



K.M.G. COLLEGE OF ARTS AND SCIENCE **(AUTONOMOUS)**

Approved by the Government of Tamil Nadu
Permanently Affiliated to Thiruvalluvar University, Vellore
Recognized under Section 2(f) and 12(B) of the UGC Act 1956
Accredited by NAAC (2nd Cycle) with (CGPA of 3.24/4) 'A' Grade

P.G. & RESEARCH DEPARTMENT OF MICROBIOLOGY

M.Sc., Microbiology

SYLLABUS

Under

LEARNING OUTCOMES-BASED CURRICULUM

FRAMEWORK (LOCF)

(Effective for the Batch of Students Admitted from 2024-2025)

PREFACE

The curriculum of Postgraduate Microbiology has been designed to explain the concepts in various fields of Microbiology such as Medical Microbiology, Soil Microbiology, Pharmaceutical Microbiology etc., and also explain both beneficial and harmful organisms. The purpose of the outcome-based education is meant to provide an exposure to the fundamental aspects in different area of Microbiology and its applications, keeping in mind the growing needs for higher education, employability, entrepreneurship and social responsibility. The periodical restructuring of the syllabi is carried out to fulfill the requirements of graduate attributes, qualification descriptors, programme learning outcomes and course outcomes. The outcome-based education enriches the curriculum to deliver the basic principles, synthetic strategies, mechanisms and application-oriented learning for the benefit of students. It also includes self-learning module, minor projects and industrial internship to enable students to get equipped for higher studies and employment. The programme also includes training to students for seminar presentation, preparation of internship reports, hands-on training in lab courses, skills to handle instruments, synthesis and its analysis, developing leadership qualities, organization and participation in the interdepartmental academic competitions. The allied papers provide a platform to strengthen the understanding of the core subjects. The non-major elective courses offer chances to learn and augment interest in other related fields. The outcome-based curriculum is intended to enrich the learning pedagogy to global standards. The seminars periodically delivered by industrialists, subject experts and former professors would certainly help the students to update with latest technology/trends in different fields of Microbiology. The exposure to the industrial internship and MoUs with industries can open an avenue for a start-up and its progress would be followed regularly. The OBE based evaluation methods will reflect the true cognitive levels of the students as the curriculum is designed with course outcomes and cognitive level correlations as per BLOOM's Taxonomy.

The College was founded in the new millennium 2000 by the vision of late Shri.K.M.Govindarajan fondly known as Iyah, with a mission to offer higher education in the fields of Arts and Science to the needy and the poor middle class students of this area and make them fully employable and economically self-reliant. With a humble beginning of launching an elementary school named Thiruvalluvar Elementary School in the year 1952, Iyah groomed it into a Higher Secondary School and later into a college. Education was his soul and breath. The college has grown into a full-fledged educational hub offering 12 under graduate programmes, 8 post graduate programmes, 5 M.Phil research programmes and 4 Ph.D programmes. The college has been accredited with 'A' grade by NAAC in 2nd cycle and recognized under section 2(f) & 12(B) of the UGC act 1956. The College is permanently affiliated to Thiruvalluvar University. The College is also acquired the status of Autonomous from the academic year 2024-2025. The College is an associate member of ICT Academy and registered member of NPTEL and Spoken Tutorials of IIT Bombay. The college is also a member of INFLIBNET and NDL.

VISION OF THE COLLEGE

Empower young men and women by educating them in the pursuit of excellence, character building and responsible citizen.

MISSION OF THE COLLEGE

Offer higher education in the fields of Arts, Science & Management to the needy and make them fully self-dependent.

QUALITY POLICY OF THE COLLEGE

KMG Students achieve the best learning results and personal growth with modern education that equip them for working life and a changing society to become deserving citizens.

ABOUT THE DEPARTMENT

The Department of Microbiology was established in year 2005. The department offers the courses at the UG level and the department upgraded to UG Microbiology into PG Applied Microbiology 2017 -2018 Batch onwards and the department upgraded in Research level (Ph.D) during the Academic Year 2019-2020. Microbiology is a broad discipline that involves a study of classification of Microorganisms, Ecology, and Applications in Agriculture, Food and Medicine. It teaches about microorganisms with particular emphasis on the biology of Bacteria, Viruses, Fungi, Algae and Protozoan Parasites The department is very zealous in providing quality education to the students. The well-equipped UG and PG laboratory and library have made the teaching- learning process more effective.

VISION OF THE DEPARTMENT

The Vision of the Department of Microbiology is that the knowledge in theory and practical aspects of Microbiology is imperative for the development of students. Upgrading of existing teaching and research activities in order to keep pace with the global scientific progress and to meet the requirements of society.

