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.

VISIONOF THE COLLEGE

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

MISSIONOF THE COLLEGE

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

QUALITY POLICYOF 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 peace 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 Enhancement Course II	APSMB36	Organic Farming and Bio fertiliser Technology	3	2	25	75	100
		Compulsory	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 oroverview
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-*Chlamydomonas*, *Volvox* (Greenalgae), *Nostoc* and *Spirulina (Cyanobacteria), Sargassum* (Brownalgae), *Polysiphonia* and *Porphyridium* (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 ofvaccines. 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. LehningerPrinciplesofBiochemistry(8thEdition)ByDavidL.NelsonandMichaelM.CoxBookFreeDownload–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	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 *E.coli* 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 *E.coli.* 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. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6thEdition). Pearson Education, Publication, New Delhi.
3. CullimoreD.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 andApplications 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. OxfordUniversity Press.
3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7thEdition). John Wiley andJones, 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 eon 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. actors 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

Recommended Text Books

1. Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of HumanNutrition. (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:9781405163071Online 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, BanarsidasBhanot 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 andtheir 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 – *Botryococcus braunii*. 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., Bauddh 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 Eastrn 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- laminarair 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: *Emblica officinalis*, *Withania somnifera*, *Phyllanthusamarus*, Tinosporacordifolia, Andrographispaniculata, *Piper longum*, *Ocimum sanctum*, *Azardirchata indica*, *Terminalia chebula*, *Allium sativum*. 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

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). CRCPress. 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 forbiohazards. 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 advisorycommittee(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. (1st Edition). Notion Press. ISBN 10: 1645878856
3. Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services. (2016). (5th Edition). Lulu.com.
4. Kanai. L. Mukherjee. (Medical Laboratory Technology(4th Edition). CBS Publishers.
5. Ramakrishnan (2012). Manual of Medical Laboratory Techniques. JP brothers.

Reference Books

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

COURSE DESCRIPTORS

Title of the Course	**Medical Bacteriology and Mycology**	**Hours/Week**	06
Course Code	**APCMB21**	**Credits**	05
Category	**Core Course IV**	**Year &Semester**	I & II
Prerequisites		**Regulation**	2024

Objectives of the course:

- Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.
- Explain morphology, characteristics and pathogenesis of bacteria.
- Discuss various factors leading to pathogenesis of bacteria.
- Acquire knowledge on antifungal agents and their importance.
- Describe various diagnostic methods available for fungal disease diagnosis.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci, Streptococci, Pneumococci, Neisseriae., Bacillus, Corynebacteria, Mycobacteria* and *Clostridium.* Nosocomial, zoonotic and opportunistic infections -prevention and control.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members- *E.coli, Klebsiella, Salmonella, Shigella, Proteus, Pseudomonas, Vibrio, Yersinia, , Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella., Spirochaetes-Leptospira, Treponema and Borrelia.*	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-IV	Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. *Trichophyton, Epidermophyton & Microsporum.* Yeasts of medical importance – *Candida, Cryptococcus*. Mycotoxins. Antifungal agents, testing methods and quality control.	CO1 CO4 CO5	K1 K2 K4 K5 K6

UNIT-V	Dimorphic fungi causing Systemic mycoses, *Histoplasma, Coccidioides, Sporothrix, Blastomyces.* Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents.	CO1 CO4 CO5	K1 K2 K4 K5 K6

Recommended Text Books

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.
2. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
3. Finegold, S. M. (2000) Diagnostic Microbiology, (10th Edition). C.V. Mosby Company, St. Louis.
4. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology, (4th Edition). Wiley Publishers.
5. Chander J. (2018). Textbook of Medical Mycology. (4th Edition). Jaypee brothers Medical Publishers.

Reference Books

1. Salle A. J. (2007). Fundamental Principles of Bacteriology. (4th Edition). Tata McGraw-Hill Publications.
2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14thedn, Churchill Livingston.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn.Cambridge University Press.
4. Topley and Wilson's. (1998). Principles of Bacteriology.9thedn. Edward Arnold, London.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology.Pfaller. 7thedn. Elsevier, Mosby Saunders.

Website and e-learning source

1. http://textbookofbacteriology.net/ndh
2. https://microbiologysociety.org/members-outreach-resources/links.html
3. https://www.pathelective.com/micro-resources
4. http://mycology.cornell.edu/fteach.html
5. https://www.adelaide.edu.au/mycology/

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	Collect, transport and process of various kinds of clinical specimens.	K1,K2,K3,K4,K5, K6
CO2	Analyze various bacteria based on morphology and pathogenesis.	K1,K2,K3,K4
CO3	Discuss various treatment methods for bacterial disease.	K1,K2,K3,K4
CO4	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents.	K1,K2,K3,K4,K5, K6
CO5	Apply various immunodiagnostic method to detect fungal infections.	K1,K2,K3,K4,K5, K6

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

COURSE DESCRIPTORS

Title of the Course	**Medical Virology and Parasitology**	**Hours/Week**	06
Course Code	**APCMB22**	**Credits**	05
Category	**Core Course V**	**Year &Semester**	I & II
Prerequisites		**Regulation**	2024

Objectives of the course:

- Describe the replication strategy and cultivation methods of viruses.
- Acquire knowledge about oncogenic virus and human viral infections.
- Develop diagnostic skills, in the identification of virus infections.
- Impart knowledge about parasitic infections.
- Develop diagnostic skills, in the identification of parasitic infections.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Virus Entry, Host Defenses Against Viral Infections, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, treatment for the following viruses: DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and reemerging viral infections	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics. Diagnosis of viral infections – conventional serological and molecular methods. Antiviral agents and viral vaccines.	CO1 CO2 CO3	K2 K3 K4
UNIT-IV	Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba,* Aerobic and Anaerobic amoebae, *Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania,* and *Trypanasoma.*	CO4 CO5	K1 K2 K3 K4

UNIT-V	Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia solium, T. saginata, T.Echinococcus*. Trematodes – *Fasciola Hepatica, Fasciolopsis buski, Paragonimus, Schistosomes*. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides* and *Wuchereria*. Other parasites causing infections in immune compromised hosts and AIDS.	CO4 CO5	K1 K2 K3 K4

Recommended Text Books

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.
3. Rajan S. (2007). Medical Microbiology. MJP publisher.
4. Paniker J. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi.
5. Arora, D. R. and Arora B. B. (2020). Medical Parasitology. (5th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

Reference Books

1. Carter J. (2001). Virology: Principles and Applications (1st Edition). Wiley Publications.
2. Willey J., Sandman K. and Wood D. Prescott's Microbiology. (11th Edition). McGraw Hill Book.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
4. Finegold S.M. (2000). Diagnostic Microbiology. (10th Edition). C.V. Mosby Company, St. Louis.

