Sadakathullah Appa College

(Autonomous)

(Reaccredited by NAAC at an 'A^{++}' Grade. An ISO 9001:2015 Certified Institution)

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

PG AND RESEARCH

DEPARTMENT OF MICROBIOLOGY

CBCS SYLLABUS

Learning Outcomes-Based Curriculum Framework For

M.Sc. MICROBIOLOGY

(Applicable for students admitted in June 2024 and onwards)

(As per the Resolutions of the Academic Council Meeting held on 01.06.2024)

CONTENTS

S. No.	Course Title	Course Code
1	General Microbiology and Microbial Diversity	24PCMB11
2	Immunology and Immunomics	24PCMB12
3	Microbial Genetics	24PCMB13
4	Techniques in General Microbiology and Microbial Diversity	24PCMB1P1
5	Techniques in Immunology, Immunomics and Microbial Genetics	24PCMB1P2
6	Forensic Science	24PEMB11A
7	Health and Hygiene	24PEMB11B
8	Microalgal Technology	24PEMB11C
9	Entrepreneurship in Microbiology	24PIMB11
10	Medical Bacteriology and Mycology	24PCMB21
11	Medical Virology and Parasitology	24PCMB22
12	Techniques in Medical Bacteriology and Mycology	24PCMB2P1
13	Techniques in Medical Virology, Parasitology and Bioinformatics	24PCMB2P2
14	Nanobiotechnology	24PEMB21A
15	Bioremediation	24PEMB21B
16	Clinical Research and Clinical Trials	24PEMB21C
17	Microbiology and Human Health	24PIMB21
18	Bioinformatics	24PSMB21
19	Skill Enhancement Course-III NPTEL-SWAYAM Online Certification Course (or) Naan Muthalvan : (Choose any one course from the list of courses suggested by TANSCHE)	24PSMB22

Sadakathullah Appa College, Rahmath Nagar,
Tirunelveli – 627 011.
Programme Structure & Credits – PG MICROBIOLOGY - 2024 – 2027

Sem	Course Type	Title of the Course	Course Code	H/W	C	Marks		
						I	E	T
I	Core-I	General Microbiology and Microbial Diversity	24PCMB11	6	5	40	60	100
	Core-II	Immunology and Immunomics	24PCMB12	5	5	40	60	100
	Core-III	Microbial Genetics	24PCMB13	5	4	40	60	100
	Core-P-I	Techniques in General Microbiology and Microbial Diversity	24PCMB1P1	4	2	20	30	50
	Core-P-II	Techniques in Immunology, Immunomics and Microbial Genetics	24PCMB1P2	4	2	20	30	50
	EC-I	Forensic Science	24PEMB11A	4	3	40	60	100
		Health and Hygiene	24PEMB11B					
		Microalgal Technology	24PEMB11C					
	EC-II (IDC-I)	Entrepreneurship in Microbiology	24PIMB11	2	2	15	35	50
		SOP		-	-			
				30	**23**			**550**
II	Core-IV	Medical Bacteriology and Mycology	24PCMB21	5	5	40	60	100
	Core-V	Medical Virology and Parasitology	24PCMB22	5	4	40	60	100
	Core-P-III	Techniques in Medical Bacteriology and Mycology	24PCMB2P1	4	2	20	30	50
	Core-P-IV	Techniques in Medical Virology, Parasitology and Bioinformatics	24PCMB2P2	4	2	20	30	50
	EC-III	Nanobiotechnology	24PEMB21A	4	3	40	60	100
		Bioremediation	24PEMB21B					
		Clinical Research and Clinical Trials	24PEMB21C					
	EC-IV (IDC-II)	Microbiology and Human Health	24PIMB21	2	2	15	35	50
	SEC-I	Bioinformatics	24PSMB21	4	3	40	60	100
	SEC-II	NPTEL-SWAYAM Online Certification Course (or) Naan Muthalvan : (Choose any one course from the list of courses suggested by TANSCHE)	24PSMB22	2	2	-	-	50
		SOP		-	1			100
	Summer – Internship Industry Training during the 1st year vacation - credits be given in the third semester mark statement							
				30	**23+1**			**700**

M.Sc. Microbiology

Programme Outcomes

PO	Upon completion of the M.Sc. Degree Programme, the graduate will be able to
PO1	**Disciplinary Knowledge** • Acquire in-depth scientific knowledge in the core areas of study.
PO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** • Enrich skills of observation to draw logical inferences from scientific experiments /programming and skills of creative thinking to develop novel ideas. • Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** • Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. • Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. • Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PO 4	**Ethical Awareness / Team Work / Environmental Conservation and Sustainability** • Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviors such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. • Realize that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PO 5	**Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning** • Get access to digital resources, to use them judiciously for updating the knowledge and also to engage in remote/ independent learning. • Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes

PSO	Upon completion of the M.Sc. Microbiology Degree Programme, the students will be able to
PSO-1	**Placement** Prepare the students in varied disciplines like agriculture, industry, medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement.
PSO-2	**Entrepreneurship** To create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO-3	**Research and Development** Design and implement HR systems that comply with good laboratory practices, following ethical values, leading the organization towards growth and development.
PSO-4	**Contribution to Society** To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.
PSO-5	**Quality Management** Apply theories related to the various recent emerging areas of Microbiology and acquire the knowledge to analyze the Quality Laboratory Management (QLM) ethical issues regarding the modern Biology.

Semester - I	General Microbiology and Microbial Diversity		24PCMB11			
Core – I			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	5	1	-	5

General Objective:

The course helps to create curiosity in microbial world with the basic, advanced concepts of General Microbiology and Bacteriology.

Learning Objectives:

LO	The learners will be able to:
LO-1	Acquire knowledge on the principles of different types of microscopes and their applications.
LO-2	Explain various pure culture techniques and discuss sterilization methods.
LO-3	Discuss the importance and conservation of microbial diversity.
LO-4	Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
LO-5	Exemplify, isolate and cultivate microalgae from diverse environmental sources.

UNIT I - Microscope and Microscopy (20 Hours)

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.

UNIT II - Microbial techniques (20 Hours)

Microbial techniques - Safety guidelines in Microbiology Laboratories. 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.

UNIT III – Biodiversity and Microbial Growth (20 Hours)

Biodiversity - Introduction to microbial biodiversity. Conservation of Biodiversity. Bacteria, 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.

UNIT IV – Archaebacteria (15 Hours)

Thermophiles - Classification, Thermophilic Archaebacteria and its applications. Methanogens - Classification, Habitats, applications. Alkalophiles and Acidophiles - Classification, discovery basin, its cell wall and membrane. Barophiles - Classification and its applications. Halophiles - Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes, Osmoadaptation / halotolerance - Applications of halophiles.