MISSION OF THE DEPARTMENT

The PG and Research Department of Microbiology considers its mission as to produce personnel with expertise of the highest standard in the field of Microbiology to cater the increasing demand in the country for Microbiologists. Also development of academic processes to enhance scientific research through strategic planning and a clear view for science and technology.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- PEO1 : Knowledge Enhancement and Application:** Graduates will demonstrate proficiency in their chosen discipline by applying theoretical knowledge and analytical skills to solve complex problems in diverse professional contexts
- PEO2 : Effective Communication and Leadership:** Graduates will exhibit strong communication skills and leadership abilities, enabling them to effectively collaborate with diverse teams, convey ideas persuasively, and contribute positively to organizational goals.
- PEO3 : Ethical Decision-Making and Social Responsibility:** Graduates will uphold ethical principles and social responsibility in their professional practices, making informed decisions that consider the well-being of stakeholders and society at large.
- PEO4 : Continuous Learning and Adaptability:** Graduates will embrace a commitment to lifelong learning, continuously updating their knowledge and skills to remain agile and adaptable in dynamic work environments characterized by rapid technological advancements and evolving global trends.
- PEO5 : Entrepreneurial Mindset and Innovation:** Graduates will demonstrate an entrepreneurial mindset, leveraging their knowledge and skills to identify opportunities, innovate solutions, and potentially initiate and manage ventures that contribute to economic growth and societal development

PROGRAM OUTCOMES (POs)

On successful completion of the programme, the students will be able to:

POs	Graduate Attributes	Statements
PO1	Disciplinary Knowledge	Capable of demonstrating detailed knowledge and expertise in all the disciplines of the subject.
PO2	Communication Skill	Ability to develop communication, managerial and interpersonal skills.
PO3	Decision Making Skill	Foster analytical and critical thinking abilities for data-based decision-making.
PO4	Analytical Reasoning	Ability to evaluate the reliability and relevance of evidence, identify flaws, analyze and synthesize data from different sources.
PO5	Problem Solving Skill	Apply knowledge of Scientific and Management theories and Human Resource practices to solve business problems through research in Global context.
PO6	Employability and Entrepreneurial Skill	Equip the skills in current trends and future expectations for placements and be efficient entrepreneurs by accelerating qualities to facilitate startups in the competitive environment.
PO7	Individual and Team Leadership Skill	Capability to lead themselves and the team to achieve organizational goals and contribute significantly to society.
PO8	Multicultural competence	Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO 9	Moral and ethical awareness/reasoning	Ability to embrace moral/ethical values in conducting one's life.
PO10	Lifelong Learning	Identify the need for skills necessary to be successful in future at personal development and demands of work place.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On successful completion of the B.Sc., Microbiology, the students will be able to:

PSOs	Statements
PSO1	To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, and beliefs and apply diverse frames of reference to decisions and actions.
PSO2	To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate start ups and high potential organizations.
PSO3	Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development.

Correlation Rubrics:

High	Moderate	Low	No Correlation
3	2	1	-

Mapping of PSOs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	3	2	2	2	2	2	2	2	2	2
PSO2	3	2	3	2	3	3	3	2	1	1
PSO3	3	2	2	2	2	3	3	3	1	2

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Subject and Credit System- M.Sc., Microbiology

(Effective for the Batch of Students Admitted from 2024-2025)

Semester	Part	Category	Course Code	Course Title	Ins. Hrs/ Week	Credit	Maximum Marks		
							Internal	External	Total
SEMESTER- I	PART - I	Core I	APCMB11	General Microbiology and Microbial Diversity	7	5	25	75	100
		Core II	APCMB12	Immunology, Immunomics and Microbial Genetics	7	5	25	75	100
		Core III	APCPMB13	Practical-I	6	4	25	75	100
		Elective I (Choose any One)	APEMB14A	Forensic Science	5	3	25	75	100
			APEMB14B	Health Hygiene					
			APEMB14C	Microalgal Technology					
		Elective II (Choose any One)	APEMB15A	Bioinstrumentation	5	3	25	75	100
			APEMB15B	Herbal Technology and Cosmetic Microbiology					
			APEMB15C	Essentials of Laboratory Management and Biosafety					
						Semester Total	30	20	

SEMESTER- II	Part I	Core IV	APCMB21	Medical Bacteriology and Mycology	6	5	25	75	100
		Core V	APCMB22	Medical Virology and Parasitology	6	5	25	75	100
		Core VI	APCPMB23	Practical-II	6	4	25	75	100
		Elective III	APEMB24A/ APEMB24B/ APEMB24C	Epidemiology/ Clinical Diagnostic Microbiology/ Bioremediation (Among the three choices anyone can be chosen by the student)	3	3	25	75	100
		Elective IV	APEMB25A/ APEMB25B/ APEMB25C	Bioinformatics/Nano biotechnology/Clinical Research and Clinical Trials (Among the three choices anyone can be chosen by the student)	3	3	25	75	100
		Skill Enhancement Course I	APSMB26	Vermitechnology	4	2	25	75	100
	Part II	Compulsory	APHR20	Human Rights	2	2	25	75	100
		Compulsory	APMOOC20	MOOC course	-	2	-	100	100
				Semester Total	30	26			

SEMESTER – III	Part I	Core VII	APCMB31	Soil and Environmental Microbiology	6	5	25	75	100
		Core VIII	APCMB32	Molecular Biology and Recombinant DNA Technology	6	5	25	75	100
		Core IX	APCPMB33	Practical's III	6	4	25	75	100
		Core X Industry Module	APCMB34	Fermentation Technology and Pharmaceutical Microbiology	6	5	25	75	100
		Elective V	APEMB35A	Biosafety, Bioethics and IPR	3	3	25	75	100
			APEMB35B	Toxinology					
			APEMB35C	Water Conservation and Water Treatment					
		Skill Enhancem ent Course II	APSMB36	Organic Farming and Bio fertiliser Technology	3	2	25	75	100
		Compulso ry	APIMB37	Internship / Industrial Activity	-	2	100	-	100
					Semester Total		30	26	

