright and development, exploitation of patented invention. Indian patent laws. Regulating the use of biotechnology: recombinant DNA Technology, food and agricultural ingredients, - patenting biotechnology inventions - Biosafety and Bioethics.		
Practice: Preparation of basic patent application for a hypothetical biotechnology invention.		

Text Book(s):

1. Nancy, S. J, Albert, R.J., Robert A. Pearlman. 2011. Bioethics: An Introduction to history, methods and practice. Jones and Barlett Publishers.
2. Sibi, G. 2020. Intellectual Property rights, bioethics, biosafety and entrepreneurship in biotechnology, 1st edition. IK International Publishing House Pvt. Ltd.
3. Tom, L.B., Childress, F. 2013. Principles of biomedical ethics, 5th edition, Oxford University Press, USA.
4. Frederic, H., Erbisch., Karim, M. Maredia. 2004. Intellectual Property Rights in Agricultural Biotechnology, CABI publisher.
5. Sateesh, M.K. 2008. Bioethics and Biosafety, I.K. International Pvt. Ltd, New Delhi, India.
6. Deepa Goel., Shomini Parashar. 2013. IPR, Biosafety and Bioethics, 1st edition, Pearson Education, India.

Reference Book(s):

1. Vaughan Manomy. 2009. Animal Experimentation: A guide to the issues, 2nd edition, Cambridge university press.
2. Lewis Vaughn 2013. Bioethics: Principles, Issues and Cases, Oxford University Press, USA.
3. Beauchamp, T., Childress, J. 2013. A Principles of Biomedical Ethics, 7th edition, New York: Oxford University Press.
4. Macer D.R.J. 1990. Shaping Genes: Ethics, Law and Science of Using New Genetic Technology in Medicine and Agriculture, [online (Eubios Ethics Institute)].

e Resources:

1. <https://www.slideshare.net/ishahak16/lecture-3-ethics-and-bioethics>
2. https://www.asrm.org/globalassets/asrm/asrm-content/news-andpublications/ethics-committee- opinions/ethics_in_embryo_research.pdf
3. <https://www.ndsu.edu/pubweb/~mcclean/plsc431/students/bergeson.html>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26010			Bio-Safety and IPR								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	2	2	2	1	2	3	3	1	1	2	2	3	2	2.00
CO2	2	3	3	2	2	3	3	1	1	2	2	3	3	2.31
CO3	2	3	2	2	1	2	3	1	2	1	2	2	2	1.92
CO4	2	3	2	2	1	2	3	1	2	1	2	2	2	1.92
CO5	3	2	2	2	2	1	2	-	2	3	2	2	3	2.00
Mean Overall Score	2.2	2.6	2.2	1.8	1.6	2.2	2.8	0.8	1.6	1.8	2	2.4	2.4	

Practice: Minimum Inhibitory Concentration (MIC)		
Unit-III		09 Hrs.
Chromosomal mutations and evolution of resistance. Horizontal gene transfer: conjugation, transformation, and transduction. Mobile genetic elements: plasmids, transposons, and integrons. Resistome and environmental reservoirs. Selective pressure, fitness cost, co-selection, and cross-resistance. Practice: Detection of Resistance Mechanisms		
Unit-IV		09 Hrs.
Drivers of AMR in human health, veterinary medicine, and agriculture. Environmental factors contributing to AMR. One Health approach. Epidemiology and surveillance of priority resistant pathogens (MRSA, VRE, MDR-TB, CRE, ESKAPE pathogens). Practice: Molecular Detection of AMR Genes.		
Unit-V		09 Hrs.
Phenotypic methods for antimicrobial susceptibility testing (AST): Disk diffusion, Broth microdilution, E-test. MIC determination. Detection of major resistance phenotypes (MRSA, VRE, ESBL, carbapenemase producers). Genotypic methods: PCR and whole-genome sequencing. Molecular surveillance and outbreak investigation. AMR databases: CARD, ResFinder, and NCBI Pathogen Detection. Practice: Bioinformatics and AMR Databases.		

