AVS

COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

Attur Main Road, Ramalingapuram, Salem - 106.

(Recognized under section 2(f) & 12(B) of UGC Act 1956 and

Accredited by NAAC with 'A' Grade)

(Co - Educational Institution | Affiliated to Periyar University, Salem

ISO 9001 : 2015 Certified Institution)

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Syllabus for

M.Sc. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM –

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK

(CBCS – LOCF)

(Applicable to the Candidates admitted from 2023-24 onwards)

VISION

- To attain excellence in the field of education by creating competent scholars with a touch of human values.

MISSION

- To accomplish eminence in the academic domain.
- To provide updated infrastructure.
- To educate value based education.
- To impart skills through efficient training programs.
- To cultivate culture and tradition with discipline and determination.

REGULATIONS

1. Eligibility for Admission:

Candidate who has passed the B.Sc. degree in any Life Sciences [Microbiology / Applied Microbiology/Industrial Microbiology/ Botany/Plant Sciences and Plant Biotechnology/Zoology/ Animal Science/ Applied Animal Science and Animal Biotechnology/Biochemistry/Bioinformatics /Biology/ Food Science & Nutrition/ /BSc Medical Lab Technology/ BSMS /BAMS /BUMS/ BHMS/ Chemistry with Botany/Zoology]as Allied Subjects of this University or an Examination of any other University accepted by the Syndicate as equivalent there to shall be eligible for admission to M.Sc. Degree Course in Applied Microbiology. Candidate shall be admitted to the examination only if he/she has taken the qualifying degree in Science/Medical subjects as mentioned after having completed the prescribed courses consisting of twelve years of Study and has passed the qualifying examination.

2. Duration:

The duration of the course is for two academic years consisting of four semesters.

3. Eligibility for award of degree:

A candidate shall be eligible for the award of the degree only if he / she has undergone the prescribed course of Study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning 90 credits (plus 2 credits for Human Rights) and fulfilled such conditions as have been prescribed therefore.

4. Course of Study:

TheCourseofStudyshallcompriseinstructioninthefollowingsubjectsaccordingtothesyllabusand bookspresc ribed from time to time.

5. Scheme of Examination:

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively.

6. Passing Rules:

Theory- Internal Mark-25 External Mark-75 = 100 Marks

Practical- Internal Mark-40 External Mark- 60 = 100 Marks

i) Theory

Maximum Mark-75

Minimum Pass Mark-38

ii) Practical

Maximum Mark- 60

Minimum Pass Mark-24

Programme Outcomes (POs) On successful completion of the **M.Sc. Microbiology**	
PO1	**PO1:ProblemSolvingSkill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO2	**PO2:DecisionMakingSkill** Foster analytical and critical thinking abilities for data-based decision-making.
PO3	**PO3:EthicalValue** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
PO4	**PO4:CommunicationSkill** Ability to develop communication, managerial and inter personal skills.
PO5	**PO5:IndividualandTeamLeadershipSkill** Capability to lead themselves and the team to achieve organizational goals.
PO6	**PO6:EmployabilitySkill** Inculcate contemporary business practices to enhance employability skills in the competitive environment
PO7	**PO7:EntrepreneurialSkill** Equip with skills and competencies to become an entrepreneur.
PO8	**PO8:ContributiontoSociety** Succeed in career endeavors and contribute significantly to society.
PO9	**PO9:Multiculturalcompetence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO10	**PO10:Moralandethicalawareness/reasoning** Ability to embrace moral/ethical values in conductin gone'slife.

Program Specific Outcomes (PSOs)

After the successful completion of **M.Sc Microbiology** programme the students are expected to

PSO1	**PSO1–Placement** To prepare the students who will demonstrate respectful Engagement with others' ideas, behaviors, beliefs and apply diverse frame so freference to decisions and actions.
PSO2	**PSO2–Entrepreneur** To creat effective entrepreneurs by enhancing their critical thinking, problem Solving, decision making and leadership skill that will facilitates artups and high potential organizations.
PSO3	**PSO3–Research and Development** DesignandimplementHRsystemsandpracticesgroundedinresearchthatcomplywithemploymentlaws,leadingtheorganizationtowards growth and development
PSO4	**PSO4–Contribution to Business World** To produce employable, ethical and innovativepr of essionals to sustain in the dynamic business world.
PSO5	**PSO5–Contribution to the Society** To contribute to the development of the society by collaborating with stake holders for mutual benefit.

Programme Educational Objectives (PEOs)

The **M.Sc. Microbiology** programme describes accomplishments that graduates are expected to attain within five to seven years after graduation.

PEO1	Impart basic knowledge about the History and classification of Microbiology.
PEO2	Throw light on principles and working of different microscopes.
PEO3	Explain Eukaryotic and Prokaryotic cell structure and staining techniques.
PEO4	Provide insights on cultivation techniques and antibiotics.
PEO5	Demonstrate the importance of various sterilization methods.