SEMESTER – IV	Part I	Core XI	APCMB41	Food & Dairy Microbiology	6	5	25	75	100
		Core XII	APCMB42	Research Methodology & Biostatistics	6	5	25	75	100
		Project	APPMB43	Project with Viva Voce	10	7	25	75	100
		Elective VI	APEMB44A	Bioenergy	4	3	25	75	100
			APEMB44B	Marine Microbiology					
			APEMB44C	Life Science for Competitive Examinations					
		Skill Enhancement Course III	APSMB45	Microbial Quality Control and Testing	4	2	25	75	100
	Part II	Compulsory	APEA40	Extension Activity	-	1	100	-	100
				Semester Total	30	23			

Consolidated Semester wise and Component wise Credit distribution

Part	Semester-I	Semester-II	Semester-III	Semester-IV	Total Credits
Part I	20	22	26	22	90
Part II	-	4	-	1	05
Total	20	26	26	23	95

*Part I and Part II components will be separately taken into account for CGPA calculation and classification for the post graduate programme and has to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

Methods of Evaluation	
Continuous Internal Assessment Tests	25 Marks
Assignments	
Seminars	
Attendance and Class Participation	
End Semester Examination	75 Marks
Total	100 Marks
Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

QUESTION PAPER PATTERN**Question paper pattern Theory:**

External Maximum 75 Marks – wherever applicable (Ext.75 + Int.25 = Total. 100)			
Section A	Very short answer questions	10X 2=20	10 questions – 2 from each unit
Section B	Short answer questions of either / or type (like 1a (or) 1b)	5X5=25	5 questions – 1 from each unit
Section C	Essay-type questions / Problem (Answer any 3 out of 5)	3X10=30	5 questions – 1 from each unit

Question paper pattern Practical:

External Maximum 75 Marks – wherever applicable (Ext.75 + Int.25 = Total. 100)	
Major Practical	1x30=30
Minor Practical	1x20=20
Spotters	5x3=15
Record	10
Total	75

COURSE DESCRIPTORS

Title of the Course	General Microbiology and Microbial Diversity	Hours/Week	07
Course Code	APCMB11	Credits	05
Category	Core Course I	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Acquire knowledge on the principles of different types of microscopes and their applications.
- Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
- Exemplify, isolate and cultivate microalgae from diverse environmental sources.
- Explain various pure culture techniques and discuss sterilization methods.
- Discuss the importance and conservation of microbial diversity.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	History and Scope of Microbiology. Microscopy–Principles and applications. Types of Microscopes – Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry–Stage, Ocular and its applications.	CO1 CO2 CO3 CO4	K1,K2,K4. K5, K6
UNIT-II	Bacterial Structure, properties and biosynthesis of cellular components– Cellwall. Actinomycetes and Fungi-Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition –Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.	CO1 CO2 CO3 CO4 CO5	K1, K2, K4. K5, K6
UNIT-III	Algae-Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Lifecycle- <i>Chlamydomonas</i> , <i>Volvox</i> (Greenalgae), <i>Nostoc</i> and <i>Spirulina</i> (Cyanobacteria), <i>Sargassum</i> (Brownalgae), <i>Polysiphonia</i> and <i>Porphyridium</i> (Red algae).	CO1 CO2 CO3 CO4 CO5	K1, K2, K4. K5, K6

UNIT-IV	Microbial techniques-Sterilization, Disinfection and its validation. Staining methods– Simple, Differential and Special staining. Automated Microbial identification systems- Pure cultures techniques. Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres- National and International.	CO1 CO2 CO3 CO4 CO5	K1, K2, K4. K5, K6
UNIT-V	Biodiversity-Introduction to microbial biodiversity–Classification and applications of Thermophiles, Alkaliphiles Acidophiles, Barophiles and Halophiles. Methanogenes, Conservation of Biodiversity.	CO1 CO2 CO3 CO4 CO5	K1, K2, K4. K5, K6

Recommended Text Books

1. Kanunga R.(2017). Ananthanarayanan and Panicker’s Textbook of Microbiology. (10thEdition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Pelczar M.J.Jr. and KriegN.R. (2010). Microbiology. (5thEdition). Mc.GrawHill.Inc, NewYork.
3. Prescott L.M., HarleyJ.P. and KleinD.A. (2004). Microbiology. (6thEdition). McGraw-Hillcompany,NewYork.
4. White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5. Dubey R.C. and Maheshwari D.K. (2022). Textbook of Microbiology (5th Edition).S.Chand, Limited.

Reference Books

1. Tortora G.J., Funke B.R. and Case C.L. (2015). Microbiology: An Introduction (12thEdition). Pearson, London, United Kingdom
2. Webster J.and Weber R.W.S.(2007). Introduction to Fungi. (3rdEdition).Cambridge University Press, Cambridge.
3. Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California.
4. Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2ndEdition). Books / Cole Thomson Learning, UK.
5. Madigan M.T., Bender K.S., Buckley D.H.Sattley W.M. and Stahl (2018) Brock Biology of Microorganisms. (15thEdition). Pearson.