Website and e-learning source

1. https://en.wikipedia.org/wiki/Virology
2. https://academic.oup.com/femsre/article/30/3/321/546048
3. https://www.sciencedirect.com/science/article/pii/S0042682215000859
4. https://nptel.ac.in/courses/102/103/102103039/
5. https://www.healthline.com/health/viral-diseases#contagiousness

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	Cultivate viruses by different methods and aid in diagnosis. Perform purification and viral assay.	K1,K3,K4
CO2	Investigate the symptoms of viral infections and presumptively identify the viral disease.	K1,K2,K4
CO3	Diagnose various viral diseases by different methods.(serological, conventional and molecular)	K2,K3,K4
CO4	Educate public about the spread, control and prevention of parasitic diseases.	K2,K3,K4
CO5	Identify the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.	K1,K2,K4

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

COURSE DESCRIPTORS

Title of the Course	Practical II	Hours/Week	06
Course Code	APCPMB23	Credits	04
Category	Core Course VI – Practical II	Year & Semester	I & II
Prerequisites		Regulation	2024

Objectives of the course:

- Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
- Impart knowledge on fungal infections and its diagnosis.
- Diagnose parasitic
- To gain knowledge about industrially important microbes.
- Screen and utilize microorganisms for effective industrial production of metabolites.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Staining of clinical specimens - Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria. Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.	CO1 CO2 CO3 CO4	K1 K2 K3 K4 K5
UNIT-II	Identification and Classification of common fungi. Mounting and staining of VAM spores. Examination of different fungi by Lactophenol cotton blue staining.Examination of different fungi by KOH staining. Cultivation of fungi by Slide culture Techniques and their identification. Microscopic observation of different asexual fungal spores. Microscopic observation of fungal fruiting bodies. Identification of Dermatophytes by KOH. Germ Tube Test for *Candida albicans.* Isolation and characterization of bacteriophage from sewage sources by phage titration. Cultivation of viruses –Egg Inoculation methods. Diagnosis of Viral Infections –ELISA –HIA. Spotters of viral inclusions and CPE-stained smears.	CO1 CO2 CO3	K1 K2 K3 K4

UNIT-III	Examination of parasites in clinical specimens - Ova/cysts in faeces. Concentration: methods – Floatation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods-Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. Identification of common arthropods of medical importance - spotters of *Anopheles, Glossina, Phlebotomus, Aedes,* Ticks and mites.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-IV	Good Laboratory Practices in Industrial Microbiology laboratory. Study of Bioreactor and its essential parts. Culturing and Characterization of microorganisms used in Dairy and Pharmaceutical industry. Screening for Enzyme producers (amylase /protease). Optimization of parameters for Amylase production. Screening for Organic acid producers (acetic acid/lactic acid). Screening for Antibiotic producers by crowded plate techniques.	CO1 CO2 CO3 CO4 CO5	K1 K3 K4 K5
UNIT-V	Immobilization of microbial cells and enzyme and its assessment. Microbiological assays of fermentation products. Microbiological assay of antibiotics by cup plate method and other methods. Sterility testing of pharmaceuticals.	CO4 CO5	K2 K3 K4 K5 K6

Recommended Text Books

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. Cappuccimo, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6thEdition). Pearson Education, Publication, New Delhi.
5. Morag C. and Timbury M.C. (1994).Medical Virology. 4th edn. Blackwell Scientific Publishers.

Reference Book

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 22ndEdition.Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders

Website and e-learning source

1. http://textbookofbacteriology.net/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
5. https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics- and-biotechnological-applications/vaccines-and-antiviral-agents

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	Collection of different clinical samples, transport, culture and examination.	K1,K2,K3,K4,K5
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	K1,K2,K3,K4
CO3	Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	K1,K2,K3,K4
CO4	Perform antibiotic sensitivity tests and compare with the standard tests.	K1,K3,K4,K5
CO5	Screening of industrially important microbes for metabolite production.	K2,K4,K5,K6

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

COURSE DESCRIPTORS

Title of the Course	EPIDEMIOLOGY	Hours/Week	03
Course Code	APEMB24A	Credits	03
Category	Elective Course III	Year & Semester	I&II
Prerequisites		Regulation	2024

Objectives of the course:

- Describe the role of epidemiology in public health
- Explain about epidemiology tools and disease surveillance methods.
- Analyze various communicable and non-communicable diseases in India.
- Discuss on mechanism of antimicrobial resistance.
- Outline on National health programmes that have been designed to address the issues.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Fundamentals of epidemiology - Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission -Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Tools of Epidemiology - Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology - Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies - Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.	CO1 CO2 CO3	K2 K3 K4
UNIT-III	Epidemiological aspects of diseases of national importance - Background to communicable and non-communicable diseases. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Malaria, Avian flu, Swine Flu. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.	CO3 CO4	K2 K3 K4
UNIT-IV	Mechanisms of Antimicrobial resistance - Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Hospital acquired infections - Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of *Acinetobacter*, *Clostridium difficile*, HCV,*Cryptosporidium.*	CO4 CO5	K2 K3 K4

UNIT-V	National Programmes related to Communicable and Non-Communicable diseases - National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, Vector Borne Disease Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme. Biochemical and immunological tools in epidemiology - Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Curie Point PyMS (Pyrolysis Mass spectrometry), Protein profiling, Molecular typing methods.	CO3 CO5	K2 K4 K5

Recommended Text Books

1. Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of Epidemiology in Public Health Practice., (3rd Edition). CDC.
2. Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
4. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
5. Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology.5thedn. Blackwell Scientific Publishers.

Reference Books

1. Bhopal R. S. (2016).Concepts of Epidemiology - An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. (3rd Edition). Oxford University Press, New York.
2. Celentano D. D. and Szklo M. (2018). Gordis Epidemiology. (6th Edition). Elseiver, USA.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn.Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
5. Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London.

Website and e-learning source

1. https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en
2. https://hal.archives-ouvertes.fr/hal-00902711/document
3. https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/
5. https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_outbreaks.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	Apply the knowledge acquired on concepts of epidemiology to clinical and public health environment.	K1,K2,K3,K4
CO2	Plan various strategies to trace the epidemiology.	K1,K2,K3,K4
CO3	Plan the control of communicable and non-communicable diseases.	K2,K3,K4
CO4	Analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management.	K2,K3,K4
CO5	Employ National control programs related to Communicable and Non-Communicable diseases with the public.	K2,K4,K5

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

COURSEDESCRIPTORS

Title of the Course	**Clinical and Diagnostic Microbiology**	**Hours/Week**	03
Course Code	**APEMB24B**	**Credits**	03
Category	**Elective Course III**	**Year & Semester**	I &II
Prerequisites		**Regulation**	2024

Objectives of the course:

- Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
- Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
- Elucidate various diagnostic procedures in microbiology.
- Acquire knowledge on different methods employed to check antibiotic sensitivity.
- Gain knowledge on hospital acquired infections and their control measures.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Microbiology Laboratory Safety Practices -General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.	CO1 CO2	K1 K2 K3
UNIT-II	Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Diagnosis of microbial diseases - Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-IV	Antibiotic sensitivity tests - Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution - Agar dilution & broth dilution - MBC/MIC - Quality control for antibiotics and standard strains.	CO3 CO4	K3 K4

UNIT-V	Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.	CO3 CO5	K3 K4 K5

Recommended Text Books

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi. ISBN-10:0443047219 / ISBN-13-978-0443047213.
2. Tille P. M. (2021). Bailey and Scott's Diagnostic Microbiology. (15th Edition). Elsevier. ISBN:9780323681056.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
4. Mukherjee K.L. (2000). Medical Laboratory Technology.Vol. 1-3. (2nd Edition). Tata McGraw-Hill Education. ISBN-10:0074632604.
5. Sood R. (2009). Medical Laboratory Technology – Methods and Interpretations. (6th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN:9788184484496.