CREDIT DISTRIBUTION FOR 2 YEARS M.Sc. MICROBIOLOGY PROGRAMME

SEMESTER	Course Type	Credits per Course	No. of Papers	Total Credits
	Core Courses- Theory	5-4	9	44
	Core Courses- Practical	4+4+5	3	13
	Major Elective Courses- Theory			
	Major Elective Courses- Practical			
	Generic Discipline Specific/ Allied Courses – Theory	3	6	18
	Generic Discipline Specific/ Allied Courses – Practical			
			Total	**75**
	Non Major Elective Courses	2	2	4
	Skill Enhancement Courses			
	Professional Competency Skill Enhancement Course	2	1	2
	EVS (Environmental Studies)			
	Value Education			
	Internship	2	1	2
	Field Project			
	Research Project (for PG only)	7	1	7
	MOOC/ SWAYAM/ NPTEL Courses			
			Total	**15**
	Extension Activity (NSS/NCC/Physical Education)	1	1	1
	Fundamentals Of Human Rights	1	1	1
			Total Credits	**92**

CONSOLIDATED SEMESTER WISE AND COMPONENT WISE CREDIT DISTRIBUTION FOR 2 YEARS M.Sc. MICROBIOLOGY PROGRAMME

Parts	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI	Total Credits
C-Theory	10	10	14	10	-	-	44
C-Practical	4	4	5	-	-	-	13
Generic Discipline	6	6	3	3	-	-	18
NME	-	2	2	-	-	-	4
Project	-	-	-	7	-	-	7
Internship	-	-	2	-	-	-	2
Professional Competency Skill	-	-	-	2	-	-	2
Extension Activity	-	Fundamentals Of Human Rights-1	-	1	-	-	2
Total	20	23	26	23	-	-	92

METHOD OF EVALUATION

Evaluation	Components		Marks
Internal Evaluation	Continuous Internal Assessment Test	15	25 Marks
	Assignments	3	
	Class Participation	2	
	Distribution of marks for Attendance (in percentage) 96 – 100: 5 Marks 91 – 95: 4 Marks 86 – 90: 3 Marks 81 – 85: 2 Marks	5	
External Evaluation	End Semester Examination		75 Marks
Total			**100 Marks**

Note: 1.PG Programmes- A candidate must score minimum 13 marks in Internal and 38 marks in External Evaluation.

CONTINUOUS INTERNAL ASSESSMENT

Categorizing Outcome Assessment Levels Using Bloom's Taxonomy

level	Cognitive Domain	Description
K1	Remember	It is the ability to remember the previously learned concepts or ideas.
K2	Understand	The learner explains concepts or ideas.
K3	Apply	The learner uses existing knowledge in new contexts.
K4	Analyze	The learner is expected to draw relations among ideas and to compare and contrast.
K5	Evaluate	The learner makes judgments based on sound analysis.
K6	Create	The learner creates something unique or original.

Question Paper Blue Print for Continuous Internal Assessment - I & II

Duration: 2 Hours							Maximum: 50 marks
Section	K level						Marks
	K1	K2	K3	K4	K5	K6	
A (no choice)	10						10 X 1 =10
B (no choice)		1	1				2 X 5 =10
C (either or choice)				3			3 x 10 = 30
Total							50 marks

Note: K4 and K5 levels will be assessed in the Model Examination whereas K5 and K6 Levels will be assessed in the End Semester Examinations.

Question Paper Blue Print for Continuous Internal Assessment - I

Time: 2 Hours Total Marks: 50 Marks Minimum Pass: 20 Marks

Unit	Section - A	Section - B	Section – C
I	Q.N. 1, 2, 3, 4, 5	Q.N. 11	Q.N. 13 A, 13 B
I or II	-	-	Q.N. 14 A, 14 B
II	Q.N. 6, 7, 8, 9, 10	Q.N. 12	Q.N. 15 A, 15 B

SECTION – A (10 X 1 = 10 Marks)

ANSWER ALL THE QUESTIONS

SECTION – B (2 X 5 = 10 Marks)

ANSWER ALL THE QUESTIONS

SECTION – C (3 X 10 = 30 Marks)

ANSWER ALL THE QUESTIONS (Either or Choice)

Question Paper Blue Print for Continuous Internal Assessment - II

Time: 2 Hours Total Marks: 50 Marks Minimum Pass: 20 Marks

Unit	Section - A	Section - B	Section – C
III	Q.N. 1, 2, 3, 4, 5	Q.N. 11	Q.N. 13 A, 13 B
III or IV	-	-	Q.N. 14 A, 14 B
IV	Q.N. 6, 7, 8, 9, 10	Q.N. 12	Q.N. 15 A, 15 B

SECTION – A (10 X 1 = 10 Marks)

ANSWER ALL THE QUESTIONS

SECTION – B (2 X 5 = 10 Marks)