Website and e-learning source

1. <http://sciencenetlinks.com/tools/microbeworld>
2. <https://www.microbes.info/>
3. <https://www.asmscience.org/VisualLibrary>
4. <https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404>
5. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Examine various microbes employing the microscopic techniques Learnt. Measure and compare the size of microbes.	K1, K4,K5
CO2	Differentiate and appreciate the anatomy of various microbes. Plan The growth of microbes for different environmental conditions.	K2,K6
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its Economic importance.	K1,K2, K4,
CO4	Create aseptic conditions by following good laboratory practices.	K1,K2,K6
CO5	Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.	K4,K6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	2	2	2	3	1	3	2	2
CO2	3	2	1	1	1	2	2	1	-	1	3	2	3
CO3	2	2	1	2	1	1	3	2	-	1	3	2	3
CO4	3	2	2	2	2	2	2	3	1	2	3	2	3
CO5	2	2	2	2	2	2	1	1	1	1	3	2	3

COURSE DESCRIPTORS

Title of the Course	Immunology, Immunomics and Microbial Genetics	Hours/Week	07
Course Code	APCMB12	Credits	05
Category	Core Course II	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
- Describe immunoglobulin and its types. Categorize MHC and understand its significance.
- Elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
- Acquire knowledge the structure DNA in prokaryotes and eukaryotes
- Explain out gene transfer studies in microbes.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction to biology of the immune system – Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity and Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules. Antigen processing and presentation to T- lymphocytes.	CO1 CO2 CO5	K1 K2 K3 K4 K5
UNIT-II	Immunoglobulins. Theories of antibody production. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR– various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.	CO1 CO2 CO3 CO4	K1 K2 K3 K4 K5
UNIT-III	Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO and Rh System. Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Agglutination- Labeled Assay- Immuno fluorescence assay, Radio immunoassay, ELISA. Introduction to Vaccines and Adjuvants - Types of vaccines. Immunomics - Introduction and Applications. Reverse vaccinology.	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

UNIT-IV	Structure of prokaryotic and eukaryotic genome. Introduction to prokaryotic genomic structure, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications- methylation, acetylation, phosphorylation.	CO4 CO5	K1 K2 K3 K4
UNIT-V	Gene Transfer Mechanisms- Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition, Mechanism and Types of Transposition reactions.	CO4 CO5	K1 K2 K3 K4

Recommended Text Books

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. Malacinski G.M. (2008). Freifelder’s Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.
5. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd.

Reference Books

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). Wiley-Blackwell.
4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.
5. Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.

Website and e-learning source

1. <https://www.ncbi.nlm.nih.gov/books/NBK279395/>
2. <https://med.stanford.edu/immunol/phd-program/ebook.html>
3. <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/>
4. [Lehninger Principles of Biochemistry \(8th Edition\) By David L. Nelson and Michael M. Cox Book Free Download – Study Materialz.in](https://www.studydrive.net/books/lehninger-principles-of-biochemistry-8th-edition-by-david-l-nelson-and-michael-m-cox-book-free-download-study-materialz.in)
5. <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity.	K1, K4
CO2	Justify the significance of MHC molecules in immune response and antibody production.	K1,K2,K5
CO3	Design antibodies and evaluate immunological assays in patient samples.	K5, K6
CO4	Analyze genomic DNA of prokaryotes and eukaryotes.	K1, K4
CO5	Summarize gene transfer mechanisms for experimental study.	K2,K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	2	1	2	1	1	2	2	2
CO2	2	2	3	2	2	2	1	1	1	1	3	2	2
CO3	2	2	3	2	2	2	2	-	1	2	3	2	3
CO4	3	2	2	3	2	2	1	2	-	1	3	2	3
CO5	3	2	2	2	3	2	1	1	1	2	3	2	3

COURSE DESCRIPTORS

Title of the Course	Practical I	Hours/Week	06
Course Code	APCPMB13	Credits	04
Category	Core Course III-Practical I	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.
- Prepare media for bacterial growth. Discuss plating and growth measurement techniques.
- Acquire adequate skills to perform blood grouping and serological reactions.
- Provide fundamentals skills in preparation, separation and purification of Immunoglobulin.
- Apply the knowledge of molecular biology skills in clinical diagnosis.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy – Motility. Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method. Staining techniques - Simple staining, Gram's staining, Acid fast staining, Spore, Capsule, Flagella.	CO1 CO2	K1 K2 K3
UNIT-II	Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities. Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Anaerobic culture methods.	CO1 CO2 CO3	K1 K2 K3
UNIT-III	Hematological reactions - Blood Grouping – forward and reverse, Rh Typing Identification of various immune cells by morphology – Leishman staining. Agglutination Reactions- Latex Agglutination reactions- RF, ASO. Detection of HBs Ag by ELISA. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID) Immuno-electrophoresis - Rocket immuno electrophoresis and counter current immuno electrophoresis.	CO2 CO3 CO4	K3 K4 K5 K6

UNIT-IV	Preparation of lymphocytes from peripheral blood by density gradient centrifugation.	CO2 CO3 CO4	K3 K4 K5 K6
UNIT-V	Western Blotting – Demonstration. Isolation of genomic DNA from <i>E.coli</i> and analysis by agarose gel electrophoresis Estimation of DNA using colorimeter (Diphenylamine reagent) Separation of proteins by polyacrylamide gel electrophoresis(SDS-PAGE). Plasmid DNA isolation from <i>E.coli</i> . RNA estimation by Orcinol method.	CO1 CO5	K1 K2 K3 K4 K5

Recommended Text Books

1. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2. Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6thEdition). Pearson Education, Publication, New Delhi.
3. Cullimore D.R.(2010).Practical Atlas for Bacterial Identification. (2ndEdition).-Taylor &Francis.
4. Rich R. R., Fleisher T. A., Shearer W. T., Schroeder H, Frew A. J. and Weyand C. M. (2018). Clinical Immunology: Principles and Practice. (5thEdition). Elsevier.
5. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5thEdition). ASM Press.