UNIT V – Algae and Life cycles (15 Hours)

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. Life cycle - *Chlamydomonas*, *VolvoxSpirogyra* (Green algae), *Nostoc* (Cyanobacteria) *Ectocarpus, Sargassum* (Brown algae), *Polysiphonia*, *Batrachospermum* (Red algae).

Textbooks:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.
3. Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6th Edition). McGraw - Hill company, New York.
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. (2009). Textbook of Microbiology. S. Chand, Limited.

Reference Books:

1. Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12th Edition).Pearson, London, United Kingdom
2. Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3rd Edition). 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. (2nd Edition). 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. (15th Edition). Pearson.

Web Resources:

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Interpret the various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	1,3,4,5	K3,K5
CO-2	Discuss the aseptic conditions by following good laboratory practices.	1,2,3,5	K2
CO-3	Explain the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.	1,2,3,4	K2, K5
CO-4	Compare a variety of extremophiles following standard protocols for industrial applications.	1,3,4,5	K4, K6
CO-5	Analyze and identify the algae understanding their habitat., classify and propagate depending on its economic importance.	1,3,4,5	K1,K4
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCMB11	General Microbiology and Microbial Diversity	90	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	3	3	2	3	2
CO-2	2	2	3	3	3	3	3	3	2	2
CO-3	2	3	3	3	2	3	2	3	3	2
CO-4	3	2	3	2	3	3	3	2	3	3
CO-5	3	3	2	3	3	3	3	2	3	2
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Immunology and Immunomics		24PCMB12			
Core – II			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	5

General Objective:

The course helps to understand the fundamentals of Immunology, the importance of immunization and various diagnostic methods.

Learning Objectives:

LO	The learners will be able to:
LO-1	Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
LO-2	Describe immunoglobulin and its types. Categorize MHC and understand its significance.
LO-3	Elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
LO-4	Acquire knowledge the structure DNA in prokaryotes and eukaryotes
LO-5	Explain out gene transfer studies in microbes.

UNIT I - Immune System (15 Hours)

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-Complement, Toll-like receptors and other components. 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.

UNIT II – Immunoglobulins and Immune Response (15 Hours)

Immunoglobulins. Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, Diversity of TCR, T cell surface alloantigens, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.

UNIT III – Hypersensitivity and Genetics of Immunohematology (15 Hours)

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetic basis and

significance of ABO and other minor blood groups in humans, Bombay blood group, Rh System and genetic basis of D- antigens.

UNIT IV – Immune Regulation Mechanisms and Immunomics (15 Hours)

Immune regulation mechanisms – immuno-induction, immuno-suppression, immuno-tolerance, immuno-potentiation, Immunomodulation. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants. Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development - multiepitope vaccines. Reverse vaccinology.

UNIT V – Diagnostic Immunology (15 Hours)

Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry.

Textbooks:

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.

Web Resources

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. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Illustrate the immune response to a variety of antigens. Identify different immune cells involved in immunity.	1,2,4,5	K3,K4
CO-2	Identify the significance of MHC molecules in immune response and antibody production.	2,3,4,5	K1,K4
CO-3	Relate the antibodies and evaluate the immunological assays in patient samples.	1,3,4,5	K1,K3
CO-4	Demonstrate the concept of genomic DNA of prokaryotes and eukaryotes.	1,2,3,5	K3,K5
CO-5	Compare gene transfer mechanisms for experimental study.	2,3,4,5	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credits	
I	24PCMB12	Immunology and Immunomics				75		5	
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	2	3	3	2	3	3
CO-2	3	3	2	3	3	3	3	2	3	3
CO-3	2	3	3	3	2	3	2	3	3	2
CO-4	3	3	3	2	3	2	3	2	3	3
CO-5	2	3	2	3	3	3	3	2	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Microbial Genetics		24PCMB13			
Core – III			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100				4

General Objective:

The course teaches the concept of genetic materials, molecular mechanism involved in DNA replication and Protein synthesis. The course also helps to understand the significance of gene cloning.

Learning Objectives:

LO	The learners will be able to:
LO-1	Acquire knowledge the structure DNA in prokaryotes and eukaryotes
LO-2	Explain out gene transfer studies in microbes.
LO-3	Analyze, demonstrate and appreciate DNA replication and protein synthesis.
LO-4	Investigate the types of mutation and its impact on microbes.
LO-5	Illustrate various strategies on gene cloning.

UNIT I - Prokaryotic and Eukaryotic Genome (15 Hours)

Structural of prokaryotic and eukaryotic genome. Introduction to prokaryotic genomic structure, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, organelle genome.

UNIT II – Gene Transfer Mechanisms (15 Hours)

Gene Transfer Mechanisms- Conjugation and its uses. Transduction, Generalized and Specialized, Transformation – Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.

UNIT III – DNA Replication and Translation (15 Hours)

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, Translation in prokaryotes and eukaryotes, post translational modifications.

UNIT IV – Gene regulation and expression (15 Hours)

Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems - repetitive DNA, gene rearrangement, promoters, enhancer elements.

UNIT V – Molecular Basis of Gene Mutation and Repair Mechanisms (15 Hours)

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).

Textbooks:

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 and Genomics. (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.

Web Resources

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Demonstrate the structure of DNA in prokaryotes and eukaryotes	1,3,4,5	K3,K4
CO-2	Illustrate the gene transfer studies in microbes.	1,2,3,4	K3.K4
CO-3	Relate DNA replication and protein synthesis.	2,3,4,5	K1,K4
CO-4	Categorize the types of mutation and its impact on microbes.	1,3,4,5	K4,K5
CO-5	Explain out various strategies on gene cloning.	1,2,4,5	K2,K5,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	24PCMB13	Microbial Genetics				75	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	2	3	2	3	3	3
CO-2	3	2	2	3	3	3	2	3	3	3
CO-3	2	3	3	3	3	2	3	3	2	3
CO-4	3	2	3	2	3	3	2	3	3	3
CO-5	3	3	2	3	3	3	2	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Techniques in General Microbiology and Microbial Diversity		24PCMB1P1			
Core – P-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

The courses describe the practical knowledge on general concepts of aseptic techniques used in laboratory preparation and analyze the classification of bacteria based on morphological and cultural characteristics.

Learning Objectives:

LO	The learners will be able to:
LO-1	Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.
LO-2	Prepare media for bacterial growth. Discuss plating and growth measurement techniques.
LO-3	Acquire adequate skills to perform blood grouping and serological reactions.
LO-4	Provide fundamental skills in preparation, separation and purification of immunoglobulin.
LO-5	Apply the knowledge of molecular biology skills in clinical diagnosis.