ANSWER ALL THE QUESTIONS

SECTION – C (3 X 10 = 30 Marks)

ANSWER ALL THE QUESTIONS (Either or Choice)

Question Paper Blue Print for Model Examination & End Semester Examination

Duration: 3 Hours								Maximum: 75 marks
Section		K level						Marks
		K1	K2	K3	K4	K5	K6	
A (no choice, three questions from each unit)		15						15 X 1 =15
B (choice, one question from each unit)			1	1				2 X 5 =10
C (either or choice & two questions from each unit)	Courses with K4 as the highest cognitive level				4	1		5 x 10 = 50
	Course with K5 as the highest cognitive level wherein three K4 questions and two K5 questions are compulsory.				3	2		
	Course with K6 as the highest cognitive level wherein two questions each on K4, K5 and one question on K6 are compulsory.				2	2	1	
Total								75 marks

Question Paper Blue Print for Model Examination & End Semester Examination

Time: 2 Hours Total Marks: 75 Marks Minimum Pass: 30 Marks

Unit	Section - A	Section - B	Section – C
I	Q.N. 1, 2, 3	Q.N. 16	Q.N. 21 A, 21 B
II	Q.N. 4, 5, 6	Q.N. 17	Q.N. 22 A, 22 B
III	Q.N. 7, 8, 9	Q.N. 18	Q.N. 23 A, 23 B
IV	Q.N. 10, 11, 12	Q.N. 19	Q.N. 24 A, 24 B
V	Q.N. 13, 14, 15	Q.N. 20	Q.N. 25 A, 25 B

SECTION – A (15 X 1 = 15 Marks)

ANSWER ALL THE QUESTIONS

SECTION – B (2 X 5 = 10 Marks)

ANSWER ANY TWO QUESTIONS

SECTION – C (5 X 10 = 50 Marks)

ANSWER ALL THE QUESTIONS (Either or Choice)

Question Paper Blue Print for Model Practical Examination & End Semester Examination (Practical)

Time: 3 Hours Total Marks: 60 Marks Minimum Pass: 24 Marks

Practical Marks	Maximum Mark	Minimum Mark
Internal	40	16
External	60	24
Total	100	40

Evaluation for End Semester Examinations (Practical)

Record	10 marks
Formula with expansion	05 marks
Observation with data	20 marks
Viva-voce	05 marks
Calculation	15 marks
Result with units	05 marks
TOTAL	**60 MARKS**

*Submission of record with due certification is a must for external practical examinations.

**A student should complete all requires experiments to get 10 marks for the record.

Scheme of Examination for M.Sc. Microbiology

First Year – Semester - I

Sem	Course Code	Course Title	Ins. Hrs	Credit	CIA	ESE	Total
I	23PMBCT01	Core - I General Microbiology and Microbial Diversity	5	5	25	75	100
I	23PMBCT02	Core – II Immunology, Immunomics and Microbial Genetics	5	5	25	75	100
I	23PMBCP01	Core – III - Practical - I	5	4	40	60	100
I	23PMBCE102	Elective - I Health and Hygiene	5	3	25	75	100
I	23PMBCE202	Elective - II Herbal Technology and Cosmetic Microbiology	5	3	25	75	100
Total			**25**	**20**			

First Year – Semester - II

Sem	Course Code	Course Title	Ins. Hrs	Credit	CIA	ESE	Total
II	23PMBCT03	Core - IV Medical Bacteriology and Mycology	4	5	25	75	100
II	23PMBCT04	Core - V Medical Virology and Parasitology	4	5	25	75	100
II	23PMBCP02	Core – VI - Practical - II	4	4	40	60	100
II	23PMBCE302	Elective - III Clinical And Diagnostic Microbiology	4	3	25	75	100
II	23PMBCE402	Elective - IV Nanobiotechnology	4	3	25	75	100
II	23PBTNME1	Non Major Elective Course – Gene Manipulation Technology	4	2	25	75	100
II	23PSOCCC01	Fundamentals of Human Rights	1	1	25	75	100
Total			**25**	**23**			

Second Year – Semester - III

Sem	Course Code	Course Title	Ins. Hrs	Credit	CIA	ESE	Total
III	23PMBCT05	Core - VII Soil and Environmental Microbiology	5	5	25	75	100
III	23PMBCT06	Core - VIII Molecular Biology and Recombinant DNA Technology	5	5	25	75	100
III	23PMBCP03	Core - IX - Practical III	5	5	40	60	100
III	23PMBCT07	Core - X Industry Module- Fermentation Technology and Pharmaceutical Microbiology	5	4	25	75	100
III	23PMBCE501	Elective - V Bio safety, Bioethics and IPR	3	3	25	75	100
III	23PMBSEC02	Skill Enhancement Course I - Organic Farming and Bio fertilizer Technology	2	2	25	75	100
III	23PMBIT01	Internship/Industrial Activity	-	2	-	-	-
Total			**25**	**26**			