Reference Books

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Yolken R.H. (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. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7th Edition. Hodder Arnold Publication. ISBN-10:0340554231 / ISBN-13:9780340554234.
4. Koneman E.W., Allen S. D., Schreckenberg P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378.
5. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1 / ISBN-10:0-521-67631-

Website and e-learning source

1. https://www.ncbi.nlm.nih.gov/books/NBK20370/
2. https://www.msdmanuals.com/en-in/home/infections/diagnosis-of-infectious3disease/diagnosis-of-infectious-disease
3. https://journals.asm.org/doi/10.1128/JCM.02592-20
4. https://www.sciencedirect.com/science/article/pii/S2221169116309509
5. http://www.textbookofbacteriology.net/normalflora_3.html

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 Laboratory safety procedures and hospital waste disposal strategies.	K1,K2,K3,K4
CO2	Collect various clinical specimens, handle, preserve and process safely.	K1,K2,K3,K4
CO3	Plan the control of communicable and non-communicable diseases.	K1,K2,K3,K4
CO4	Assess the antimicrobial susceptibility pattern of pathogens.	K3,K4
CO5	Trace the sources of nosocomial infection and recommend control measures.	K3,K4,K5

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

COURSE DESCRIPTORS

Title of the Course	Bioremediation	Hours/Week	03
Course Code	APEMB24C	Credits	03
Category	Elective Course III	Year & Semester	I &II
Prerequisites		Regulation	2024

Objectives of the course:

- Describe the nature and importance of bioremediation and use in real world applications.
- Describe the typical composition of waste water and application of efficient technologies for water treatment.
- Explain the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.
- Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
- Familiarize the role of plants and their associated microbes in remediation and management of Environmental pollution.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Bioremediation - process and organisms involved. Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Microbes involved in aerobic and anaerobic processes in nature. Water treatment - BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents.	CO2 CO3	K2 K3 K4
UNIT-IV	Microbial leaching of ores - process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.	CO4 CO5	K3 K4 K5

UNIT-V	Phytoremediation of heavy metals in soil - Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.	CO4 CO5	K4 K5 K6

Recommended Text Books

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications. Tille P. M. (2021). Bailey and Scott's Diagnostic Microbiology. (15th Edition). Elsevier. ISBN:9780323681056.
2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.
3. Pichtel, J. (2014). WasteManagementPractices:Municipal,Hazardous,andIndustrial,2nd edition, CRC Press.
4. Liu,D.H.Fand Liptak,B.G(2005).Hazardous Wastes and Solid Wastes, Lewis Publishers.
5. Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJP Publishers

Reference Books

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1st Edition). Apple Academic Press.
2. Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.
3. Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.
4. Atlas, R.M &Bartha, R. (2000). Microbial Ecology. Addison Wesley Longman Inc.
5. Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1st edition. I.K. International Publishing House Pvt. Ltd.

Website and e-learning source

1. Bioremediation- Objective, Principle, Categories, Types, Methods, Applications (microbenotes.com)
2. https://agris.fao.org › agris-search
3. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation
4. https://www.intechopen.com/chapters/70661
5. https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CODescription	Cognitive Level
CO1	Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.	K1,K2,K3,K4
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.	K1,K2,K3,K4
CO3	Identify, formulate and design engineered solutions to environmental problems.	K1,K2,K3,K4
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.	K3,K4,K5
CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting *Rhizobacteria* in phytoremediation.	K4,K5,K6

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

COURSE DESCRIPTORS

Title of the Course	Bioinformatics	Hours/Week	03
Course Code	APEMB25A	Credits	03
Category	Elective Course IV	Year & Semester	I&II
Prerequisites		Regulation	2024

Objectives of the course:

- Discuss about various biological data mining concepts, tools.
- Elucidate the principles and applications of sequence alignment methods and tools.
- Demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.
- Acquaint with various approaches in predicting 3D and 2D structure of proteins.
- Describe various tools and techniques used in molecular docking, immune informatics and subtractive genomics.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Computational Protein Structure prediction – Secondary structure – Homology modelling- Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats- Molecular visualization tools.	CO3 CO4 CO5	K2 K3 K4 K5
UNIT-IV	Prediction of Properties of Ligand Compounds – 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds	CO4 CO5	K4 K5 K6

UNIT-V	Molecular Docking- Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.	CO4 CO5	K4 K5 K6

RecommendedTextBooks

1. Lesk A. M. (2002). Introduction to Bioinformatics. (4th Edition). Oxford University Press.
2. Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley- VCH.
3. Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4th Edition). Prentice-Hall of India Pvt.Ltd.
4. Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addision Wesley Longman Limited, England.
5. Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2nd edn.CBS Publishers, New Delhi.

Reference Books

1. Baxevanis A. D. and Ouellette F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (2nd Edition). John Wiley and Sons.
2. Bosu O. and Kaur S. (2007). Bioinformatics - Database, Tools, and Algorithms. Oxford University Press.
3. David W. M. (2001). Bioinformatics Sequence and Genome Analysis (2nd Edition). CBS Publishers and Distributors(Pvt.)Ltd.
4. Xiong J, (2011). Essential bioinformatics, First south Indian Edition, Cambridge University Press.
5. Harshawardhan P.Bal, (2006). Bioinformatics Principles and Applications, Tata McGraw-Hill Publishing Company Limited.

Website and e-learning source

1. https://www.hsls.pitt.edu/obrc/
2. https://www.hsls.pitt.edu/obrc/index.php?page=dna
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4. https://www.ebi.ac.uk/
5. https://www.kegg.jp/kegg/kegg2.html

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

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

COURSE DESCRIPTORS

Title of the Course	Nanobiotechnology	Hours/Week	03
Course Code	APEMB25B	Credits	03
Category	Elective Course IV	Year & Semester	I&II
Prerequisites		Regulation	2024

Objectives of the course:

- Analyze nanomaterials based on the understanding of nanobiotechnology.
- Discuss the methods of fabrication of nanomaterials.
- Gain Knowledge on characterization of nanomaterials.
- Discover nanomaterials for targeted drug delivery.
- Explain nanomaterials in nanomedicine and environmental pollution.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Introduction to nanobiotechnology, Nano size-changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials),Class of nanomaterials and their applications. Need for nanomaterials and the risks associated with the materials.	CO1 CO2	K1 K2 K3
UNIT-II	Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Characterization of nanoparticles – Based on particle size/morphology- Dynamic light scattering (DLS),Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy(AFM), Based on surface charge-zeta potential, Based on structure –X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX),Based on optical properties- UV – Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer(VSM).	CO3 CO4	K3 K4 K5
UNIT-IV	Nanomaterial based Drug delivery and therapeutics-surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxidenano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.	CO4 CO5	K4 K5 K6

UNIT-V	Nanomaterials in diagnosis-Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.	CO4 CO5	K4 K5 K6

Recommended Text Books

1. Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
2. Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
3. Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.
4. Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.
5. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.