Reference Books

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14thEdition). Elsevier, New Delhi.
2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7thEdition). John Wiley and Jones, Ltd.
4. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rdEdition). John Wileys and Sons Ltd. 2012.
5. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2ndEdition). Narosa Publishing Home Pvt Ltd.

Website and e-learning source

1. <http://textbookofbacteriology.net/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/>
3. <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-005/pages/lecture-notes/>
4. Lehninger Principles of Biochemistry (8thEdition) By David L. Nelson and Michael M. Cox Book Free Download – StudyMaterialz.in
5. <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Apply microscopic techniques and staining methods in the identification and differentiation of microbes.	K1, K2, K3
CO2	Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	K1,K2,K3
CO3	Perform and evaluate immunological reactions to aid diagnosis.	K4, K5
CO4	Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	K3, K6
CO5	Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	K1,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	3	1	2	2	2	3
CO2	2	2	2	2	1	2	1	1	1	1	2	2	2
CO3	2	2	2	3	2	1	1	-	2	2	3	2	3
CO4	2	1	1	2	2	3	2	1	1	1	3	2	2
CO5	3	1	2	3	3	1	1	2	-	2	2	2	3

COURSE DESCRIPTORS

Title of the Course	Forensic Science	Hours/Week	05
Course Code	APEMB14A	Credits	03
Category	Elective Course I (Choice-1)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Understand the Scope, need and learn the tools and techniques in forensic science.
- Comprehend organizational setup of a forensic science laboratory.
- Identify and examine body fluids for identification.
- Extract DNA from blood samples for investigation.
- Recognize medico legal postmortem procedures and their importance.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.	CO1 CO2 CO3 CO5	K1 K2 K3 K4 K6
UNIT-II	Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.	CO1 CO2 CO3	K1 K2 K4 K6
UNIT-III	Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fiber.	CO1 CO2 CO3 CO4	K1 K4 K6
UNIT-IV	DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.	CO1 CO2 CO3 CO4 CO5	K1 K2 K4 K6
UNIT-V	Forensic toxicology - Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action.	CO4 CO5	K1 K2 K4

Recommended Text Books

1. Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN- 10:8190113526 / ISBN-13:9788190113526.
2. James S. H. and Nordby, J. J. (2015) Forensic Science: An Introduction to Scientific and Investigative Techniques. (5thEdition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3. Li R. (2015) Forensic Biology. (2ndEdition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4. Sharma B.R (2020) Forensic science in criminal investigation and trials. (6thEdition)Universal Press.
5. Richard Saferstein (2017). Criminalistics- An introduction toForensic Science. (12thEdition).Pearson Press.

Reference Books

1. Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, NewYork. ISBN: 0-8493-8122-3.
2. Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3rdEdition).CRC Press, New York. ISBN-10:1498720196.
3. Lincoln, P.J. and Thomson, J. (1998). (2ndEdition). Forensic DNA Profiling Protocols.Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4. Val McDermid (2014). Forensics. (2ndEdition). ISBN 9780802125156.
5. Vincent J. DiMaio., DominickDiMaio. (2001). Forensic Pathology (2ndEdition). CRCPress.

Website and e-learning source

1. <http://clsjournal.ascls.org/content/25/2/114>
2. <https://www.ncbi.nlm.nih.gov/books/NBK234877/>
3. <https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8>
4. https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics
5. <https://cisac.fsi.stanford.edu/events/microbialforensics>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Identify the scope and need of forensic science in the present scenario.	K1
CO2	Plan for the organizational setup and functioning of forensic science laboratories.	K1,K2, K6
CO3	Analyze the biological samples found at the crime scene.	K4
CO4	Perform extraction and identification of DNA obtained from body fluids.	K1, K4
CO5	Discuss the concept of forensic toxicology.	K1, K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	1	1	2	1	3	2	3
CO2	2	2	3	2	2	3	2	1	-	2	2	2	2
CO3	3	2	2	2	2	3	1	2	1	1	2	2	3
CO4	2	2	2	2	2	2	1	1	1	1	2	2	2
CO5	2	2	2	3	2	2	2	1	2	1	2	2	2