UNIT I - Microscopic Techniques (12 Hours)

1.1. Microscopic Techniques: Light microscopy

1.2. Hay infusion broth. Wet mount to show different types of microbes hanging drop.

1.3. Dark field microscopy – Motility of Spirochetes.

1.4. Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration.

UNIT II - Staining techniques (12 Hours)

2.1. Staining techniques - Simple staining

2.2. Gram's staining

2.3. Acid fast staining

2.4. Meta chromatic granule staining

2.5. Spore, Capsule

2.6. Flagella staining

UNIT III – Media Preparation (12 Hours)

3.1. Media Preparation: Preparation of liquid, solid and semisolid media.

3.2. Agar deeps, slants, plates.

3.3. Preparation of basal, enriched, selective and enrichment media.

UNIT IV – Biochemical Tests (12 Hours)

4.1. Preparation of Biochemical test media:

4.2. IMViC

4.3. Triple sugar iron test

4.4. H_2S test, Urease test

4.5. Catalase test

4.6. Nitrate reduction,

4.7. Oxidase Test

4.8. media to demonstrate enzymatic activities (starch, casein, lipid, gelatin).

4.9. Anaerobic culture methods.

UNIT V – Purification and Maintenance of Microbes (12 Hours)

5.1. Purification and maintenance of microbes - Streak plate, pour plate.

5.2. Slide culture technique.

5.3. Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate.

5.4. Bacterial growth curve

5.5. Effect of physical and chemical factors on growth.

Textbooks:

1. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.
3. Cullimore, D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -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. (5th Edition). Elsevier.
5. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

Reference 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.
2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.

4. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd. 2012.
5. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt. Ltd.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Practice microscopic techniques and staining methods in the identification and differentiation of microbes.	1,3,4,5	K3,K4
CO-2	Estimate the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	1.2,3,4,5	K2,K6
CO-3	Relate the different biochemical tests and carbohydrate fermentation tests to identify the test organism	1,2,4,5	K1,K3
CO-4	Examine the production of various enzymes for effective utilization of raw materials by microorganisms	2,,3,45	K4,K6
CO-5	Review and separate the biomolecules using standardized methods	1,2,4,5	K2,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCMB1P1	Techniques in General Microbiology and Microbial Diversity	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	3	3	2	3	3	3
CO-2	3	3	2	3	3	3	3	3	3	2
CO-3	3	3	2	3	3	2	3	3	3	2
CO-4	3	3	3	2	3	3	2	3	3	2
CO-5	3	3	2	3	3	3	2	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Techniques in Immunology		24PCMB1P2			
Core – P-II	Immunomics and Microbial Genetics		L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

The courses describe the practical knowledge on handling and applications of microscopy, sterilization methods, staining techniques for bacterial growth and to apply the knowledge of molecular biology skills in clinical diagnosis.

Learning Objectives:

LO	The learners will be able to:
LO-1	Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.
LO-2	Prepare media for bacterial growth. Discuss plating and growth measurement techniques.
LO-3	Acquire adequate skills to perform blood grouping and serological reactions.
LO-4	Provide fundamental skills in preparation, separation and purification of immunoglobulin.
LO-5	Apply the knowledge of molecular biology skills in clinical diagnosis.

UNIT I - Hematological and Agglutination reactions (12 Hours)

1.1. Hematological reactions - Blood Grouping – forward and reverse, Rh Typing.

1.2. Identification of various immune cells by morphology – Leishman staining and Giemsa staining.

1.3. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.

1.4. Detection of HBs Ag by ELISA.

UNIT II – Immunodiffusion and Immunoelectrophoresis (12 Hours)

2.1. Ouchterlony double immunodiffusion (ODD)

2.2. Mancini's single radial immunodiffusion (SRID).

2.3. Immuno-electrophoresis and staining of precipitin lines

2.4. Rocket immuno electrophoresis

2.5. Counter current immuno electrophoresis.

UNIT III – Lymphocyte Preparation and Immunoglobulin Purification (12 Hours)

3.1. Preparation of lymphocytes from peripheral blood by density gradient centrifugation.

3.2. Purification of immunoglobulin– Ammonium Sulphate Precipitation.

3.3. Separation of IgG by chromatography using DEAE cellulose or Sephadex.

UNIT IV –Induced Mutation and Isolation of Mutants (12 Hours)

4.1. UV induced mutation and isolation of mutants by Replica plate method

4.2. Gradient plate technique.

UNIT V – Isolation and Estimation of DNA (12 Hours)

5.1. Isolation of genomic DNA from *E.coli* and analysis by agarose gel electrophoresis.

5.2. Estimation of DNA using colorimeter (Diphenylamine reagent).

Textbooks:

1. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.
3. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -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. (5th Edition). Elsevier.
5. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

Reference 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.
2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
4. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd. 2012.
5. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt Ltd.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Demonstrate hematological assays and agglutination reactions through standardized procedures.	1,3,4,5	K3,K5
CO-2	Summarize the knowledge on the immunotechnology by different methods and measurement of immunodiffusion assays	2, ,3,4,5	K2,K5
CO-3	Discuss immunological reactions to aid diagnosis.	1,2,4,5	K2,K6
CO-4	Examine the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	1,2,4,5	K3,K4
CO-5	Evaluate the DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	1,2,3,4,5	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCMB1P2	Techniques in Immunology and Microbial Genetics	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	2	3	3	3	2	3	3	3
CO-2	3	3	2	3	2	3	3	3	2	3
CO-3	3	2	3	3	3	2	3	3	3	2
CO-4	3	2	3	2	3	3	3	3	2	3
CO-5	3	2	2	3	3	3	3	3	2	2
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Forensic Science		24PEMB11A			
EC – IA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

The course describes the tools and techniques in forensic science and also comprehend organizational setup of a forensic science laboratory.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the Scope, need and learn the tools and techniques in forensic science.
LO-2	Comprehend organizational setup of a forensic science laboratory.
LO-3	Identify and Examine body fluids for identification.
LO-4	Extract DNA from blood samples for investigation.
LO-5	Recognize medico legal post mortem procedures and their importance.

UNIT I - Definition and Techniques of Forensic Science (12 Hours)

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.

UNIT II - Forensic science laboratories (12 Hours)

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.

UNIT III – Forensic serology (12 Hours)

Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.

UNIT IV – DNA profiling (12 Hours)

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.

UNIT V – Forensic toxicology (12 Hours)

Forensic toxicology - Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action.