Text Book(s):

1. Walsh, T. R. (2013). Antimicrobial Resistance: A Global Perspective. In: Antimicrobial Resistance and Food Safety. Academic Press. USA.
2. Walsh, T. R., & Wencewicz, T. A. (2020). Antimicrobial Resistance: A Problem-Based Approach. ASM Press. USA.
3. Tenover, F. C., & Nicolau, D. P. (Eds.). (2016). Antimicrobial Resistance in Bacteria. Springer. USA.
4. Pucci, M. J., & Bush, K. (Eds.). (2017). Antimicrobial Resistance: Mechanisms and Clinical Implications. CRC Press. USA.
5. World Health Organization. (2015). Global Action Plan on Antimicrobial Resistance. WHO. Geneva.
6. O'Neill, J. (2016). Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. The Review on Antimicrobial Resistance. UK.
7. CLSI. (2024). Performance Standards for Antimicrobial Susceptibility Testing, 34th Edition. CLSI. USA.
8. EUCAST. (2024). Breakpoint Tables for Interpretation of MICs and Zone Diameters. European Committee on Antimicrobial Susceptibility Testing. Europe.
9. Zaman, S. B., et al. (2017). A Review on Antibiotic Resistance: Alarm Bells are Ringing. Cureus, 9(6), e1403.
10. Holmes, A. H., et al. (2016). Understanding the mechanisms and drivers of antimicrobial resistance. The Lancet, 387(10014), 176-187.

e Resources:

1. <https://www.who.int/health-topics/antimicrobial-resistance>
2. <https://www.cdc.gov/antimicrobial-resistance/>
3. <https://card.mcmaster.ca/>
4. <https://cge.food.dtu.dk/services/ResFinder/>
5. <https://www.ncbi.nlm.nih.gov/pathogens/>
6. <https://www.coursera.org/learn/antimicrobial-resistance>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26011			Antimicrobial Resistance								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)	Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11			PSO1
CO1	3	2	-	-	-	2	2	-	-	-	1	3	2	2.14
CO2	3	2	2	-	-	-	-	-	-	-	1	3	3	2.33
CO3	3	2	2	-	2	-	-	-	2	-	1	3	3	2.25
CO4	3	3	2	2	2	3	3	2	2	-	1	3	3	2.5
CO5	3	3	3	2	3	2	2	-	2	2	1	3	3	2.58
Mean Overall Score	3	2.4	2.3	2	2.3	2.3	2.3	2	2	2	1	3	2.8	

Sem	Course Code	Title of the Course		Course Category	L	T	P	Credits
II	PMB26012	EPIDEMIOLOGY		DEC	2	0	2	3
Pre-Requisite: Bachelor’s degree in Life Sciences or related discipline								
Co- Requisite: Medical Microbiology, Immunotechnology								
Progressive Course: Semester III - Agriculture and Environmental Microbiology, Food and Industrial Microbiology, Microbial Genetics and Molecular Biology								
Course Objectives:								
1. To define epidemiology and understand the modes of disease transmission								
2. To define a disease and differentiate a communicable from a non-communicable disease								
3. To understand public health surveillance and field investigations								
4. To learn statistical methods for field epidemiology								
5. To understand the severity of chronic diseases and health problems								
Course Outcomes:								
CO1: Understand epidemiology and modes of disease transmission. (K2)								
CO2: Differentiate between a communicable and non-communicable disease and to define a disease. (K2)								
CO3: Understand public health surveillance and field investigations. (K2)								
CO4: Learn statistic methods for field epidemiology. (K3)								
CO5: Understand the severity of chronic diseases and health problems. (K2)								
K1-Remember		K2-Understand		K3-Apply	K4-Analyze	K5-Evaluate		K6-Create
Unit-I		Introduction to epidemiology						09 Hrs.
Introduction: foundations in epidemiology, definitions, the epidemiology triangle, modes of disease transmission, chain ofinfection, levels of prevention. Measuring disease frequency: measuring disease occurrence,measuring disease frequency anddata organization.								
Practice: Case study on air borne epidemic disease.								
Unit-II		Disease classification and control						09 Hrs.
Practical disease concepts in epidemiology: communicable and non-communicable diseases, natural history of the disease, classifications of the disease, portals of entry into the human body, protecting public health through immunization.Communicable disease prevention and control, disability.								
Practice: Case study on the waterborne epidemic disease.								
Unit-III		Descriptive and field epidemiology						09 Hrs.
Descriptive epidemiology according to person place and time: public health surveillance, person, place and time.Health indicators, selected health indicators. Field epidemiology:field investigation and steps for conducting a field investigation.								
Practice: Numerical analysis of epidemic disease								
Unit-IV		Methods in descriptive epidemiology						09 Hrs.