COURSE DESCRIPTORS

Title of the Course	Health and Hygiene	Hours/Week	05
Course Code	APEMB14B	Credits	03
Category	Elective Course I (Choice-2)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Acquire knowledge on hygiene and live healthy.
- Provide insights on health laws for food safety and hygiene.
- Explain health, physical exercises and their importance.
- Illustrate mental hygiene and involved in mental hygiene.
- Describe the various health and health education programmes by the government.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction to hygiene and healthful live. factors affecting health, health habits, and practices. Recognizing positive and negative practices in the community. Scientific principles related to health.	CO1 CO2 CO5	K1 K3 K5
UNIT-II	Nutrition and Health – Balanced diet, Food surveillance, food Fortification, adulteration and preventive measures. Health laws for food safety. Environmental and housing hygiene. Ventilation and lighting.	CO1 CO2 CO3 CO5	K1 K2 K3 K5
UNIT-III	Physical health, physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief. International control of health, WHO. Personal hygiene, Sun bathing, Colon Hygiene. Health destroying habits and addictions - Pan, supari, ganja, drinking, smoking, tea and coffee.	CO1 CO3 CO4 CO5	K1 K2 K3
UNIT-IV	Mental hygiene - factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adulthood and old age. Mental health occupational hazards.	CO4 CO5	K1 K2 K3

UNIT-V	Health programme and health education – Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive and Child health programmes (RCH).	CO5	K1, K3
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Recommended Text Books

1. Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4thEdition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Swaminathan (1995) Food & Nutrition (Vol I) (2nd Edition). The Bangalore Printing & Publishing Co Ltd., Bangalore.
3. Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10thEdition). Universities Press (India) Pvt. Ltd
4. Lindsay Dingwall.(2010). Personal Hygiene CarePrint ISBN:9781405163071 Online ISBN:9781444318708|DOI:10.1002/9781444318708
5. Walter C. C. Pakes(1900). The Science of Hygiene: a Text-book of Laboratory Practice. (London: Methuen and Co.,).

Reference Books

1. Khader V. (2000) Food, Nutrition and Health, Kalyan Publishers, New Delhi.
2. Srilakshmi, B. (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi.
3. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4. Park K. 2007, Park’s text book of Preventive and Social Medicine, Banarsidas Bhanot publishers, India.
5. Srilakshmi, 2002, Dietetics, New Age Publications, India.

Website and e-learning source

1. HealthandHygiene-PersonalHygiene,CommunityHygieneandDiseases(vedantu.com)
2. Chapter-32.pdf(nios.ac.in)
3. MenstrualHealthandHygieneGuide|StudentHealthandCounselingServices(ucdavis.edu)
4. <https://nap.nationalacademies.org/read/11756/chapter/13>
5. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Identify factors affecting health and health habits.	K1
CO2	Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.	K1,K2, K5
CO3	Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.	K1, K2
CO4	Explore Mental hygiene and maintain emotional stability.	K1, K2
CO5	Participate in health education programmes	K1,K2, K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2	2	1	3	3	2	2	3
CO2	3	2	2	2	2	2	2	2	1	2	3	3	3
CO3	2	2	3	2	2	2	1	1	2	3	3	2	3
CO4	2	2	2	2	2	2	1	-	1	2	3	2	3
CO5	3	2	2	2	2	2	1	2	2	1	3	2	3

COURSE DESCRIPTORS

Title of the Course	Microalgal Technology	Hours/Week	05
Course Code	APEMB14C	Credits	03
Category	Elective Course I (Choice-3)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Characterize the different groups of algae.
- Describe the cultivation and harvesting of algae.
- Identify the commercial applications of various algal products.
- Apply microalgae for environmental applications.
- Employ microalgae as alternate fuels.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction to Algae - General characteristics. Classification of algae. Salient features of different groups of algae. Distribution - Freshwater, brackish water and marine algae. Identification methods.	CO1 CO2	K1 K2 K4
UNIT-II	Cultivation of freshwater and marine microalgae - Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting of microalgae biomass.	CO1 CO2	K1 K2 K4
UNIT-III	Microalgae in food and nutraceutical applications - Algal single cell proteins. Cultivation of Spirulina. Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications.	CO1 CO2 CO3	K1 K3 K4
UNIT-IV	Microalgae in environmental applications. Phycoremediation - Domestic and industrial wastewater treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Algal blooms, algicides for algal control.	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5 K6
UNIT-V	Microalgae as feed stock for production of biofuels - Carbon-neutral fuels. Lipid-rich algal strains – <i>Botryococcus braunii</i> . Drop-in fuels from algae - hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass.	CO3 CO5	K1 K2 K3 K5

Recommended Text Books

1. Lee R.E. (2008). Phycology. Cambridge University Press.
2. Sharma O.P. (2011). Algae. Tata McGraw-Hill Education.
3. Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.
4. Lele. S.S., JyothiKishen Kumar (2008). Algal bio process technology. New Age International P(Ltd)
5. Das., Mihirkumar. Algal Biotechnology. Daya Publishing House, New Delhi.

Reference Books

1. Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.
2. Bux F. (2013). Biotechnological Applications of Microalgae: Biodiesel and Valueadded Products. CRC Press.
3. Singh B., Baudhdh K., Bux, F. (2015). Algae and Environmental Sustainability. Springer.
4. Das D. (2015). An algal biorefinery: An integrated approach. Springer.
5. Bux F. and Chisti Y. (2016). Algae Biotechnology: Products and Processes. Springer.