Textbooks:

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. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3. Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4. Sharma B.R (2020) Forensic science in criminal investigation and trials. (6th Edition) Universal Press.
5. Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12th Edition). Pearson Press.

Reference Books:

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

Web resources

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/microbial forensics

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Relate the Scope, need and learn the tools and techniques in forensic science.	1,3,4,5	K1,K3
CO-2	Compute organizational setup of a forensic science laboratory.	1,2,4,5	K3,K5
CO-3	Categorize and examine body fluids for identification.	2,34,5	K4, K5
CO-4	Illustrate the extraction of DNA from blood samples for investigation.	1,2,3,4	K4,K5
CO-5	Explain medico legal post mortem procedures and their importance.	1,2,3,4,5	K2,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours		Credits
I	24PEMB11A	Forensic Science					60		3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	2	3	3	2	3	3	3
CO-2	3	2	2	3	3	3	3	3	2	3
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	3	2	2	3	2	3	3	3
CO-5	3	3	3	2	3	3	2	3	3	2
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Health and Hygiene		24PEMB11B			
EC – IB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

The course aims at providing knowledge on hygiene, health (physical and mental) and health education programmes by the government.

Learning Objectives:

LO	The learners will be able to:
LO-1	Acquire knowledge on hygiene and live healthy.
LO-2	Provide insights on health laws for food safety and hygiene.
LO-3	Explain health, physical exercises and their importance.
LO-4	Illustrate mental hygiene and involved in mental hygiene.
LO-5	Describe the various health and health education programmes by the government.

UNIT I - Hygiene and Healthy Living (12 Hours)

Introduction to hygiene and healthful live. Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.

UNIT II - Nutrition and Health (12 Hours)

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.

UNIT III – Awareness on Physical Health (12 Hours)

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.

UNIT IV – Mental Hygiene (12 Hours)

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.

UNIT V – Health Programme and Health Education (12 Hours)

Health programme and health education – Malaria control, Tuberculosis control, AIDS control programmes and Immunization

Programmes. Family planning, Reproductive and Child health programmes (RCH).

Textbooks:

1. Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4th Edition). 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. (10th Edition). Universities Press (India) Pvt. Ltd
4. Lindsay Dingwall (2010). Personal Hygiene Care. Print ISBN:9781405163071 |Online ISBN:9781444318708 |DOI:10.1002 / 9781444318708
5. Walter C. C. Pakes (1900). The Science of Hygiene: a Text-book of Laboratory Practice.
   (London: Methuen and Co.,).

Reference Books:

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

Web Resources

1. Health and Hygiene - Personal Hygiene, Community Hygiene and Diseases (vedantu.com) Chapter-32.pdf (nios.ac.in)
2. Menstrual Health and Hygiene Guide | Student Health and Counseling Services (ucdavis.edu)
3. https://nap.nationalacademies.org/read/11756/chapter/13
4. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Review factors affecting health and health habits.	1,3,4,5	K2,K5
CO-2	Identify the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.	1,2,4,5	K1,K2
CO-3	Evaluate personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.	1,2,3,4	K3,K6
CO-4	Criticize the Mental hygiene and maintain emotional stability.	1,3,4,5	K4,K5
CO-5	Illustrate health education programmes	1,2,3,4,5	K3,K4
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours			Credits
I	24PEMB11B	Health and Hygiene					60			3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	2	3	3	2	3	3	3
CO-2	3	3	2	3	3	3	3	3	2	3
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	3	2	3	3	3	3	2	3
CO-5	3	3	2	3	3	3	3	3	3	2
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Microalgal Technology		24PEMB11C			
EC – IC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

The course enlightens the students about the algal species, their cultivation techniques and also emphasize on their commercial applications especially as alternate fuels.

Learning Objectives:

LO	The learners will be able to:
LO-1	Characterize the different groups of algae.
LO-2	Describe the cultivation and harvesting of algae.
LO-3	Identify the commercial applications of various algal products.
LO-4	Apply microalgae for environmental applications.
LO-5	Employ microalgae as alternate fuels.

UNIT I - Diversification of Algae and Identification Methods (12 Hours)

Introduction to Algae - General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution - Freshwater, brackish water and marine algae. Identification methods. An overview of applied Phycology. Economically important microalgae.

UNIT II - Cultivation of Freshwater and Marine Microalgae (12 Hours)

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.

UNIT III – Microalgae in Food and Nutraceutical Applications (12 Hours)

Microalgae in food and nutraceutical applications - Algal single cell proteins. Cultivation of *Spirulina* and *Dunaliella.* Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Phycobiliproteins- production and commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications.

UNIT IV – Microalgae in Environmental Applications (12 Hours)

Microalgae in environmental applications. Phycoremediation - Domestic and industrial waste water treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.

UNIT V – Microalgae as Biofuels (12 Hours)

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. Biocrude synthesis from microalgae. Integrated biorefinery concept. Life cycle analysis of algae biofuels.

Textbooks:

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., Jyothi Kishen 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 Value-added 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.

Web Resources

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/10310320
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Relate knowledge in the field of microalgal technology and their characteristics.	1,3,4,5	K1,K3
CO-2	Illustrate the methods of algal cultivation and harvesting.	2,3,4,5	K3,K4
CO-3	Demonstrate and recommend the use of microalgae as food, feed and fodder.	1,2,3,4	K3,K4
CO-4	Explain the usage of microalgae in phytoremediation.	1,3,4,5	K2,K6
CO-5	Categorize and critically evaluate recent applied research in these Microalgal applications.	1,2,4,5	K4,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours		Credits
I	24PEMB11C	Microalgal Technology					60		3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	2	3	3	3	2	3	3	3
CO-2	3	2	2	3	3	3	3	2	2	3
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	3	2	3	3	2	3	2	3
CO-5	3	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Signature: Head of the Department

Semester - I	Entrepreneurship in Microbiology		24PIMB11			
EC – II-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

The course explains about the term entrepreneurship, ideas to become a successful entrepreneur, production of biological products and their marketing strategies of value addition for the upliftment of the society.

Learning Objectives:

LO	The learners will be able to:
LO-1	Explain Entrepreneur and Entrepreneurship
LO-2	Relate the Production of microbiological products
LO-3	Analyse the Production of Biofertilizer
LO-4	Assemble the various Marine resources
LO-5	Choose the Marine resources cultivation and harvesting methods

UNIT I - Concept of Entrepreneur and Entrepreneurship (6 Hours)

Entrepreneur: Definition, Characteristics, Function, Types, Entrepreneurship: Definitions - concept, Factors affecting Entrepreneurial growth, Entrepreneurial motivation, Entrepreneurial competencies– Role of Entrepreneurship in Economic Development.