Second Year – Semester - IV

Part	Course Code	Course Title	Ins. Hrs	Credit	CIA	ESE	Total
IV	23PMBCT08	Core - XI Food & Dairy Microbiology	5	5	25	75	100
IV	23PMBCT09	Core - XII Research Methodology & Biostatistics	5	5	25	75	100
IV	23PMBCE602	Elective - VI Marine Microbiology	4	3	25	75	100
IV	23PMBPR01	Project - Project with Viva Voce	7	7	25	75	100
IV	23PMBSEC03	Skill Enhancement Course – II Microbial Quality Control and Testing	4	2	25	75	100
IV	23PMBEC01	Extension Activity	-	1	-	-	-
Total			**25**	**23**			

****Ins. Hrs –** Instructional Hours**, CIA-** Continuous Internal Assessment**, ESE-** End Semester Examination

Semester: I	Course Code: 23PMBCT01	Hours/Week: 7	Credit: 5
COURSE TITLE: CORE I - GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY			

Course Overview:

1. Microbial diversity can be defined as the range of different kinds of unicellular organisms, bacteria, archaea, protists, and fungi.
2. Various different microbes thrive throughout the biosphere, defining the limits of life and creating conditions conducive for the survival and evolution of other living beings.
3. 'Microbial diversity' considers the vast array of microorganisms—the smallest forms of life—which exist everywhere.
4. The three primary groups of microorganisms are bacteria, archaea, and eukaryotes. Bacteria and archaea are prokaryotes with their genetic material held in a single chromosome.

Learning Objectives:

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

Unit - I	History and Scope of Microbiology	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	Bacterial Structure & Classification	20 Hours

Bacterial Structure, properties and biosynthesis of cellular components – Cell wall. 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 - III	Algae Morphology, Classification & Life Cycle	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, Volvox Spirogyra (Green algae), Nostoc (Cyanobacteria). Ectocarpus, Sargassum (Brown algae), Polysiphonia, Batrachospermum (Red algae).

Unit - IV	Microbial Techniques	15 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 - V	Biodiversity	20 Hours

Biodiversity - Introduction to microbial biodiversity – Thermophiles - Classification, Thermophilic Archaebacteria and its applications. Methanogens - Classification, Habitats, applications. Alkaliphiles 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 / halo tolerance - Applications of halophiles. Conservation of Biodiversity.

Text Book(s):

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). McGraw 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 6
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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	K1
CO2	Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.	K2
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.	K3
CO4	Create aseptic conditions by following good laboratory practices.	K4
CO5	Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**S**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**M**	**S**	**M**	**M**	**S**	**S**	**M**	**M**	**S**
CO3	**S**	**M**	**-**	**S**	**-**	**M**	**S**	**S**	**S**
CO4	**S**	**-**	**S**	**-**	**S**	**-**	**-**	**S**	**S**
CO5	**-**	**S**	**-**	**M**	**M**	**M**	**S**	**-**	**-**

S - Strong, M – Medium, L – Low

Semester: I	Course Code: 23PMBCT02	Hours/Week: 7	Credit: 5
COURSE TITLE: CORE II - IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS			

Course Overview:

1. Genetics of bacteria and phage, focusing on replication, repair, transcription, translation, gene regulation, genetic networks, plasmids, conjugation, transformation, microbial and phage interactions, and different types of phage and their lifestyles.
2. Microbial genetics has traditionally been a field of basic science research as microorganisms offer several features that facilitate the Study of evolutionary processes.
3. Immunology is the Study of the immune system in a diversity of organisms.
4. Immunology and Molecular Genetics integrative programs focus on Studying microbiology and immunology as they relate to pathogenesis and host defense against microbial infection, to autoimmune diseases or allergy/cancer

Learning Objectives:

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

Unit - I	Introduction to Biology of the Immune System	20 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, Genetics of HLA Systems – Antigens and HLA typing. Antigen processing and presentation to T lymphocytes.

Unit - II	Theories of Antibody Production	20 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 Genetic of Immunohematology	25 Hours

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immune deficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D- antigens. Diagnostic Immunology - Precipitation reaction, Immuno diffusion methods - SRID, ODD. Immuno electrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry. Immune regulation mechanisms – immuno-induction, immuno- suppression, immune 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 - IV	Structural of Prokaryotic and Eukaryotic Gene	13 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 - V	Gene Transfer Mechanisms	12 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.

Text Book(s):

1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5 th Edition). Wiley-Blackwell, New York.
2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7 th 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. (4 th Edition). Narosa Publishing House, New Delhi.
5. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8 th Edition). Wiley India Pvt. Ltd.