Reference Books

1. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
2. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
3. Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
4. Rehm, B. (2006). Microbial Bionanotechnology: Biological Self-Assembly Systems and Biopolymer-Based Nanostructures. Horizon Scientific Press.
5. Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press

Websiteande-learningsource

1.https://www.gale.com/nanotechnology
2.https://www.understandingnano.com/resources.html
3.http://dbtnanobiotech.com/index2.php
4.http://www.istl.org/11-winter/internet1.html
5https://www.cdc.gov/niosh/topics/nanotech/default.html

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 knowledge in the field of nanobiotechnology for development.	K1,K2,K3
CO2	Identify various applications of nanomaterials in the field of medicine and environment.	K1,K2,K3,K4
CO3	Examine the prospects and significance of nanobiotechnology.	K3,K4,K5
CO4	Identify recent advances in this area and create a career or pursue research in the field.	K4,K5,K6
CO5	Design non-toxic nanoparticles for targeted drug delivery.	K4,K5,K6

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

COURSE DESCRIPTORS

Title of the Course	Clinical Research and Clinical Trails	Hours/Week	03
Course Code	APEMB25C	Credits	03
Category	Elective Course IV	Year &Semester	I & II
Prerequisites		Regulation	2024

Objectives of the course:

- Provide an overview of history and methods involved in conducting clinical research..
- Design the principles involved in ethical, legal, and regulatory issues in clinical research on human subjects.
- Describe principles and issues involved in monitoring patient-oriented research.
- Formulate a well- defined quality assurance and quality control plans.
- Acquire business development skills in the area of clinical research.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Introduction to Clinical Research: Clinical Research: An Overview, Different types of Clinical Research. Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Pharmacoepidemiology, Bioavailability, Bioequivalence, Terminologies and definition in Clinical Research. Drug Development Process: Drug Discovery Pipeline, Drug Discovery Process. Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV).	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Ethical Considerations and Guideline in Clinical Research: Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Belmont report. International Conference on Harmonization (ICH)-Brief history of ICH, Structure of ICH & ICH Harmonization Process, Guidelines for Good Clinical Practice. Regulation in Clinical Research-Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.	CO2 CO3 CO4	K2 K3 K4 K5
UNIT-III	Clinical Trial Management: Key Stakeholders in Clinical Research, Ethics Committees and Institutional Review Board, Responsibilities of Sponsor. Responsibilities of Investigator, Protocol in Clinical Research Clinical Trial Design, Project Planning Project Managements - Informed Consent, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding. Essential Documents in clinical research -IB, ICF, PIS, TMF, ISF, CDA & CTA.	CO2 CO3 CO4	K2 K3 K4 K5

UNIT-IV	Quality Assurance, Quality Control & Clinical Monitoring: Defining the terminology-Quality, Quality system, Quality Assurance & Quality Control-QA audit plan. 21 CRF Part 11, Site Auditing, Sponsor Compliance and Auditing, SOP For Clinical Research-CRF Review & Source Data Verification, Drug Safety Reporting Corrective and preventative action process.	CO4 CO5	K4 K5 K6

UNIT-V	Business Development in the Clinical Research Industry: Introduction & Stages of Business Development-Start-up Phase, Growth Phase, Maturity Phase, Decline Phase. Outsourcing in Clinical Research, Reasons for outsourcing to contract research organizations, The India Advantage, Scope and Future of CRO, List of Clinical Research Organizations in India, List of IT companies offering services in Clinical Research. Role of business development manager.	CO4 CO5	K4 K5 K6

Recommended TextBooks

1. Gallin J. I., Ognibene F. P. and Johnson L. L. (2007). Principles and Practice of Clinical Research. (4th Edition). Elsevier, 2007.ISBN-10: 0128499052
2. Friedman L. M., Furberg C. D. and Demets D. (1998). Fundamentals of Clinical Trials, Vol: XVIII. (3rd Edition). Springer Science & Business Media.
3. Hulley S. B., Cummings S. R., Browner W. S., Grady D. G. and Newman T. B. (2013). Designing Clinical Research. (4th Edition). Jaypee Medical. ISBN-13: 978-1608318049.
4. Reed,G. (2004). Prescott and Dunn's Industrial Microbiology, 4thedn, CBS publication and distributors.
5. Himanshu B. Text book of Clinical Research, Pee Vee books.

ReferenceBooks

1.Friedman L.M., Fuberge C.D., DeMets D. and Reboussen, D.M. (2015). Fundamentals of Clinical Trials, Springer.

2. Browner W. S., (2012). Publishing and Presenting Clinical Research. (3rd Edition). Lippincott Williams and Wilkins.

3.Rondel R. K., Varley S. A. and Webb C. F. (2008). Clinical Data Management. (2nd Edition). Wiley.

4.Peppler, H.J. and Pearl Man, D. (1979). Fermentation Technology, Vol 1 & 2, 2ndEdition Academic Press, London.

5. E1-Mansi, E.M.T., Bryce, C.F.A., Demain, A.L. and Allman,A.R. (2007). Fermentation Microbiology and Biotechnology. 2ndEdition, CRC press, Taylor and Francis Group.

Website and e-learning source

1. https://www.hzu.edu.in/uploads/2020/10/Textbook-of-Clinical-Trials-Wiley-(2004).pdf
2. https://www.routledge.com/A-Practical-Guide-to-Managing-Clinical-Trials/Pfeiffer-Wells/p/book/9780367497828
3. https://www.auctoresonline.org/journals/clinical-research-and-clinical-trials
4. https://www.who.int/health-topics/clinical-trials#tab=tab_1
5. https://www.cancerresearchuk.org/about-cancer/find-a-clinical-trial/what-clinical-trials-are/types-of-clinical-trials

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	Apprehend the Drug Development process and different phases of clinical trials.	K1,K2,K3, K4
CO2	Recognize the ethics and regulatory perspectives on clinical research trials activities.	K2,K3,K4,K5
CO3	Accentuate about clinical trails, management, concept and documentation process.	K2,K3,K4,K5
CO4	Accomplish quality assurance and quality control to ensure the protection of human subjects and the reliability of clinical trial results.	K4,K5,K6
CO5	To nurture skills recitation to commercial start up and industriousness.	K4,K5,K6

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

COURSE DESCRIPTORS

Title of the Course	Vermitechnology	Hours/Week	04
Course Code	APSMB26	Credits	02
Category	Skill Enhancement Course I	Year & Semester	I & II
Prerequisites		Regulation	2024

Objectives of the course:

- Introduce the concepts of vermicomposting.
- Explain the physiology, anatomy and biology of earthworms.
- Acquire the knowledge of the vermicomposting process.
- Explain the trouble shooting, harvesting and packaging of vermin composts.
- Gain knowledge on applications of vermin composts and their value added products.

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Introduction to Vermiculture - Definition, classification, history, economic importance- In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure. Its role in the bio transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-II	Earthworm Biology and Rearing - Key to identify the species of earthworms. Biology of *Eisenia fetida*. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.	CO3 CO4	K2 K3 K4

UNIT-IV	Vermicomposting - Trouble Shooting-Temperature-Aeration-Acidity- Pests and Diseases-Predators of earthworms. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method- migration method. Packing & Nutritional analysis of vermicompost.	CO4 CO5	K3 K4 K5 K6

UNIT-V	Applications of Vermiculture - Vermiculture Bio-technology, use of vermicastings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Vermiwash and its preaparation.	CO4 CO5	K3 K4 K5 K6

Recommended Text Books

1. Ismail S. A. (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Rathoure A. K., Bharati P. K. and Ray J. (2020). Vermitechnology, Farm and Fertilizer. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3. Christy M. V. 2008. Vermitechnology, (1st Edition), MJP Publishers.
4. The complete technology book on Vermiculture and Vermicompost with manufacturing Process, machinery equipment details and Plant Layout. AB Press.
5. Keshav Singh (2014). A Textbook of vermicompost: Vermiwash and Biopesticide.

Reference Books

1.Roy D. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
2.Kumar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
3.Lekshmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.
4. Edwards CA, Arancon NQ ShermanRL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1stedn.CRC Press.
5. Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1st edn. Orient longman.