UNIT II - Production of Microbiological Products (6 Hours)

Production of microbiological products: Fermented dairy products, Food-SCP (Algae, Spirulina, Yeast, Mushroom, Bacterial probiotics). Commercial SCP Products in the market.

UNIT III – Biofertilizer and Bioinsecticide (6 Hours)

Biofertilizer: Introduction- (Cyanobacteria, *Rhizobium, Azospirillum, Azotobacter, Frankia*, VAM). Vermicompost, Bioinsecticide (*Bacillus thuriengiensis*). Panchakavya, Fish Amino acids.

UNIT IV – Cultivation of Marine Resources and Spirulina (6 Hours)

Marine resources: Seaweed, Seagrass, Coral reefs- Types, cultivation and harvesting methods and products. Spirulina

UNIT V – Financial Support to Bio entrepreneurs (6 Hours)

Finance and Support to Bio entrepreneurs. Introduction - Government initiatives and Schemes. DST, CSIR, ICMR, DBT-BIRAC, BIG scheme, SIPCOT. Nationalized banks and other financial institutions. Marketing Management.

Textbooks:

1. Gordon E and Natarajan K. Entrepreneurship Development. 5th Edition. Himalaya Publishing House, New Delhi.2005.
2. Khanka SS., Entrepreneurial Development. S Chand Publishing, New Delhi. 2006.
3. Naidu NVR and Krishnarao T., Management and Entrepreneurship. I.K. International Pvt. Ltd, New Delhi. 2008.
4. Venkataraman G.S., Algal Biofertilizers and Rice Cultivation. Today and Tomorrow's Printers and Publishers, New Delhi. 1972.

Reference Books:

1. Bhatnagar, B. and A. Budhiraja. Entrepreneurship Development and Small Business Management. Vayu Education of India, New Delhi, 2011.
2. Gupta, C.B. and N.P. Srinivasan. Entrepreneurial Development in India. Sultan Chand & Sons, New Delhi, 2014.
3. Hisrich, R.D, M.P. Peters and D.A. Shepherd. Entrepreneurship. 6th Edition, Mc Graw Hill; Irwin, 2005.
4. Tilak, KVBR. Bacterial Biofertilizers. IARI Publications, New Delhi, 1990.

Web Resources

1. https://www.profitableventure.com/biotech-business-ideas/
2. https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
3. https://www.nature.com/articles/s41587-021-01110-3
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003900/
5. https://springhouse.in/government-schemes-every-entrepreneur/

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Summarize the skills for entrepreneurs and finance management.	1,3,4.5	K2,K5,K6
CO-2	Dramatize the production of fermented dairy products.	2,,3,4,5	K3,K5
CO-3	Relate different types of biofertilizers and bioinsecticides.	1,2,4,5	K1,K3
CO-4	Illustrate the importance of cultivation of marine recourses.	1,2,4,5	K3,K4
CO-5	Relate the products from marine resources like sea weed, seagrass, coral reefs.	1,3,4,5	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PIMB11	Entrepreneurship in Microbiology	30	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	2	3	3	2	2	3	3	3
CO-2	3	2	2	3	3	3	3	2	2	3
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	2	3	2	3
CO-5	2	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Signature: Head of the Department

Semester – II	Medical Bacteriology and Mycology		24PCMB21			
Core-IV			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	5

General Objective:

The course helps to understand the fundamental principles and clinical significance of bacteria and fungi in medical microbiology.

Learning Objectives:

LO	The learners will be able to:
LO-1	Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.
LO-2	Explain morphology, characteristics and pathogenesis of bacteria.
LO-3	Discuss various factors leading to pathogenesis of bacteria.
LO-4	Acquire knowledge on antifungal agents and their importance.
LO-5	Describe various diagnostic methods available for fungal disease diagnosis.

UNIT I: Basics in Medical Microbiology andLaboratory Practices (15 Hours)

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.

UNIT II: Bacterial Diseases I (15 Hours)

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci, Streptococci, Pneumococci, Neisseriae.*, *Bacillus*, *Corynebacteria, Mycobacteria* and *Clostridium.*

UNIT III: Bacterial Diseases II (15 Hours)

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, *Yersinia, Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella., Spirochaetes-*

Leptospira, Treponema and *Borrelia.* Nosocomial, zoonotic and opportunistic infections -prevention and control.

UNIT IV: Mycotic Infections I (15 Hours)

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.

UNIT V: Mycotic Infections II (15 Hours)

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.

Textbooks:

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.9th edn. Edward Arnold, London.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th edn. Elsevier, Mosby Saunders.

Web Resources

1. http://textbookofbacteriology.net/nd

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Illustrate the transport and process of various kinds of clinical specimens.	1,2,3,4,5	K3,K4
CO-2	Identify various bacteria based on morphology and pathogenesis.	2,3,4,5	K1,K2,K4
CO-3	Discuss various treatment methods for bacterial disease.	1,2,4,5	K2,K6
CO-4	Comply various methods to detect fungi in clinical samples and apply knowledge on antifungal agents	1,2,4,5	K5
CO-5	Evaluate various immunodiagnostic method to detect fungal infections.	1,2,3,4	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours		Credits
II	24PCMB21	Medical Bacteriology and Mycology					75		4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	2	3	3	3	2	3	2	3	3
CO-2	3	2	2	3	3	3	3	2	2	3
CO-3	2	3	2	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	2	3	2	3
CO-5	2	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Medical Virology and Parasitology		24PCMB22			
Core-V			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	4

General Objective:

This course is aimed to provide the students with a thorough understanding of the biology, transmission, and pathology of viruses and parasites that affect human health.

Learning Objectives:

LO	The learners will be able to:
LO-1	Describe the replication strategy and cultivation methods of viruses.
LO-2	Acquire knowledge about oncogenic virus and human viral infections.
LO-3	Develop diagnostic skills, in the identification of virus infections.
LO-4	Impart knowledge about parasitic infections.
LO-5	Develop diagnostic skills, in the identification of parasitic infections.

UNIT I: Virus – General Properties and Cultivation (15 Hours)

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).

UNIT II: Viral Diseases of Human and Diagnosis (15 Hours)

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

UNIT III: Bacterial Viruses and Antiviral Medications (15 Hours)

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.

UNIT IV: Human Parasite Diseases and Diagnosis (15 hours)

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.*

UNIT V: Human Parasitic Infections and Medications (15 Hours)

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. Cultivation of parasites. Diagnosis of parasitic infections - Serological and molecular diagnosis. Anti-protozoan drugs.

Textbooks:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.
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. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.-Part 22ndedn.Cambridge University Press.