Reference Books:

1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3 rd 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 (4 th Edition). Wiley-Blackwell.
4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th 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-immunologyfall-2005/pages/lecture-notes/
4. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download – Study Materialz.in
5. https://microbenotes.com/gene-cloning-requirements-principle-stepsapplications/

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

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

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**S**	**-**	**-**	**S**	**-**	**-**	**-**	**S**	**-**
CO2	**-**	**M**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO3	**-**	**M**	**M**	**S**	**-**	**S**	**-**	**M**	**-**
CO4	**M**	**-**	**S**	**S**	**M**	**-**	**M**	**-**	**S**
CO5	**L**	**-**	**L**	**L**	**-**	**S**	**L**	**-**	**S**

S - Strong, M – Medium, L – Low

Semester: I	Course Code: 23PMBCP01	Hours/Week: 6	Credit: 4
COURSE TITLE: CORE III - PRACTICAL I			

Course Overview:

1. The immune system protects us from infection through various lines of defense. If the immune system is not functioning as it should, it can result in disease, such as autoimmunity, allergy and cancer.
2. Immunology is the Study of the immune system and is a very important branch of the medical and biological sciences.
3. The immune system is a complex network of organs, cells and proteins that defends the body against infection, whilst protecting the body's own cells.
4. The course content will include genome organization and different types, advantages, applications of mutation and mutagens.

Learning Objectives:

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

Unit - I	Microscopic Techniques	20 Hours

Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy – Motility of Spirochetes

Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method.

Staining techniques - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.

Unit - II	Media Preparation	20 Hours

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities.

Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer.

Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.

Unit - III	Hematological Reactions	20 Hours

Hematological reactions - Blood Grouping – forward and reverse, Rh Typing Identification of various immune cells by morphology – Leishman staining, Giemsa staining.

Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP. Detection of HBs Ag by ELISA.

Precipitation reactions in gels– Ouchter lony double immune diffusion (ODD) and Mancini's single radial immune diffusion (SRID) Immuno-electrophoresis and staining of precipitin lines Rocket immuno electrophoresis and counter current immuno electrophoresis.

Unit - IV	Centrifugation	10 Hours

Preparation of lymphocytes from peripheral blood by density gradient centrifugation.

Purification of immunoglobulin– Ammonium Sulphate Precipitation.

Separation of IgG by chromatography using DEAE cellulose or Sephadex.

Unit - V	Blotting Techniques	20 Hours

Western Blotting – Demonstration. Isolation of genomic DNA from E. coli and analysis by agarose gel electrophoresis, Estimation of DNA using colorimeter (Diphenylamine reagent) Separation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) UV induced mutation and isolation of mutants by replica plating technique. Plasmid DNA isolation from E.coli. RNA isolation from yeast. RNA estimation by Orcinol method.

Text Book(s):

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. (3 rd 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.

Web Resources:

1. http://textbookofbacteriology.net/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
3. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall2005/pages/lecture-notes/
4. Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download – Study Materialz.in
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

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

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	-	-	S	L	-	S	-	S
CO2	-	L	S	-	-	M	S	S	-
CO3	S	M	M	L	M	S	L	S	M
CO4	-	S	-	S	-	S	M	S	-
CO5	S	S	M	-	M	-	-	-	L

S - Strong, M – Medium, L – Low

Semester: I	Course Code: 23PMBCE102	Hours/Week: 4	Credit: 3

COURSE TITLE: ELECTIVE I – HEALTH AND HYGIENE

Course Overview:

1. According to scientists, health is a condition of total bodily and mental well-being.
2. A healthy person is one who is mentally and physically fit.
3. Hygiene refers to behaviors or habits that promote excellent health and a clean environment.
4. Every day, we eat a variety of meals.

Learning Objectives:

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

Unit - I	Introduction to Health and Hygiene	12 Hours

Introduction to hygiene and healthful live. Health habits and practices, Factors affecting health, 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	Physical Health	12 Hours

Physical Health, Physical Exercises And Their Importance, Walking, Jogging, Yoga, Meditation, Stress Relief, International Control Of Health, WHO, Personal Hygiene, Sun Bathing, Colon Hygiene, Health Destroying Habits and Addiction, 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, Health in infancy, Early childhood, Adolescence, Adulthood, Old age, Mental health occupational hazards.

Unit - V	Health programme & Health Education	12 Hours

Health programme, Health education, Malaria control, Tuberculosis control, AIDS control programmes, Immunization programmes, Family planning, Reproductive and Child health programmes (RCH).