Design strategies and statistical methods in descriptive epidemiology: definitions, descriptive study designs, types of data, Ratios, proportions and rates. Tables, graphs and numerical measures. Measures of statistical association.

Practice: Graphical analysis of epidemic disease.

Unit-V	Chronic disease epidemiology	09 Hrs.
Chronic disease epidemiology: chronic diseases, the environment and chronic health problems, behavior and chronic health problems, heredity and chronic health problems. Clinical epidemiology: screening and diagnosis, validity, reliability and yield. Evaluating the screening test.		
Practice: Study of models for chronic epidemic diseases		

Text Book(s):

1. Ann Aschengrau ScD; George R. Seage ScD, Essentials of Epidemiology in Public Health, fourth, Jones and Bartlett publishers, 2020
2. Botina, R., Beaglehole, R, Kjellstrom, T., Essentials of Epidemiology in Public Health., Second, Jones and Bartlett Publishers, 2006
3. Sharma AK, Immunology An Introductory Textbook, fourth, Jones & Bartlett Publishers, India, 2019

Reference Book(s):

1. Gordis, L, Epidemiology. Second Edition, 2000.
2. Sharma AK, Immunology An Introductory Textbook, Fourth, Jones & Bartlett Publishers, India, 2019.
3. Introduction to Epidemiology – Introduction to Epidemiology by Ray M. Merrill.

e Resources:

1. <https://www.who.int>
2. <https://www.cdc.gov>
3. <https://www.ecdc.europa.eu>
4. <https://ourworldindata.org>
5. <https://www.who.int/data/gho>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26012			Epidemiology								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	-	-	-	2	2	-	-	-	1	3	2	2.14
CO2	3	2		-	-	2	3	-	-	-	1	3	2	2.29
CO3	3	3	2	-	2	2	2	2	2	-	1	3	3	2.31
CO4	2	3	3	-	3	-	-	-	2	2	1	3	3	2.44
CO5	3	2	2	-	-	3	3		2	-	1	3	3	2.44
Mean Overall Score	2.8	2.4	2.3	0	2.5	2.3	2.5	2	2	2	1	3	2.6	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMB26901	PUBLIC HEALTH MICROBIOLOGY	MDC	2	0	2	3
Pre-Requisite: Bachelor's degree in any discipline							
Co- Requisite: Master's degree in any discipline							
Progressive Course: Semester II							
Course Objectives:							
1. To understand the basic concepts, scope, and significance of public health microbiology and the role of microorganisms in air, water, soil, food, and healthcare environments.							
2. To explain the sources, transmission, prevention, and control of airborne, waterborne, foodborne, and hospital-acquired infections affecting public health.							
3. To develop skills in the collection, transportation, isolation, identification, and enumeration of microorganisms from environmental and clinical samples.							
4. To analyze the microbiological quality of air, water, food, and healthcare settings and evaluate their impact on human health and disease transmission.							
5. To apply public health microbiology principles for disease surveillance, sanitation monitoring, infection control, and community health management.							
Course Outcomes:							
CO1: Explain the concepts, scope, importance of public health microbiology, and the role of microorganisms in air, water, soil, food, and healthcare environments. (K2)							
CO2: Describe the sources, transmission, epidemiology, prevention, and control of airborne, waterborne, foodborne, and hospital-acquired infections. (K2)							
CO3: Apply appropriate techniques for the collection, transportation, isolation, identification, and enumeration of microorganisms from environmental and clinical samples. (K3)							
CO4: Analyze the microbiological quality of air, water, food, and healthcare environments and assess their impact on public health. (K4)							
CO5: Evaluate public health measures, sanitation practices, infection control strategies, and disease prevention programs for protecting community health. (K5)							
K1-Remember		K2-Understand	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create	
Unit-I	Introduction to Public Health						09 Hrs.
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. Practice: Collection, perseveration and transportation of samples from the community to the laboratory.							
Unit-II	Air Borne Infections						09 Hrs.
Air borne infections: air and its composition – indoor air – outdoor air – air borne diseases (bacterial, fungaland viral) – methods of enumeration of microorganisms in air – air sanitation. Practice: Isolation and Identification of microorganisms from air.							
Unit-III	Water Borne infections						09 Hrs.

Water borne infections: kinds of water – water borne diseases (viral, bacterial, protozoan) – methods of enumeration of microorganisms in water – indicator organism – water treatment, control of water borne diseases.

Practice: Isolation and Identification of microorganisms from water and evaluation of water quality.