Website and e-learning source

1. <https://www.classcentral.com/course/algae-10442>
2. https://onlinecourses.nptel.ac.in/noc19_bt16/preview
3. <https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46>
4. <https://nptel.ac.in/courses/103103207>
5. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Acquire knowledge in the field of microalgal technology and their characteristics.	K1,K2
CO2	Identify the methods of algal cultivation and harvesting.	K1, K2,K4
CO3	Recognize and recommend the use of microalgae as food, feed and fodder.	K1.K2, K3
CO4	Promote microalgae in phycoremediation.	K1,K2,K3,K6
CO5	Compare and critically evaluate recent applied research in these microalgal applications.	K1, K2, K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	2	2	1	1	3	2	3
CO2	2	2	2	2	2	3	2	2	1	2	3	2	3
CO3	2	2	2	2	2	2	1	2	2	3	3	3	3
CO4	2	2	2	2	2	2	2	2	1	1	3	2	3
CO5	3	2	3	2	2	2	2	2	1	1	3	2	3

COURSE DESCRIPTORS

Title of the Course	Bioinstrumentation	Hours/Week	05
Course Code	APEMB15A	Credits	03
Category	Elective Course II (Choice-1)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Explain the principles and working mechanisms of laboratory instruments.
- Discuss chromatography techniques and molecular biology techniques.
- Illustrate molecular techniques in biological applications.
- Acquire knowledge on spectroscopic techniques
- Demonstrate the use of radioisotopes in various techniques.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Basic laboratory Instruments. Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation co-efficient; Applications in determination of molecular weight.	CO1 CO5	K1, K2, K3
UNIT-II	General principles of chromatography - Chromatographic Performance parameters; Types- Thin layer chromatography, Paper Chromatography, Adsorption, ion exchange, Gel filtration, affinity. Flash Chromatography and Ultra Performance convergence chromatography. Two dimensional chromatography. Stimulated moving bed chromatography (SEC).	CO1 CO2	K1, K2, K3
UNIT-III	Electrophoresis: General principles - moving boundary electrophoresis - electrophoretic mobility – supportive materials – electro endosmosis – types (horizontal, vertical and two dimensional electrophoresis) - Principle and applications - paper electrophoresis, starch gel electrophoresis, Disc gel, Agarose gel, SDS – PAGE, Immuno electrophoresis. Blotting techniques -Southern, northern and western blotting.	CO1 CO3 CO4	K2 K3 K5

UNIT-IV	Spectroscopic techniques: Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer, NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH.	CO1 CO4	K1,K2,K3 K5
UNIT-V	Radioisotopic techniques: Principle and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity. Geiger- Muller and Scintillationcounters, auto radiography and its applications- safety aspects.	CO1 CO4 CO5	K1,K2,K3 K5

Recommended Text Books

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. (3rdEdition). Prentice Hall.
5. Jayaraman J. (2011). Laboratory Manual in Biochemistry. (2ndEdition). Wiley Eastn Ltd., New Delhi.

Reference Books

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

Website and e-learning source

1. <https://norcaloa.com/BMIA>
2. <http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction- types-uses-and-other-details-with-diagram/12489>
3. <https://www.watelectrical.com/biosensors-types-its-working-and-applications>.
4. <http://www.wikiscales.com/articles/electronic-analytical-balance/>
5. <https://study.com/academy/lesson/what-is-chromatography-definition-types-uses>.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Make use of the laboratory instruments- laminar air flow, pH meter, centrifugation methods, biosafety cabinets following SOP.	K1,K2,K3
CO2	Apply chromatography techniques in the separation of biomolecules.	K1,K2,K3
CO3	Perform molecular techniques like mutagenesis and their detection.	K1,K2,K4
CO4	Estimate molecules in biological samples by adopting UV spectroscopic techniques.	K1,K2,K3,K5
CO5	Cultivate organisms anaerobically.	K1,K2,K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	1	-	1	1	2	2	3
CO2	2	2	2	2	2	2	2	2	2	1	3	2	3
CO3	3	2	2	2	2	2	2	2	1	2	3	2	3
CO4	3	2	2	2	2	2	1	1	-	2	3	2	3
CO5	2	3	2	2	2	2	2	2	-	1	3	2	S

COURSE DESCRIPTORS

Title of the Course	Herbal Technology and Cosmetic Microbiology	Hours/Week	05
Course Code	APEMB15B	Credits	03
Category	Elective Course II (Choice2)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- Impart knowledge of Indian Medicinal Plants and their applications in microbiology.
- Promote the technical skills involved in preparation of different types of plant extracts.
- Explain methods to analyze the antimicrobial activity of medicinal plants.
- Acquire knowledge on cosmetic microbiology and role of microorganisms in cosmetics.
- Gain insight into pharmacopeial microbial assays and biosafety.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Herbs, Herbal medicine - Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.	CO1 CO2 CO3	K1 K2 K5
UNIT-II	Collection and authentication of selected Indian medicinal plants: <i>Embllica officinalis</i> , <i>Withania somnifera</i> , <i>Phyllanthusamarus</i> , <i>Tinosporacordifolia</i> , <i>Andrographispaniculata</i> , <i>Piper longum</i> , <i>Ocimum sanctum</i> , <i>Azardirchata indica</i> , <i>Terminalia chebula</i> , <i>Allium sativum</i> . Preparation of extracts- Hot and cold methods. Preparation of stock solutions.	CO1 CO2 CO3	K1 K2 K5
UNIT-III	Antimicrobial activity of selected Indian medicinal Plants: - In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/ parts – well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.	CO2 CO3	K1 K2 K5
UNIT-IV	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.	CO3 CO4 CO5	K2 K4 K5

UNIT-V	Cosmetic microbiology test methods - Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods - bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics – Global regulatory and toxicological aspect of cosmetic preservatives.	CO3 CO4 CO5	K2 K4 K5
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Recommended Text Books

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

Reference Books

1. Indian Herbal Pharmacopoeia (2002). Vol. I &II Indian Drug Manufacturers Association, Mumbai.
2. British Herbal Pharmacopoeia.(1990).Vol.I. British Herbal Medicine Association.ISBN: 0903032090.
3. Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (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.