Website and e-learning source

1.https://en.wikipedia.org/wiki/Vermicompost
2.http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
3.https://www.kngac.ac.in/elearning portal/ec/admin/contents/4_18K4ZEL02_2021012803204629.pdf
4.https://composting.ces.ncsu.edu/vermicomposting-2/
5. https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/

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	Compare and contrast the uses of vermicompost to the soil.	K1,K2,K3, K4
CO2	Recommend different species of earthworms after acquiring knowledge on its biology.	K1,K2,K3, K4
CO3	Design the vermicomposting process.	K2,K3,K4
CO4	Assess the Best Practices of Vermicomposting	K3,K4,K5,K6
CO5	Recommend the applications of vermicompost to different soils and for different crops.	K3,K4,K5,K6

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

COURSE DESCRIPTORS

Title of the Course	Soil and Environmental Microbiology	Hours/Week	06
Course Code	APCMB31	Credits	05
Category	Core VII	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Explain the role of microorganisms in soil fertility.
- Discuss the benefits of interactions among soil microbes and acquire awareness about microbes as biofertilizers and biocontrol agents
- Create awareness. about components of environment, environmental pollution, and detection methods.
- Acquire in depth knowledge about solid and liquid waste treatments.
- Develop knowledge about organic matter degradation, bioremediation, and the environment risk assessment.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Soil Microbiology– Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major group of microorganisms in soil. Quantification of soil microflora, role of microorganism in soil fertility. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation- Chemistry and Genetics of BNF.	CO1 CO2 CO3 CO4	K1,K2,K4. K5, K6
UNIT-II	Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria– symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non-Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs.	CO1 CO2 CO3 CO4 CO5	K2, K4. K5,K6
UNIT-III	Components of Environment: Hydrosphere, lithosphere, atmosphere, and biosphere – definitions with examples; Energy flow in the ecosystem- Carbon, Nitrogen, Sulfur and Phosphorous cycles. Physical factors affecting distribution of microorganismsin various environments. Predisposing factors for Environmental diseases – infectious (water and air borne) and pollution related, spread and control of these diseases. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Space microbiology - Microbiological research in space environment.	CO1 CO2 CO3 CO4	K1, K2, K3, K5, K6

UNIT-IV	Waste management – Solid waste - Types - management - Factors affecting solid waste generation rates. Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process. Quality assessment of decontaminated matters and other biological effluents. Biological reference standards. Utilization of Solid Waste as Food, Feed and Fuel- Composting, Vermicomposting, Bio manure and Biogas production. E waste management.	CO1 CO3 CO4 CO5	K1, K2, K3, K5, K6
UNIT-V	Degradation of organic matter - lignin, cellulose, hemicellulose, pectin, common pesticides- herbicides (2,4-D) and pesticides (DDT), heavy metals. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers. Biodegradation of Hydrocarbons. Biodeterioration of Textiles and Leather. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, EIA guidelines, US Environment protection Agency norms.	CO1 CO2 CO3 CO4 CO5	K1, K2, K4. K5, K6

Recommended Text Books

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

Reference Books

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

Website and e-learning source

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

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	CognitiveLevel
CO1	Understand the Microbial Diversity and Functions in Soil	K1, K2
CO2	Utilize the knowledge of microbial interactions, with beneficialapplication of biofertilizers for sustainable agriculture and benefits of biopesticides.	K2,K6
CO3	Evaluate the Role of Microorganisms in Biogeochemical Cycles and Environmental Health	K1,K2,K5
CO4	Apply knowledge about waste treatments and microbial decomposition and bio-remediation process in environmental cleanup.	K1,K2,K4
CO5	Apply Environmental Laws and Pollution Control Measures	K2, K3

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

COURSE DESCRIPTORS

Title of the Course	**Molecular Biology and Recombinant DNA Technology**	**Hours/Week**	06
Course Code	**APCMB32**	**Credits**	05
Category	**Core VIII**	**Year & Semester**	II & III
Prerequisites	**Basics in Microbiology**	**Regulation**	2024

Objectives of the course:

- Provide knowledge on the structure, replication and repair mechanisms of DNA. Illustrate Discuss the gene regulatory mechanisms in prokaryotes and eukaryotes and importance of mutations.
- Provide in depth knowledge about artificial gene transfer mechanisms and selection of Recombinants.
- Impart knowledge on various molecular techniques and their importance in biotechnology Explain the applications of genetic engineering in various fields.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	DNA replication – modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, r- RNA and t-RNA. Ribosomes. Genetic Code and Wobble hypothesis.	CO1 CO3 CO5	K1 K2 K3 K5
UNIT-II	Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems - repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations- base substitutions, frame shift, deletion insertion, duplication, inversion. Silent, conditional and lethal mutation. Chemical mutagenesis. Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test).	CO1 CO2 CO4 CO5	K1 K2 K3 K4 K5
UNIT-III	Tools and methods in gene cloning. Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques - electroporation, microinjection, protoplast fusion and microparticle bombardment. Screening for recombinants. Gene cloning vectors for prokaryotes and eukaryotes - cloning properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors(M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors.	CO1 CO2 CO3 CO4 CO5	K1 K3 K4 K5

UNIT-IV	Genomic DNA and cDNA library - Construction and Screening. Substrative hybridization for tissue specific DNA libraries. Techniques in genetic engineering Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking, Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array.	CO2 CO4 CO5	K1 K2 K4 K5
UNIT-V	Plant biotechnology - constituents and concepts of sterilization - preparation, isolation and selection of explant. Suspension cell culture, callus culture, protoplast isolation, culture & fusion. Anther and pollen culture for production. Animal biotechnology – equipment and media used for animal cell culture technology. Primary and established cell line culture and culture media. Applications of animal cell cultures. Serum protein media viability and cytotoxicity. Applications of Genetic Engineering - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Monoclonal Antibodies in Therapy-Vaccines and their Applications in Animal Infections - Human Gene Therapy - Germline and Somatic Cell Therapy - Ex-vivo Gene Therapy. In-vivoGene Therapy. Vectors in Gene Therapy-Viral and Non-Viral Vectors. Transgenic Plants.	CO3 CO4 CO5	K1 K2 K3 K5

Recommended Text Books

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

Reference Books

1. Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7th Edition). John Wiley and Sons, Ltd.
2. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.
3. Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.
4. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria. (4th Edition). ASM Press Washington-D.C. ASM Press.
5. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd

Website and e-learning source

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

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	Explain the molecular mechanisms of DNA replication, transcription, and translation across prokaryotic and eukaryotic systems.	K1,K3, K4
CO2	Analyze gene regulation mechanisms, including the Lac, arabinose, and tryptophan operons, and compare prokaryotic and eukaryotic gene expression systems.	K1,K2,K4
CO3	Evaluate types of mutations, DNA repair mechanisms, and methods for detecting mutations, including Ames test and replica plating.	K4, K6
CO4	Design a gene cloning experiment using appropriate vectors, enzymes, and gene transfer techniques for recombinant DNA production.	K2, K4
CO5	Apply biotechnological techniques like cell culture, transgenics, and gene therapy to solve problems in animal and plant biotechnology.	K1,K3

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

COURSE DESCRIPTORS

Title of the Course	Practical III	Hours/Week	06
Course Code	APCPMB33	Credits	04
Category	Core Course IX-Practical III	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Illustrate the significance of artificial transformation and mutations.
- Discuss blotting techniques and PCR.
- Analyze and estimate water quality and potability
- Prepare Biofertilizers, vermicompost and test their efficiency
- Familiarize with common plant infections