Unit-IV	Food Borne Diseases	09 Hrs.
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Foodborne diseases: definition and importance of food hygiene – types (spoilage of meat and its products, milk and dairy product, 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.

Practice: Isolation and identification of microorganism from different food products: meat, canned juice, milk, cheese and ice cream.

Unit-V	Hospital Acquired Infection	09 Hrs.
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Hospital acquired infection: Prophylactic immunization – disposal of infective hospital and laboratory materials – monitoring of sanitation in community – techniques used for the diagnosis of hospital acquired infection.

Practice: Isolation and identification of microorganisms (hospital acquired infection).

Text Book(s):

1. A Text Book of Microbiology, by Ghimire P. & Parajuli K. Vidhyarthi Pustak Bhandar Publication, Kathmandu.
2. Text Book of Social and Preventive Medicine by Park J. E. and Park K.
3. Modern Food Microbiology, by Jay, J. H. 3rd Edition CBS Publication and Distributors Delhi 1987.
4. Epidemiology for Public Health Practice, by Friis, R.H., and Sellers, T.A., 2nd Edition, Gaithersburg, MD: Aspen Publication.
5. Evidence Based Public Health by Brownson, R.C., Baker, E.A., Leet, T.L., Gillespie, K.N., Oxford University Press

Reference Book(s):

1. Evidence Based Public Health by Brownson, R.C., Baker, E.A., Leet, T.L., Gillespie, K.N., Oxford University Press.
2. Evidence-Based Public Health – Evidence-Based Public Health by Ross C. Brownson, Elizabeth A. Baker, Terry L. Leet, and Kathleen N. Gillespie.
3. Essentials of Public Health – Essentials of Public Health by Bernard J. Turnock.
4. Essentials of Health Policy and Law – Essentials of Health Policy and Law by Joel B. Teitelbaum and Sara E. Wilensky.
5. Introduction to Epidemiology – Introduction to Epidemiology by Ray M. Merrill.

e Resources:

1. https://www.who.int/?utm_source=chatgpt.com
2. https://www.ncbi.nlm.nih.gov/?utm_source=chatgpt.com
3. https://nhm.gov.in/?utm_source=chatgpt.com

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
I	PMB26901			Public Health Microbiology								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	1	1	-	-	2	1	-	1	-	2	3	2	1.62
CO2	3	2	1	-	-	2	1	-	1	-	2	3	2	1.77
CO3	3	2	2	-	1	3	1	-	1	-	2	3	3	2.00
CO4	3	2	2	1	1	2	1	-	1	1	2	3	3	2.08
CO5	3	3	2	1	2	2	2	1	1	1	2	3	3	2.31
Mean Overall Score	3	2	1.6	0.4	0.8	2.2	1.2	0.2	1	0.4	2	3	2.6	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMB26902	MICROBES IN HUMAN HEALTH	MDC	2	0	2	3
Pre-Requisite: Bachelor's degree in any discipline							
Co- Requisite: Master's degree in any discipline							
Progressive Course: Semester III							
Course Objectives:							
1. To understand the composition, distribution, and significance of the human microbiome, and explain the factors influencing microbial colonization and survival in different parts of the human body.							
2. To explain the principles, applications, advantages, and limitations of conventional and molecular techniques used for studying the human microbiome, including DNA isolation and sequencing methods.							
3. To describe the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of major bacterial, protozoan, fungal, and viral diseases affecting humans.							
4. To understand the concept, applications, and challenges of bacteriophage therapy, and develop practical laboratory skills in microbial isolation, staining, bacteriophage isolation, and molecular techniques.							
5. To evaluate the role of beneficial microorganisms in human health by distinguishing between prebiotics, probiotics, and synbiotics, and explain the characteristics, mechanisms of action, and therapeutic applications of probiotic microorganisms.							
Course Outcomes:							
CO1: Explain the composition, functions, and significance of the human microbiome, and the factors influencing microbial colonization in different human body sites. (K2)							
CO2: Demonstrate the principles and applications of microbiome analysis techniques, including microbial isolation, DNA extraction, molecular profiling, and sequencing methods. (K3)							
CO3: Identify the causative agents, symptoms, transmission, diagnosis, and control measures of major bacterial, protozoan, fungal, and viral diseases affecting humans. (K3)							
CO4: Analyze the therapeutic potential of bacteriophage therapy and probiotics in disease prevention and management, distinguishing them from prebiotics and synbiotics. (K4)							
CO5: Perform fundamental microbiological laboratory techniques, including microbial isolation, staining, bacteriophage isolation, and characterization of probiotic bacteria while interpreting experimental observations. (K3)							
<i>K1-Remember</i>	<i>K2-Understand</i>	<i>K3-Apply</i>	<i>K4-Analyze</i>	<i>K5-Evaluate</i>	<i>K6-Create</i>		
Unit-I	Role of Microbiome in Human Health						09 Hrs.
Importance of human microbiome in health. Factors affecting the survival and colonization of microorganisms on various organs including skin, throat and upper respiratory tract, gastrointestinal tract and genitourinary tract. Practice: Isolation of microorganisms from skin by swab method using specific media.							
Unit-II	Technologies for Assaying the Human Microbiome						09 Hrs.
Direct observation methods, molecular profiling techniques, sequencing methods, strengths and weaknesses of the technologies. Practice: Isolation of DNA from clinical samples and visualization using agarose gel electrophoresis.							
Unit-III	Microorganisms in Human Diseases						09 Hrs.