Website and e-learning source

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/>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Identify the applications of Indian medicinal plants in treating diseases.	K1,K2, K3
CO2	Identify and authenticate herbal plants.	K1,K2,K3
CO3	Evaluate the antimicrobial activity of medicinal plants.	K1,K2,K5
CO4	Describe the role of microorganisms and their metabolites in the preparation of cosmetics.	K1,K2
CO5	Validate procedures and biosafety measures in the mass production of cosmetics.	K1,K2,K4, K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	3	1	1	3	2	3	3
CO2	2	2	2	2	2	3	2	3	1	3	3	3	3
CO3	3	2	2	2	2	2	1	1	-	2	3	2	3
CO4	2	2	2	2	3	2	1	-	-	2	3	2	3
CO5	3	2	2	2	2	2	2	2	1	2	3	2	3

COURSE DESCRIPTORS

Title of the Course	Essentials of Laboratory Management and Biosafety	Hours/Week	05
Course Code	APEMB15C	Credits	03
Category	Elective Course II (Choice3)	Year & Semester	I & I
Prerequisites	B.Sc., MICROBIOLOGY	Regulation	2024

Objectives of the course:

- To utilize containment principles to ensure biosafety.
- To enrich the student role and responsibilities of laboratory hazards and their control.
- To know the importance of first aid technique for various common lab accidents.
- To acquire knowledge of biosafety level, risk assessment and maintain proper hygiene in the laboratory.
- To discuss the biosafety regulations and guidelines and implementation of safety programs.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction to the laboratory and laboratory hazards -General laboratory facilities – Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan.	CO1 CO2 CO3 CO4 CO5	K1 K3 K5 K6
UNIT-II	Common hazards in laboratory: Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling- Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Potential ignition sources in the lab. Stages of Fire. Fire Extinguishers. Fire Response.	CO3 CO4	K1,K3
UNIT-III	Prevention and First aid for laboratory accidents. Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

UNIT-IV	Biosafety - Historical background. Blood bore pathogens (BBP) and laboratory - acquired infections. Introduction to biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms. Recommended biosafety. Levels for infectious agents and infected animals. Risk groups with examples - Risk assessment. Safety levels. Case studies - Safe working, hand hygiene. Laboratory instruments, packing, sending, transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization.	CO4 CO5	K3 K5
UNIT-V	Biosafety regulations and guidelines. Centers for disease control and prevention and the National institutes of health. Occupational safety and health administration. Recombinant DNA advisory committee (RDAC), Institutional biosafety committee (IBSC), Review committee on genetic manipulation (RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines.	CO4 CO5	K3 K5

Recommended Text Books

1. Sateesh M. K. (2013). Bioethics and Biosafety, IK International Pvt Ltd. ISBN : 8190675702.
2. Muthuraj M. and Usharani B. (2019). Biosafety in Microbiological Laboratories. (1stEdition). Notion Press. ISBN 10: 1645878856
3. Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services. (2016). (5thEdition). Lulu.com.
4. Kanai. L. Mukherjee. (Medical Laboratory Technology(4thEdition). CBS Publishers.
5. Ramakrishnan (2012). Manual of Medical Laboratory Techniques. JP brothers.

Reference Books

1. World Health Organization, Biosafety programme management. (2010). (4thEdition). WHO Publications.
2. Rashid N. (2013). Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1stEdition).
- 3 Dayuan X. (2015). Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, ISBN-10 : 1842657917
4. Ochei J. Kolhatkar(2000). A. (Medical Laboratory Science – Theory and Practice. ISBN; 13:978-0074632239.
5. Lynne S. Garcia. Clinical Laboratory Management (2ndEdition). ASM Press.

Website and e-learning source

1. <https://www.cdc.gov/labs/pdf/CDCBiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf>
2. https://ucanapplym.s3.ap-south-1.amazonaws.com/RGU/notifications/E_learning/online_study/PG-SEM-IVBiosafety%20regulation.pdf
3. <https://consteril.com/biosafety-levels-difference/>
4. <https://www.cdc.gov/labs/pdf/CDCBiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf>
5. <https://www.who.int/publications/i/item/9789240011311>

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Employ skills on laboratory safety and avoid laboratory accidents	K1,K2
CO2	Prevent laboratory hazards by practicing safety strategies.	K1,K2,K3,K6
CO3	Practice various first aid procedures during common laboratory accidents.	K1,K3
CO4	Ensure biosafety strategies in laboratory.	K1,K3
CO5	Recognize the importance of biosafety guidelines.	K1,K2,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	2	1	2	2	3	2	3
CO2	3	2	2	2	2	2	2	1	2	3	3	2	3
CO3	3	2	2	2	2	2	2	1	1	3	3	2	3
CO4	3	2	2	2	2	3	2	1	-	3	2	2	3
CO5	2	2	2	2	2	2	2	-	-	2	3	2	3