UNITS	Contents	Cos	Cognitive Levels
UNIT-I	Detection of Antibiotic resistant mutants Identification of mutants by replica plating method	CO1 CO3	K1 K3 K4
UNIT-II	Amplification of DNA by PCR (Demonstration) Western blotting - Demonstration Southern blotting – Demonstration	CO1 CO3 CO5	K1 K3 K5
UNIT-III	Microbiological analysis of water B) Test for indicative organisms 1) MPN 2) Membrane Filtration Enumeration of bacteria and fungi from air – Air sampler Isolation of free-living nitrogen fixers from soil and*Rhizobium* from root nodules of leguminous plants. Isolation and enumeration of phosphate-solubilizing bacteriafrom soil	CO2 CO3 CO5	K3 K4 K5 K6

UNIT-IV	Estimation of soil enzymes- urease and phosphatase Study of phylloplane microflora by leaf impression methodIsolation of cellulose degrading bacteria Preparation of a vermicompost Isolation of VAM fungi from soil (Demonstration) Cultivation of edible mushroom from solid waste Cultivation of *Azolla*	CO2 CO3 CO4	K3 K4 K5 K6
UNIT-V	Visual examination, observation, and identification of some common plant infections. Collection of 5 herbarium specimens of infected leaves.	CO3 CO5	K1 K2 K3 K4 K5

Recommended Text Books

1. Russell P. J. (2019). Genetics – A Molecular Approach (3rd Edition). Pearson Education, Inc.
2. Glick B. R. and Patten C. L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA (5th Edition). ASM Press.
3. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
4. James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratorymanual. (5th Edition). The Benjamin publishing company. New York.
5. Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3rd Edition). American Societyfor Microbiology.

Reference Books

1. Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.Gupta P. S. (2003). Clinical Immunology. OxfordUniversity Press.
2. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
3. Dale J. W., Schantz M. V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd.
4. Pepper I., Gerba C. and Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual. (2nd Edition). Academic Press, Elsevier.
5. Yates M.V., Nakatsu C.H., Miller R.V. and Pillai, S.D. (2016). Manual of Environmental Microbiology. (4th Edition). Wiley.

Website and e-learning source

1. https://www.molbiotools.com/usefullinks.html
2. https://geneticgenie.org3.
3. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4. https://vlab.amrita.edu/index.php?sub=3&brch=272
5. https://nptel.ac.in/courses/102105087

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	Utilize various molecular techniques for gene manipulation and detection of mutants.	K1, K2, K3
CO2	Undertake novel research with techniques like PCR and blotting analysis.	K1,K2,K5
CO3	Assess the microbial quality of water and air and relate the results to standards.	K4, K6
CO4	Synthesize biofertilizers and vermicompost. Cultivate mushrooms using solid waste.	K3, K6
CO5	Identify various plant pathogens	K3,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	3	3	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	3	3	3	3	3	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	Fermentation Technology and Pharmaceutical Microbiology	Hours/Week	06
Course Code	APCMB34	Credits	05
Category	Core X Industry Module	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Discuss about fermentation and its types, sensitize on methods of strain development for improved yield.
- Impart knowledge on the fermenter design and types.
- Acquire knowledge on the effective recovery and purification of the products.
- Explain the importance of pharmaceutical microbiology.
- Illustrate methods for production products using microorganisms and their quality control.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculums for fermentation process. Media for industrial fermentation - Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter pre- culture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.	CO1 CO2 CO3 CO5	K1 K2 K3 K4 K6
UNIT-II	Fermenter – Design, types and construction, Instrumentation and control. Productivity. Yield coefficients. Heat production. Aeration and agitation. Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.	CO1 CO2 CO3	K1 K2 K4 K6
UNIT-III	Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.	CO1 CO2 CO3 CO4	K1 K4 K6
UNIT-IV	Overview of pharmaceutical microbiology - Ecology of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, ophthalmologic preparation, implants..	CO1 CO2 CO3 CO4 CO5	K1 K2 K4 K6

UNIT-V	Production of pharmaceutical products and quality assurance – Vaccines, immunodiagnostics, immuno-sera, immunoglobulin. Antibiotics - Penicillin, Griseofulvin, Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.	CO4 CO5	K1 K2 K4

Recommended Text Books

1. Patel A. H. (2016). Industrial Microbiology. (2nd Edition). Laxmi Publications, New Delhi.
2. Casida L. E. J. R. (2019). Industrial Microbiology. New Age International Publishers.
3. Sathyanarayana U. (2005). Biotechnology. (1st Edition). Books and Allied (P) Ltd.
4. Reed G. (2004). Prescott and Dunn's Industrial Microbiology. (4th Edition). CBS Publishers & Distributors.
5. Waites M. J., Morgan N. L., Rockey J. S. and Higton G. (2013). Industrial Microbiology: An Introduction. Wiley Blackwell Publishers.

Reference Books

1. Stanbury P. T. and Whitaker. (2016). Principles of Fermentation Technology. (3rd Edition). Pergamon Press. NY.
2. Handa S. S. and Kapoor V. K. (2022). Pharamcognosy, (4th Edition). Vallabh Prakashan Publishers, New Delhi.
3. Kokate C. K., Durohit A. P. and Gokhale S. R. Pharmacognosy. (2002). (12t Edition). Nirali Prakasham Publishers, Pune.
4. Hugo W. B. and Russell A. D. (2004). Pharmaceutical Microbiology. (7th Edition). Blackwell Scientific Publication, Oxford.
5. Wallis, T.E. (2005). Text book of Pharmacognosy. (5th Edition). CBS publishers and distributors, New Delhi.

Website and e-learning source

1. https://ib.bioninja.com.au/options/untitled/b1-microbiology organisms/fermenters.html
2. https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html
3. https://www.sciencedirect.com/topics/biochemistry-genetics-andmolecular-biology/ethanol-fermentation
4. https://www.usp.org/sites/default/files/usp/document/harmonization/genmethod/q05b_pf_ira_34_6_2008.pdf
5. http://www.simbhq.org/

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	Develop microbial strains, carry out fermentation and recover the products of the process.	K1,K4
CO2	Design fermenters according to needs for various products.	K1,K2, K6
CO3	Recover the end products of the fermentation process economically.	K4, K5
CO4	Utilize the knowledge on pharmaceutical microbiology for industrial production of products.	K1, K4
CO5	Evaluate pharmaceutical product quality through in-process and final-product control methods, ensuring compliance with regulatory standards like ISO, WHO, and US certifications.	K1, K2,K5

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

COURSE DESCRIPTORS

Title of the Course	Biosafety, Bioethics and IPR	Hours/Week	03
Course Code	APEMB35A	Credits	03
Category	Elective - V	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Create a research environment. Encourage investigation, analysis and study thebioethical principles, values, concepts, and social and juridical implications in the areas of science, biotechnology and medicine.
- Discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotechnological products.
- Familiarize fundamental aspects of Intellectual property Rights in the development and management of innovative projects in industries.
- Acquire knowledge about bioethics, biodiversity and Genetically modified foods and food crops.
- Provide students with an understanding of bioethics in research associated with Medicine

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Intellectual Property Rights: Different forms of Intellectual Property Rights – their relevance, importance to industry,Academia. Role of IPR's in Biotechnology, Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. International organizations and IPR - Overviewof WTO, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.	CO1 CO2 CO5	K1 K3 K5
UNIT-II	Process involved in patenting. Patent Search - Procedural steps in patenting, process of filing, PCT application, pre- grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping.	CO1 CO2 CO3 CO5	K1 K2 K3 K5
UNIT-III	Patentability of biotechnology inventions - Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Biotechnological inventions as patentable subject matter, territorial nature of patents - from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, tentative harmonisation efforts, implications of setting up a uniform world patent system.	CO1 CO3 CO4 CO5	K1 K2 K3