4. Topley and Wilson's. (1998). Principles of Bacteriology.9th edn. Edward Arnold, London.

5. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.

6. Finegold S.M. (2000). Diagnostic Microbiology. (10th Edition). C.V. Mosby Company, St. Louis.

7. Levanthal R. and Cheadle R. S. (2012). Medical Parasitology. (6th Edition). S.A. Davies Co. Philadelphia.

Web Resources

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Experiment the cultivation of viruses by different methods and aid in diagnosis. Perform purification and viral assay.	1,3,4,5	K4,K5
CO-2	Recall the symptoms of viral infections and presumptively identify the viral disease.	2,3,4,5	K1,K5
CO-3	Formulate various viral diseases by different methods.(serological, conventional and molecular)	2,3,4,5	K5,K6
CO-4	Schedule to educate public about the spread, control and prevention of parasitic diseases.	1,2,3,4	K3
CO-5	Evaluate the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.	1,3,4,5	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCMB22	Medical Virology and Parasitology	75	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	2	3	3	2	2	3	3	3
CO-2	2	2	3	3	3	3	3	2	2	3
CO-3	2	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	2	3	2	3
CO-5	2	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Techniques in Medical Bacteriology and Mycology		24PCMB2P1			
Core-P-III			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

To develop proficiency in laboratory techniques and methodologies essential for the identification, cultivation and analysis of microorganisms in Medical Microbiology.

Learning Objectives:

LO	The learners will be able to:
LO-1	Develop skills in the diagnosis of bacterial infections.
LO-2	Impart knowledge on Cultivation and Enumeration of Bacteria
LO-3	Compute Antimicrobial Sensitivity of Bacteria
LO-4	To gain knowledge about fungal infections and its diagnosis
LO-5	Assessment of fungal growth and Identification

UNIT I – Isolation and Identification of Bacteria (12 hours)

1.1. Staining of clinical specimens

1.2. Wet mount, Differential and Special staining methods.

1.3. Isolation and identification of bacterial pathogens from clinical specimens

UNIT II – Cultivation and Enumeration of Bacteria (12 hours)

2.1. Cultivation of Bacteria in basal, differential, enriched, selective and special media.

2.2. Biochemical identification tests.

2.3. Enumeration of bacteria in urine to detect significant bacteriuria.

UNIT III – Antimicrobial Sensitivity of Bacteria (12 hours)

3.1. Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method.

3.2. Minimum inhibitory concentration (MIC) test and Minimum bactericidal concentration (MBC) test.

UNIT IV – Examination of Fungi by Staining (12 hours)

4.1. Identification and Classification of common fungi.

4.2. Mounting and staining of VAM spores.

4.3. Examination of different fungi by Lactophenol cotton blue staining.

4.4. Examination of different fungi by KOH staining.

UNIT V – Cultivation of Fungi and Identification (12 hours)

5.1. Cultivation of fungi and their identification - *Mucor, Rhizopus, Aspergillus, Penicillium.*

5.2. Microscopic observation of different asexual fungal spores.

5.3. Microscopic observation of fungal fruiting bodies.

5.4. Identification of Dermatophytes.

Textbooks:

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2nd Edition. Publisher-Taylor and Francis.

2. Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.

3. Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.

4. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.

5. Morag C. and Timbury M.C. (1994) Medical Virology. 4th edn. Blackwell Scientific Publishers

Reference 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.

2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14thedn, Churchill Livingston.

3. Chart H. (2018). Practical Laboratory Bacteriology. CRC Press..

4. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.

5. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22nd Edition.Cambridge University Press.

6. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Practice skills in the diagnosis of bacterial infections.	1,3,4,5	K3,K4
CO-2	Illustrate knowledge on Cultivation and Enumeration of Bacteria	1,2,4,5	K3,K4
CO-3	Assess Antimicrobial Sensitivity of Bacteria	2, 3,4,5	K4,K6
CO-4	Explain knowledge about fungal infections and its diagnosis	1,3,4,5	K2,K5,K6
CO-5	Collect information on fungal growth and Identification	1,2,4,5	K2,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCMB2P1	Techniques in Medical Bacteriology and Mycology	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	3	2	3	3	3
CO-2	3	3	3	2	3	3	3	2	3	3
CO-3	2	3	3	3	3	3	2	3	3	3
CO-4	2	3	3	2	3	3	3	2	3	3
CO-5	3	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Signature: Head of the Department

Semester – II	Techniques in Medical Virology, Parasitology and Bioinformatics		24PCMB2P2			
Core-P-IV			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

To integrate microbiological techniques with bioinformatics tools to investigate the impact of microorganisms on human health, emphasizing data analysis, interpretation, and the development of effective health interventions.

Learning Objectives:

LO	The learners will be able to:
LO-1	Outline the Isolation and Cultivation of Virus
LO-2	Discuss the Detection of Parasites from Clinical Samples
LO-3	Dramatize the examination of Parasites from Clinical Samples
LO-4	Illustrate the knowledge on Sequence Analysis packages.
LO-5	Summarize the concept of Protein Motif and Phylogenetic Analysis

UNIT I – Isolation and Cultivation of Virus (12 hours)

1.1. Isolation and characterization of bacteriophage from natural sources by phage titration.

1.2. Cultivation of viruses – Egg Inoculation methods.

1.3. Diagnosis of Viral Infections –ELISA – HIA.

1.4. Spotters of viral inclusions and CPE-stained smears.

UNIT II - Detection of Parasites from Clinical Samples (12 hours)

2.1. Examination of parasites in clinical specimens - Ova / cysts in faeces.

2.2. Concentration: methods – Floatation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods-Formal ether method.

UNIT III – Examination of Parasites from Clinical Samples (12 hours)

3.1. Blood smear examination for malarial parasites - Thin smear by Leishman's stain – Thick smear by J.B. Stain.

3.2. Identification of common arthropods of medical importance - spotters of *Anopheles, Glossina, Phlebotomus, Aedes,* Ticks and mites.

UNIT IV – Sequence Analysis (12 hours)

4.1. Sequence Analysis Packages: EMBOSS, NCBI Tool Kit, SMS

4.2. Pairwise alignment: Search tools against Databases: BLAST, FASTA

4.3. Multiple sequence alignment: Clustal, Dialign, Multalign

UNIT V – Protein Motif and Phylogenetic Analysis (12 hours)

5.1. Protein motif and domain analysis: MEME/MAST, eMotif, InterproScan, ProSite.

5.2. Phylogenetic analysis – MEGA, PAUP, PHYLIP.

Textbooks:

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. Lesk A. M. (2002). Introduction to Bioinformatics. (4th Edition). Oxford University Press.