Text Book(s):

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

Reference Books:

1. Health and Hygiene-Personal Hygiene, Community Hygiene and Diseases (vedantu.com)
2. Chapter-32.pdf (nios.ac.in)
3. Menstrual Health and Hygiene Guide Student Health and Counseling Services (ucdavis. edu)

Web Resources:

1. https://nap.nationalacademies.org/read/11756/chapter/13
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Identify factors affecting health and health habits.	K1
CO2	Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.	K2
CO3	Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.	K3
CO4	Explore Mental hygiene and maintain emotional stability.	K4
CO5	Participate in health education programmes	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	S	M	-	-	S	M	S	-
CO2	-	-	S	-	M	-	S	-	M
CO3	-	M	-	S	-	-	-	M	-
CO4	-	-	M	-	S	-	M	S	-
CO5	S	-	S	-	-	S	-	-	M

S - Strong, M – Medium, L - Low

Semester: I	Course Code: 23PMB CE202	Hours/Week: 12	Credit: 3

COURSE TITLE: ELECTIVE II - HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY

Course Overview:

1. The Global Herbal Cosmetic market is anticipated to rise at a considerable rate during the forecast period, between 2024 and 2031.
2. Herbal cosmetics are referred to as beauty products which are formulated by using various herbal ingredients to provide defined cosmetic benefits.
3. Natural beauty is blessing and cosmetics help in presenting and increasing the beauty and personality aspects of human beings.
4. The course gives extensive training in Cosmetic Formulation, Manufacturing, Analysis and Marketing.

Learning Objectives:

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

Unit - I	Scope and Applications of Indian Medicinal Plants	12 Hours

Herbs, Herbal medicine - Indian medicinal plants, Scope and Applications of Indian medicinal plants, medicinal plants in treating bacterial, fungal and viral diseases, Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.

Unit - II	Indian medicinal plants	12 Hours

Emblica officinalis, Withaniasomnifera, Phyllanthusamarus, Tinosporacordifolia, Andrographispaniculata, Piper longum, Ocimum sanctum, Azardirchataindica, STerminaliachebula, Allium sativum. Preparation of extracts Hot and cold methods. Preparation of stock solutions. In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/ parts, well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.

Unit - III	Antimicrobial Activity of Selected Indian Medicinal Plants	12 Hours

Antimicrobial activity of selected Indian medicinal Plants, In vitro determination of antibacterial and fungal activity of medicinal plants well-diffusion, methods, MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.

Unit - IV	Cosmetic Microbiology	12 Hours

History of Cosmetic Microbiology – Need for cosmetic microbiology, Scope of cosmetic microbiology, Role of microbes in cosmetic preparation. Preservation of cosmetics, Antimicrobial properties of natural cosmetic products – Garlic , neem, turmeric, aloe vera and tulsi, Sanitary practices in cosmetic manufacturing, HACCP protocols in cosmetic microbiology.

Unit - V	Cosmetic Microbiology Test Methods	12 Hours

Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing, Validation methods - bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives.

Text Book(s):

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

Reference Books:

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

Web Resources:

1. https://www.academia.edu/50236711/Modern Extraction Methods for Preparation of Bioactive Plant Extracts
2. https://www.nhp.gov.in/introduction and importance of medicinal plants and herbs mtl
3. https://pubmed.ncbi.nlm.nih.gov/17004305/
4. https://www.fda.gov/cosmetics/potential-contaminants-cosmetics/microbiological-safety-and-cosmetics

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Identify the applications of Indian medicinal plants in Treating diseases.	K1
CO2	Identify and authenticate herbal plants.	K2
CO3	Evaluate the antimicrobial activity of medicinal plants.	K3
CO4	Describe the role of microorganisms and their metabolites In the preparation of cosmetics.	K4
CO5	Validate procedures and biosafety measures in the mass Production of cosmetics.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**M**	-	-	-	**S**	-	-	-	-
CO2	-	-	-	-	-	**S**	**M**	-	-
CO3	-	-	-	**S**	-	**S**	-	**M**	-
CO4	**M**	-	-	-	**S**	-	**S**	-	-
CO5	-	-	-	-	-	**M**	**S**	-	-

S - Strong, M – Medium, L – Low

SEMESTER - II

Semester: II	Course Code: 23PMBCT03	Hours/Week: 6	Credit: 5
COURSE TITLE: CORE - IV MEDICAL BACTERIOLOGY AND MYCOLOGY			

Course Overview:

1. A program that focuses on the scientific Study of pathogenic bacteria that are significant factors in causing or facilitating human disease.
2. Bacteriology is the Study of bacteria and their relation to medicine. Bacteriology evolved from physicians needing to apply the germ theory to address the concerns relating to disease spreading in hospitals
3. Microbes are used for a variety of purposes, such as manufacturing antibiotics, synthesizing vitamins, and performing gene therapy to treat genetic diseases.
4. Medical Microbiology course is to introduce basic principles and application relevance of clinical disease for students who are in preparation for physicians.

Learning Objectives:

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

Unit - I	Bacteriology	20 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	Bacteriology	20 Hours

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

Unit - III	Bacteriology	20 Hours

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, Yersinia, Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of Pseudomonas, Vibrio, Mycoplasma, Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of Helicobacter, Rickettsiae, Chlamydiae, Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of Bordetella ,Francisella., Spirochaetes , Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of Leptospira, Treponema and Borrelia. Nosocomial, zoonotic and opportunistic infections-prevention and control.