UNIT-IV	Introduction to bioethics - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods and food crops, organisms and their possible health implications and mixing up with the gene- pool.	CO4 CO5	K1 K2 K3
UNIT-V	Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: stem cell research, human genome project, use of animals in research, human volunteers for clinical research, studies on ethnic races. he Nuremberg code.	CO5	K1, K3

Recommended Text Books

1. Usharani B., Anbazhagi S. and Vidya C. K. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN-101645878856
2. Satheesh M. K. (2009). Bioethics and Biosafety. (1st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703
3. Goel D. and Parashar S. (2013). IPR, Biosaftey and Bioethics. (1st Edition).Pearson education: Chennai. ISBN-13: 978-8131774700
4. Raj Mohan joshi. Biosafety and Bioethics. Wiley Publications.
5. Sibi. GIntellectual, Property Rights, Bioethics, Biosafety and Entreepreneurship inbiotechnology. (2021). Wiley Publications.

Reference Books

1. Nithyananda K. V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
2. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: LexisNexis.
4. Tony Hope (2004). Medical Ethics: A very Short introduction,. Oxford Publication.
5. Goel Parashar. IPR, Biosafety and Bioethics (2013). Pearson Publications.

Website and e-learning source

1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf.
3. https://www.cdc.gov/training/quicklearns/biosafety/
4. https://bioethics.msu.edu/what-is-bioethics
5. https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

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	Execute the role of IPR, Patent, Trademarks and its importance.	K1,K4
CO2	Develop patent procedure, patent filling and itsmapping.	K1,K2, K5
CO3	Become Patent attorneys and Patent officers.	K1, K2,K3
CO4	Apply bioethics in GMO, food crops and its biodiversity.	K1, K2,K4
CO5	Analyze the importance of bioethics in researchassociated with HGP, clinical research, stem celltherapy.	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	3	3	2	2	3	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	3	2	2	2	2	-	2	3	2	3
CO5	3	3	2	2	2	2	2	2	2	1	3	3	3

COURSE DESCRIPTORS

Title of the Course	Toxinology	Hours/Week	03
Course Code	APEMB35B	Credits	03
Category	Elective - V	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Recognize the various categories of environmental toxins and their hazardous consequence
- Enhance the knowledge of underlying etiology of diseases
- Strengthen the evidence for a causal link between the exposure of hazardous agentand the development of diseases
- Illustrate various techniques to isolate and characterize the toxin
- Examine, interpret and discuss the certainty of toxic substances, proposing the deepunderstanding of medicinal and industrial applications.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	General Introduction - Definition of toxins, different categories of toxins and venoms, recent trends in venom and toxin research.	CO1 CO2	K1 K2 K4
UNIT-II	Bacterial toxins - Bacterial toxins Bacterial toxinogenesis, endotoxins, exotoxins, exotoxins, bacterial protein toxins with special reference to cholera, diphtheria and tetanus toxins,molecular mechanism of action of endotoxins, exotoxins, enterotoxins, neurotoxins and mycotoxins.	CO1 CO2	K1 K2 K4
UNIT-III	Plant toxins & Toxins from snake venom - Natural toxins in plants, Plant toxic proteins, impact of plant toxin on human, natural toxins in food, plants, allelopathy. Toxins from snake venom Snakes and Biological significance of their venoms, composition of snake venom, anti-venom and medicinal plants in treatment of snakebite patients.	CO1 CO2 CO3	K1 K3 K4
UNIT-IV	Tools for isolation and characterization of toxins - Multidimensional chromatographic techniques (gel-filtration, ion-exchange reverse-phase HPLC, SDS-PAGE, 2- dimensional gel electrophoresis).	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5 K6
UNIT-V	Medicinal and industrial applications of venoms and toxins. Use of toxin in neurobiology and muscular research, anticancer drug, diagnosis of haemostatic disorders, antibacterial agents, bioinsecticides and other industrial applications.	CO3 CO5	K1 K2 K3 K5

Recommended Text Books

1. Holst O. (2008). Bacterial Toxin –Methods & Protocols. Humana Press.ISBN9781592590520.
2. Shier W. T. (1990). Handbook of Toxinology. CRC Press. ISBN 9780824783747..
3. Wilson K. and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. (7thEdition). Cambridge University Press India Pvt.Ltd. ISBN 1- 4051-3544-1.
4. Pholtan Rajeev S.R. (2021Pictorial handbookfor toxinology. Rudra Publications.
5. oCra Lancester. (2015). Molecular Toxinology Handbook. Callisto Reference

Reference Books

1. Reilly M. J. (2018). Bioinstrumentation. CBS Publishers and Distributors Pvt Ltd. ISBN13 978-8123928395.
2. Greenberg M., Hamilton R., Phillips S. and McCluskey G. J. (2003). Occupational, Industrial and Environmental Toxicology. St Louis: C.V. Mosby.
3. Wiley-Vch. (2005). Ullmann's Industrial Toxicology. New York: John Wiley & Sons.
4. Winder C. and Stacey N.H. and Boca Raton F. L. (2004). Occupational Toxicology. (2ndEdition). CRC Press.
5. Gopalakrishnakone(2015). Biological Toxins and Bioterrorism. Springer.

Website and e-learning source

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869414/
2. https://www.reseachgate.net/publication/269037373_TOXIN_AS_A_MEDICINE
3. https://www.toxinology.org/
4. https://www.mdpi.com/journal/toxins/special_issues/snakebite_clinical_toxinology
5. https://pubmed.ncbi.nlm.nih.gov/12807310

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	Perceive the adverse effects of toxin and its potential role in research.	K1,K2,K5
CO2	Identify the methods of algal cultivation and harvesting.	K1, K3,K4
CO3	Explicate the mode of actions and their biological significance.	K1.K2, K4
CO4	Evaluate the toxicity level with the help of advanced techniques.	K1,K2,K3,K6
CO5	Elucidate the various natures of application of toxic substances.	K1, K2, K5

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

COURSE DESCRIPTORS

Title of the Course	Water Conservation and Water Treatment	Hours/Week	03
Course Code	APEMB35C	Credits	03
Category	Elective - V	Year & Semester	II & III
Prerequisites	Basics in Microbiology	Regulation	2024

Objectives of the course:

- Explain how societal and climatic changes will distress water supply and water demand in future
- Ascertain promising elucidations to the global water crisis and assess the pros and cons
- Acquire knowledge to identify the quality of water by standard method
- Illustrate the methods of water treatment technologies and assessing the impact of HWTS
- Describe the application and uses of various emerging water treatment technologies

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Water Scarcity; Major Causes of Water Scarcity, Types of Water Scarcity, Water Footprint- Effects of Water Scarcity Across the Globe-, Water Scarcity in India; Effects of Water Scarcity in India - Social and Political Effects and Economic Risks of Water Scarcity in India.	CO1 CO5	K1, K2,K3
UNIT-II	Multi-pronged approach to Prevent Water Scarcity; Aquifer Recharging, Water reuse and Zero-Liquid Discharge Technology, Coastal Reservoir, Desalination Plants- Measures for Preventing Water Scarcity in India - Jal Shakti Abhiyan Campaign, Atal Bhujal Yojana, Adoption of Composite Water Management Index (CWMI), Water conservation resource management, Rain Water Harvesting.	CO1 CO2 CO3	K1,K2,K3, K4
UNIT-III	Water Quality and Pollution; Impurities in the water, Characteristics of different water sources Vulnerability of the water sources to contamination, Water quality criteria - Quality of surface waters, flowing waters, impounded waters, Groundwater, Water quality standards, Microbiological quality of drinking Water, Chemical quality of drinking water.	CO1 CO3 CO4	K2 K3 K4 K5