5. 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.

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. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press.

3. Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.

4. Bosu O. and Kaur S. (2007). Bioinformatics - Database, Tools, and Algorithms. Oxford University Press.

5.Harshawardhan P.Bal, (2006). Bioinformatics Principles and Applications, Tata McGraw-Hill Publishing Company Limited.

Course Outcomes:

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Relate the Isolation and Cultivation of Virus	2,3,4,5	K1,K3,K6
CO-2	Summarize the Detection of Parasites from Clinical Samples	1,2,3,4,5	K4,K5
CO-3	Illustrate the examination of Parasites from Clinical Samples	1,2,4,5	K3,K4
CO-4	Describe the knowledge on Sequence Analysis packages.	1,3,4,5	K1,K2,K6
CO-5	Explain the concept of Protein Motif and Phylogenetic Analysis	1,3,4,5	K2,K5,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PSMB2P2	Techniques in Medical Virology, Parasitology and Bioinformatics	60	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	2	3	2	3	3	2	3	3	3	3
CO-2	3	2	3	3	2	3	3	2	3	2
CO-3	2	3	2	3	3	3	2	3	3	3
CO-4	3	3	2	3	3	2	3	3	2	3
CO-5	2	3	2	3	3	3	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester – II	Nanobiotechnology		24PEMB21A			
EC-IIIA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To explore the intersection of nanotechnology and biology, focusing on the development and application of nanoscale tools and materials for biomedical research and therapies.

Learning Objectives:

LO	The learners will be able to:
LO-1	Analyze nanomaterials based on the understanding of nanobiotechnology.
LO-2	Discuss the methods of fabrication of nanomaterials.
LO-3	Gain Knowledge on characterization of nanomaterials.
LO-4	Discover nanomaterials for targeted drug delivery.
LO-5	Explain nanomaterials in nanomedicine and environmental pollution.

UNIT I - Nanobiotechnology and Class of Nanomaterials (12 hours)

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.

UNIT II - Fabrication of Nanomaterials (12 hours)

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.

UNIT III – Characterization of Nanoparticles (12 hours)

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).

UNIT IV – Nanomaterial Based Drug delivery and Therapeutics (12 hours)

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/metaloxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.

UNIT V – Nanomaterials in Diagnosis (12 hours)

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.

Textbooks:

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.

Web Resources

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
5. https://www.cdc.gov/niosh/topics/nanotech/default.html

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Employ knowledge in the field of nanobiotechnology for development.	1,2,3,4	K3,K4
CO-2	Identify various applications of nanomaterials in the field of medicine and environment.	1,3,4,5	K1,K2
CO-3	Examine the prospects and significance of nanobiotechnology.	1,2,4,5	K4,K6
CO-4	Discuss recent advances in this area and create a career or pursue research in the field.	1,2,3,4,5	K2,K6
CO-5	Design non-toxic nanoparticles for targeted drug delivery.	1,3,4,5	K3,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PEMB21A	Nanobiotechnology	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	2	3	3	3	3
CO-2	3	2	3	3	3	3	3	2	3	2
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	3	3	2	3
CO-5	2	3	2	3	3	2	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Bioremediation		24PEMB21B			
EC-IIIB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To understand and apply biological methods for the remediation of contaminated environments, focusing on the principles, techniques, and practical applications of using microorganisms to detoxify pollutants.

Learning Objectives:

LO	The learners will be able to:
LO-1	Describe the nature and importance of bioremediation and use in real world applications.
LO-2	Describe the typical composition of waste water and application of efficient technologies for water treatment.
LO-3	Explain the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.
LO-4	Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
LO-5	Familiarize the role of plants and their associated microbes in remediation and management of environmental pollution.

UNIT I - Bioremediation (12 hours)

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.

UNIT II – Microbes in Water Treatment (12 hours)

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.

UNIT III – Solid Waste Management (12 hours)

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.

UNIT IV – Microbial Transformation of Xenobiotics (12 hours)

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.

UNIT V – Phytoremediation of Heavy Metals (12 hours)

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.

Textbooks:

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications.

2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.

3.Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2nd edition, CRC Press.

4. Liu, D.H.Fand Liptak, B.G (2005). Hazardous Wastesand 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.

Web Resources

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	State the nature and importance of bioremediation and use in real world applications.	1,3,4,5	K1,K4
CO-2	Sketch out the typical composition of waste water and application of efficient technologies for water treatment.	1,2,3,5	K3,K5
CO-3	Review the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.	1,2,3,4,5	K1,K2
CO-4	Analyze the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.	1,3,4,5	K4,K6
CO-5	Justify the role of plants and their associated microbes in remediation and management of environmental pollution.	1,2,4,5	K2,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours			Credits
II	24PEMB21B	Bioremediation					60			3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	2	3	3	3	3
CO-2	3	2	3	3	3	3	3	2	3	2
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	3	3	2	3
CO-5	2	3	2	3	3	2	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Clinical Research and Clinical Trials		24PEMB21C			
EC-IIIC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide a comprehensive understanding of the principles, methodologies, and ethical considerations involved in designing, conducting, and analyzing clinical research and clinical trials.

Learning Objectives:

LO	The learners will be able to:
LO-1	Provide an overview of history and methods involved in conducting clinical research.
LO-2	Design the principles involved in ethical, legal, and regulatory issues in clinical research on human subjects.
LO-3	Describe principles and issues involved in monitoring patient-oriented research.
LO-4	Formulate a well- defined quality assurance and quality control plans.
LO-5	Acquire business development skills in the area of clinical research.

UNIT I – Clinical Research (12 hours)

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).

UNIT II – Guidelines and Regulations in Clinical Research (12 hours)

Ethical Considerations and Guidelines 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.

UNIT III – Clinical Trial Management (12 hours)

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.

UNIT IV – Quality Management (12 hours)

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.

UNIT V – Business Development in the Clinical Research Industry (12 hours)

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.

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, 4th edn, CBS publication and distributors.

5. Himanshu B. Text book of Clinical Research, Pee Vee books.

Reference Books:

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, 2nd Edition 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. 2nd Edition, CRC press, Taylor and Francis Group.