Unit - IV	Mycology	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	Mycology	15 Hours

Dimorphic fungi causing Systemic mycoses, Histoplasma, Coccidioides, Dimorphic fungi causing Systemic mycoses, Sporothrix, Blastomyces, Fungi causing Eumycotic Mycetoma Opportunistic fungi, Fungi causing secondary infections in immune compromised patients. Immunodiagnostic methods in mycology-Recent advancements in diagnosis. Anti-fungal agents.

Text Book(s):

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, (10thEdition). C.V. Mosby
4. Company, St. Louis.
    a. Alexopoulos C.J., Mims C.W. and Blackwell M. (2007). Introductory Mycology, (4thEdition).Wiley Publishers.
    b. Chander J. (2018).Text book of Medical Mycology. (4thEdition). Jaypee brothers Medical Publishers.

Reference Books:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Collect, transport and process of various kinds of clinical specimens.	K1
CO2	Analyze various bacteria based on morphology and pathogenesis.	K4
CO3	Discuss various treatment methods for bacterial disease.	K3
CO4	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents..	K2
CO5	Apply various immunodiagnostic method to detect fungal infections.	K3

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**S**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**M**	**S**	**M**	**M**	**S**	**S**	**M**	**M**	**S**
CO3	**S**	**M**	**-**	**S**	**-**	**M**	**S**	**S**	**S**
CO4	**S**	**-**	**S**	**-**	**S**	**-**	**-**	**S**	**S**
CO5	**-**	**S**	**-**	**M**	**M**	**M**	**S**	**-**	**-**

S - Strong, M – Medium, L – Low

Semester: II	Course Code: 23PMBCT04	Hours/Week: 6	Credit: 5

COURSE TITLE: CORE - V MEDICAL VIROLOGY AND PARASITOLOGY

Course Overview:

1. A multidisciplinary subject covering many topics including morphology, taxonomy, biology, behavior, life-cycles, pathogenesis, epidemiology, ecology, physiology, biochemistry, genetics and molecular biology
2. To understand the nature of viruses, including their structure, replication and classification.
3. To explore how infection and replication of viruses is constrained by the viral genome and host immune defenses.
4. Distinguish characteristics of normal cells and virus-infected cells.

Learning Objectives:

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

Unit - I	General properties of viruses	20 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 endpoint).

Unit - II	Virus in DNA	20 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	20 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	Medical Parasitology	20 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, Giardia, Trichomonas, Balantidium, Toxoplasma, Cryptosporidium, Leishmania, and Trypanasoma.

Unit - V	Life Cycle Pathogen	20 Hours

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – Taeniasolium, T. saginata, T. echinococcus, Trematodes – Fasciola hepatica, Fasciolopsisbuski, 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.

Text Book(s):

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.
3. Rajan S. (2007). Medical Microbiology. MJP publisher. (New York, NY, U.S.A.)
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. (2019). Prescott's Microbiology. (11th Edition).McGraw Hill Book.

3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
4. Levanthal R. and Cheadle R. S. (2012). Medical Parasitology. (6th Edition). S.A. Davies Co. Philadelphia.
5. Finegold S.M. (2000). Diagnostic Microbiology. (10th Edition). C.V. Mosby Company, St. Louis.

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Cultivate viruses by different methods and aid in diagnosis. Perform purification and viral assay.	K1
CO2	Investigate the symptoms of viral infections and presumptively identify the viral disease.	K2
CO3	Diagnose various viral diseases by different methods. (serological, conventional and molecular)	K3
CO4	Educate public about the spread, control and prevention of parasitic diseases.	K4
CO5	Identify the protozoa and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	-	-	S	-	-	S	-	-
CO2	M	S	M	S	M	S	M	M	S
CO3	S	M	S	-	S	M	S	S	S
CO4	S	-	S	M	S	-	M	S	S
CO5	-	S	S	M	M	M	S	-	S

S - Strong, M – Medium, L – Low

Semester: II	Course Code: 23PMBCP02	Hours/Week: 6	Credit: 4
COURSE TITLE: CORE - VI – PRACTICAL - II			

Course Overview:

1. Bacteriology is the Study of bacteria and their relation to medicine. Bacteriology evolved from physicians needing to apply the germ theory.
2. Mycological research has led to the development of such antibiotic drugs as penicillin, streptomycin, and tetracycline, as well as other drugs, including statins
3. To explore how infection and replication of viruses is constrained by the viral genome and host immune defenses.
4. Medical parasitology deals with the parasites which infect man, the diseases they produce, the response generated by him against them and various methods of diagnosis and prevention.

Learning Objectives:

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

Unit - I	Clinical Staining Techniques	20 Hours

Staining of clinical specimens - Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria. Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.