A concise overview of aetiology, symptoms, transmission and control of some common diseases: Bacterial – Tuberculosis, Cholera, Typhoid, Diphtheria. Protozoan – Malaria, Kala azar, and fungal diseases - Dermatophytoses, Candidiasis, Aspergillosis.

Practice: Gram staining of bacterial isolates and lactophenol staining for fungal isolates.

Unit-IV	Viral Diseases and Bacteriophage Therapy	09 Hrs.
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Viral – Rabies, Hepatitis, Zika, COVID, Polio, AIDS. Bacteriophage therapy: concept and challenges. A brief account of bacteriophage therapy for various diseases.

Practice: Isolation of bacteriophages from sewage sample using double layer technique.

Unit-V	Microbes and Probiotics	09 Hrs.
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Microbes for maintaining human health: Brief description and distinction between prebiotics, probiotics and symbiotics. Probiotics for maintaining human health: prerequisite characteristics of probiotic strains, common probiotic bacterial strains, modes of action of probiotics, probiotic supplementation for disease management.

Practice: Isolation and characterization of bacteria from probiotic products.

Text Book(s):

1. Brock Biology of Microorganisms by M.T. Madigan, J. Aiyer, D. Buckley, W. Sattley and D. Stahl. 16th edition. Pearson, USA. 2021.
2. Prescott Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.
3. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition. Universities Press, India. 2017.
4. Jawetz, Melnick and Adelberg's Medical Microbiology by K.C. Carroll, S.A. Morse, T.A. Mietzner and S. Miller. 27th edition. McGraw Hill Education. 2016.
5. Microbiology: An Introduction by G.J. Tortora, B.R. Funke and C.L. Case. 9th edition. Pearson Education, USA. 2007.
6. Cappucino, J. and Sherman, N. (2014). Microbiology: A Laboratory Manual. 10th edition. Pearson Education, India.
7. Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A. (2007). Mackie and McCartney Practical Medical Microbiology. Elsevier 14th edition 1996.
8. Randhawa, V.S., Mehta, G. and Sharma, K.B. (2009). Practicals and Viva in Medical Microbiology. 2nd edition. Elsevier, India.
9. Fuller, R. (2012). Probiotics: The Scientific Basis. Springer Netherlands.
10. Dhanasekaran, D. and Sankarnarayanan, A (2021). Advances in Probiotics, Microorganisms in Food and Health. Academic Press.

e Resources:

1. <https://www.mooc-list.com/tags/medical-diagnosis>
2. <https://www.mooc-list.com/tags/clinical-diagnostics>
3. <http://www.winthrop.org/diagnostic-technology-techniques>
4. <http://www.tsglobalinitiative.com/newsletter/clinical-diagnostic-technologies- face-new-obstacles/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credits
II	PMB26902			Microbes in Human Health								2L+2P		3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	2	1	–	1	2	2	–	1	–	2	3	2	1.62
CO2	3	3	3	2	3	–	1	2	2	2	2	3	3	2.23
CO3	3	3	2	–	2	2	3	–	2	1	2	3	2	1.92
CO4	3	3	2	3	2	2	2	1	2	2	2	3	3	2.31
CO5	3	3	3	2	3	1	2	2	2	3	2	3	3	2.46
Mean Overall Score	3	2.8	2.2	1.4	2.2	1.4	2	1	1.8	1.6	2	3	2.6	