Web Resources:

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Point out the Drug Development process and different phases of clinical trials.	1,2,3,5	K3,K4
CO-2	Reorganize the ethics and regulatory perspectives on clinical research trials activities.	1,2,3,4	K2,K5
CO-3	Compute clinical trials management concepts and documentation process.	2,3,4,5	K3,K4
CO-4	Relate quality assurance and quality control to ensure the protection of human subjects and the reliability of clinical trial results.	2,3,4,5	K1,K3
CO-5	Predict the skills recitation to commercial start up and industriousness.	1,2,3,4,5	K3,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours		Credits
II	24PEMB21C	Clinical Research and Clinical Trials					60		3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	2	3	3	3	3
CO-2	3	2	3	3	3	3	3	2	3	2
CO-3	2	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	3	3	3	3	3	2	3
CO-5	2	3	2	3	3	2	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Microbiology and Human Health		24PIMB21			
EC-IV-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

To explore the intricate relationship between microbiology and human health, focusing on the role of microorganisms in disease, immunity, and therapeutic applications, while emphasizing public health implications and preventive strategies.

Learning Objectives:

LO	The learners will be able to:
LO-1	State the significance of public health.
LO-2	Summarize the Air Borne Microbial Diseases
LO-3	Dramatize the knowledge in Water Borne Microbial Diseases
LO-4	Compare the Food Borne Microbial Diseases
LO-5	Assess the knowledge of Antimicrobial Agents and Vaccines

UNIT I - Public Health Microbiology (6 hours)

Public Health microbiology - Definition, scope, concept and importance – roles of microbiologist in public health. Normal flora of human body, Role of the resident flora.

UNIT II – Air Borne Microbial Diseases (6 hours)

Brief account of major air borne diseases of microbial origin and their preventive and control measures – Measles, Tuberculosis, Aspergillosis

UNIT III – Water Borne Microbial Diseases (6 hours)

Brief account of major water borne diseases of microbial origin and their preventive and control measures – *E. coli* infection, Hepatitis A, Giardiasis.

UNIT IV – Food Borne Microbial Diseases (6 hours)

Brief account of major food borne diseases of microbial origin and their preventive and control measures – Botulism, Rotaviral Gastroenteritis, Taeniasis.

UNIT V – Antimicrobial Agents and Vaccines (6 hours)

Antibiotic susceptibility test. Antibacterial, antifungal, antiviral and antiparasitic agents – Examples and their modes of action. Vaccines - Bacterial and Viral vaccines in human health.

Textbooks:

1. Atlas R. M. Principles of Microbiology, II Ed., McGraw Hill, 1997.

2. Ghimire P. and Parajuli K. A Text Book of Microbiology, Vidhyarthi Pustak Bhandar Publication, Kathmandu, 2005.

3 Parija. Textbook of Microbiology and Immunology. ELSEVIER, ISBN: 978-81-312-2810-4., 2012.

4. Talaro K. P. and Talaro A. Foundations in Microbiology (6th Ed.), McGraw-Hill College. Dimensi,2006.

5. Willey J., Sherwood L. and Woolverton C. Prescott/Harley/Klein's Microbiology, McGraw Hill, 2007.

Reference Books:

1. Brownson, R.C., Baker, E.A., Leet T.L. and Follespie K.N. Evidence Based Public Health, Oxford University Press, 2003.

2. Greenwood D. Medical Microbiology, 4th Ed., I.K. International, 2007.

3.Harvey, R.A., Champe, P.C. and Fisher, B.D. Lippincott's Illustrated Reviews: Microbiology,2007.

4.Nester E. W., Anderson D. G. and Nester M. T. Microbiology: A Human Perspective, McGrawHill,2006.

5. Willey J., Sherwood L. and Woolverton C. Prescott/Harley/Klein's Microbiology, McGraw Hill, 2007.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9837825/#:~:text=Altogether%2C%20the%20human%20microbiome%20thrives,environment%2C%20potentially%20resulting%20in%20disease.
2. https://www.nature.com/articles/s41392-022-00974-4
3. https://academic.oup.com/book/504/chapter-abstract/135266346?redirectedFrom=fulltext
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7306068/
5. https://microbiologysociety.org/our-work/75th-showcasing-why-microbiology-matters/unlocking-the-microbiome/the-microbiome-and-human-health.html

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Illustrate the significance of public health.	1,2,3,4	K3,K4
CO-2	Generate the comprehension of Air Borne Microbial Diseases	1,3,4,5	K3,K5
CO-3	Summarize the knowledge in Water Borne Microbial Diseases	2,3,4,5	K2,K5,K6
CO-4	Sketch out the Food Borne Microbial Diseases	1,3,4,5	K3,K4
CO-5	Assess the knowledge of Antimicrobial Agents and Vaccines	1,2,4,5	K4,K6
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course					Hours		Credits
II	24PIMB21	Microbiology and Human Health					30		2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	3	2	3	3	2	3	3	3	3
CO-2	3	2	3	3	3	3	3	2	3	2
CO-3	3	2	3	3	3	3	2	3	3	3
CO-4	3	3	2	3	3	3	3	3	2	3
CO-5	2	3	2	3	3	3	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Bioinformatics		24PSMB21			
SEC-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide comprehensive knowledge and practical skills in the application of computational methods to the analysis and interpretation of biological data.

Learning Objectives

LO	The learners will be able to:
LO-1	Discuss about various biological data mining concepts, tools.
LO-2	Elucidate the principles and applications of sequence alignment methods and tools.
LO-3	Demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.
LO-4	Acquaint with various approaches in predicting 3D and 2D structure of proteins.
LO-5	Describe various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics.

UNIT I - Biological Data Mining (12 hours)

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.

UNIT II - Phylogenetic Tree Construction (12 hours)

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.

UNIT III – Computational Protein Structure prediction (12 hours)

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.

UNIT IV – Prediction of Properties of Ligand Compounds (12 hours)

Prediction of Properties of Ligand Compounds – 3D Autocorrelation - 3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis.

UNIT V – Molecular Docking (12 hours)

Molecular Docking - Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Molecular Docking Software and Working Methods. Genome to drug discovery – Principles of Immunoinformatics and Vaccine Development.

Textbooks:

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.

Web Resources

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 Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Analyze databases that provides information on nucleic acids and proteins.	1,2,4,5	K4,K5
CO-2	Compute and invent algorithms for sequence alignment.	1,2,3,4,5	K3,K4
CO-3	Discuss and construct phylogenetic tree.	2,3,4,5	K2,K6
CO-4	Predict the structure of proteins.	1,2,3,4	K2,K6
CO-5	Design drugs by predicting drug ligand interactions and molecular docking.	1,2,4,5	K3,K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credits		
II	24PSMB21	Bioinformatics				60		3		
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	2	3	3	2	2	3	3	3
CO-2	3	2	2	3	3	3	3	2	2	2
CO-3	3	2	3	3	3	2	3	3	3	3
CO-4	3	3	2	2	3	3	2	3	2	3
CO-5	2	3	2	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department