UNIT-IV	Water Treatment Technologies; Sedimentation, Filtration, Coagulation and flocculation, Water softening and adsorption processes, Membrane filtration, Microfiltration, Ultrafiltration and Nanofiltration,Water disinfection, Activated carbon filtration, Household Water Treatment and Safe Storage (HWTS). Methods for household water treatment Safe water storage, Household water treatment and safe storage decision tree, Assessing the impact of HWTS, Government policies for HWTS.	CO1 CO2 CO4	K1,K2,K3 K5
UNIT-V	New and Emerging Drinking Water Treatment Technologies; Nanotechnology, Acoustic nanotube technology, Photocatalytic water purification technology, Aquaporin Inside™ technology, Automatic Variable Filtration (AVF) technology, Sun Spring System, Desalination.	CO1 CO4 CO5	K1,K2,K3 K4

Recommended Text Books

1. Vasileios A., Tzanakakis N. Paranychianakis V. and Angelakis A. N. (2020). Water Supply and Water Scarcity. MDPI, ISBN 978-3-03943-306-3 (Hbk). ISBN 978-3-03943-3070.
2. Pannirselvam M., Shu Li.,Griffin G., Philip L., Natarajan A. and Hussain S. (2019). Water Scarcity and Ways to Reduce the Impact. ISBN: 978-3-319-75199-3.
3. Tiwari A., Kumar A., Singh A., Singh T.N., Suozzi E., Matta G. and Russo S. (2022).Water Scarcity, Contamination and Management. Elsevier. ISBN: 9780323853781.
4. Daniel, C.J. (1996). Environmental Aspects of Microbiology, 1st edn. Bright SunPublications.
5. Maier RM, Pepper IL, Gerba CP (2008). Environmental Microbiology, 2nd edn.Academic Press

Reference Books

1. Fujita K. and Mizushima T. (2021). Sustainable Development in India –Groundwater Irrigation, Energy Use, and Food Production. ISBN 9780367460976.
2. Gupta R. (2008). Water Crisis in India. Atlantic Publishers. ISBN: 9788126909582, 9788126909582.
3. Ahuja S. (2013). Monitoring Water Quality-Pollution Assessment, Analysis, andRemediation. Elsevier. Book ISBN: 9780444594044. Hardcover ISBN:9780444593955.
4. Saeid Eslamian ., Faezeh Eslamian ., (2021) Water harvesting and conservation – Basic Concepts and fundamentals, Wiley Publications.
5. Buckley RG. (2016) Environmental Microbiology 1st edn. CBS Publishing.

Website and e-learning source

1. https://link.springer.com/book/10.1007/978-1-59745-278-6
2. https://apps.who.int/iris/handle/10665/206916?show=full
3. https://www.acs.org/content/acs/en/policy/publicpolicies/sustainability/water- statement.html
4. https://www.toftigers.org/best-practice/water-conservation-and-treatment/
5. https://doh.wa.gov/community-and-environment/wastewater-management/site-sewage- systems-oss

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	Appraise issues of water scarcity, stress, and conflict on global population.	K1,K2,K3
CO2	Apprehend the multiple approaches against water scarcity and to understand various government schemes for water conservation.	K1,K2,K4
CO3	Relate the connection between water quality and publichealth.	K1,K43,K4
CO4	Design and execute standard strategy for successful HWTSimplementation.	K1,K2,K3,K5
CO5	Cogitate the purpose, principles, operation, and limitation ofvarious modern water treatment technologies.	K1,K2,K3,K4

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

COURSE DESCRIPTORS

Title of the Course	**Organic Farming and Biofertilizer Technology**	**Hours/Week**	03
Course Code	**APSMB36**	**Credits**	02
Category	**Skill EnhancementCourse II**	**Year & Semester**	II & III
Prerequisites	**Basics in Microbiology**	**Regulation**	2024

Objectives of the course:

- Impart knowledge on the importance, types and advantages of organic farmingthereby creating awareness on conserving environment and natural resources,encouraging sustainable agriculture.
- Familiarize with the basic concepts of farm development and relate the development of organic farming in their countries to meet global trends.
- Explain the various types of biofertilizer and the scope in its production.
- Discuss about biofertilizer production and its field application, promoting economy.
- Develop the skill to analyze the quality of packaging, storage, assess the shelf life and bioefficacy of biofertilizers

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Organic farming – Definition, relevance. Biological nutrient management - Organic manures, vermicompost, green manure, organic residue, biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, bio pesticides etc. Organic and Conventional farming. Organic and Chemical farming – Comparison.	CO1 CO2 CO3	K1 K2 K5
UNIT-II	Certification and Schemes - Certification and Schemes. Organic certification in brief. Integrated farming system- definition, goal, components. Factors affecting ecologicalbalance. Land degradation. Soil health management. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes - NPOF, NPOF, NHM, HMNEH, NPMSH&F and RKVY.	CO1 CO2 CO3	K1 K2 K5
UNIT-III	Biofertilizers - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*.	CO2 CO3	K1 K2 K5
UNIT-IV	Cyanobacterial biofertilizers- Anabaena, Nostoc, *Hapalosiphon*and fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, potassium solubilization.	CO3 CO4 CO5	K2 K4 K5

UNIT-V	Production technology - Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid bio-fertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.	CO3 CO4 CO5	K2 K4 K5

Recommended Text Books

1. Sharma A. K. (2001). Hand book of Organic Farming. Agrobios.
2. Gaur A. C. (2006). Hand book of Organic Farming and Biofertilizers. Ambika Book Agency.
3. Subba Rao N.S. (2017). Bio-fertilizers in Agriculture and Forestry. (4th Edition). Med Tech publisher.
4. Subba Rao N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Sathe T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.

Reference Books

1. Rakshit A. and Singh H. B. (2015). ABC of Organic Farming. (1st Edition). JainBrothers.
2. Dubey R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
3. Bansal M. (2019). Basics of Organic Farming. CBS Publisher.
4. Bhoopander G., Ram Prasad., (2019) Biofertilizer for sustainable agriculture and Environment, Springer
5. Niir Board., (2012) (1st Edition) Biofertiliser and organic farming

Website and e-learning source

1. https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2. https://www.fao.org/organicag/oa-faq/oa-faq6/en/
3. https://www.india.gov.in/topics/agriculture/organic-farming
4. https://agriculture.nagaland.gov.in/bio-fertilizer/
5. https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE

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	Produce biofertilizers and distinguish between organicand conventional farming.	K1,K2, K3
CO2	Plan a Complete Farm Business including marketing,operation and financial outline.	K1,K2,K3
CO3	Practice the application of microbial bio-fertilizers in large scales, thereby increasing soil fertility.	K1,K2,K5
CO4	Develop integrated farming for sustainable agriculture.	K1,K2, K4
CO5	Promote the quality of packaging, storage, increase shelflife, accelerate the bio efficacy of bio fertilizers as per BIS standards	K1,K2,K4, K5

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