Unit - II	Fungi	20 Hours

Identification and Classification of common fungi. Mounting and staining of VAM spores. Examination of different fungi by Lactophenol cotton blue staining. Examination of different fungi by KOH staining. Cultivation of fungi and their identification - Mucor, Rhizopus, Aspergillus, Penicillium. Microscopic observation of different asexual fungal spores. Microscopic observation of fungal fruiting bodies. Identification of Dermatophytes. Isolation and characterization of bacteriophage from natural sources by phage titration. Cultivation of viruses – Egg Inoculation methods. Diagnosis of Viral Infections –ELISA –HIA. Spotters of viral inclusions and CPE-stained smears.

Unit - III	Clinical Specimens	20 Hours

Examination of parasites in clinical specimens - Ova/cysts in faeces. Concentration: methods – Floatation methods simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods- Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. Identification of common arthropods of medical importance - spotters of Anopheles, Glossina, Phlebotomus, Aedes, Ticks and mites.

Unit - IV	Clinical Laboratory	15 Hours

Good Laboratory Practices in Industrial Microbiology laboratory. Study of Bioreactor and its essential parts. Culturing and Characterization of microorganisms used in Dairy and Pharmaceutical industry. Screening for Enzyme producers (amylase /protease). Optimization of parameters for Amylase production. Screening for Organic acid producers (acetic acid/lactic acid). Screening for Antibiotic producers.

Unit - V	Microbiological Assays	15 Hours

Immobilization of microbial cells and enzyme and its assessment. Microbiological assays of fermentation products – MIC- MBC. Microbiological assay of antibiotics by cup plate method and other methods. Sterility testing of pharmaceuticals.

Text Book(s):

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2 nd Edition. Publisher-Taylor and Francis.
2. Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.
3. Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.
4. Cappuccimo, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6 th 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. Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.
3. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
4. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries. - Part 22 nd Edition. Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders.

Web Resources:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Collection of different clinical samples, transport, culture and examination.	K1
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	K2
CO3	Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	K3
CO4	Perform antibiotic sensitivity tests and compare with the standard tests.	K4
CO5	Screening of industrially important microbes for metabolite production.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	-	L	S	-	M	-	-	S
CO2	-	M	S	S	L	S	M	S	S
CO3	S	M	M	-	S	M	M	S	-
CO4	S	L	M	S	M	-	S	S	M
CO5	-	M	-	-	M	L	-	-	-

S - Strong, M – Medium, L - Low

Semester: II	Course Code: 23PMBCE302	Hours/Week: 4	Credit: 3
COURSE TITLE: ELECTIVE - III CLINICAL AND DIAGNOSTIC MICROBIOLOGY			

Course Overview:

1. Clinical microbiology has various applications, including diagnosis, identification of treatments to be carried out and monitoring of infectious outbreaks
2. Classically in this field, the Study of AMR in pathogens that cause human and animal diseases involves the isolation of bacteria in different culture media.
3. Diagnostic microbiology concentrates on the laboratory analysis of clinical specimens in cases when an infectious disease is suspected.
4. Clinical Microbiologists are based in diagnostic medical/pathology laboratories. Their work focuses on specimen collection and analysis, reporting and interpretation of results to aid in the diagnosis, treatment and surveillance of infectious diseases.

Learning Objectives:

1. Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
2. Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
3. Elucidate various diagnostic procedures in microbiology.
4. Acquire knowledge on different methods employed to check antibiotic sensitivity.
5. Gainknowledgeonhospitalacquiredinfectionsandtheircontrolmeasures.

Unit - I	Laboratory Safety Guidelines	12 Hours

Microbiology Laboratory Safety Practices, General Safety Guidelines, Handling of Biological Hazards, Infectious healthcare waste disposal, Biomedical waste management.

Unit - II	Clinical Diagnosis	12 Hours

Diagnostic procedures, General concept of Clinical specimen collection, Transport of clinical specimen, Storage of clinical specimen, General processing in Microbiology laboratory, Specimen acceptance and rejection criteria.

Unit - III	Diagnosis of Microbial Diseases	12 Hours

Diagnosis of microbial diseases, Clinical, Differential, Microbiological, Immunological, Molecular diagnosis of microbial diseases, Modern and novel microbial diagnostic methods, Automation in Microbial diagnosis, Vitro.

Unit - IV	Immunological Tests	12 Hours

Antibiotic sensitivity tests - and, - Dilution - Agar dilution & broth dilution-/-and, Disc diffusion, Stokes, Kirby Bauer methods, E test, Dilution - Agar dilution &broth dilution, Mbc, Mic, Quality control for antibiotics, Standard strains.

Unit - V	Microbial Infections	12 Hours

Nosocomial infections, Common types, Sources, Reservoir and mode of transmission, Pathogenesis, Control measures, Hospital infection control committee (HICC), Functions, Bio medical waste, Types, Disposable methods.

Text Book(s):

1. Collee J.G., Fraser A.G. Marmion B.P. and Simmons A. (1996). Mackie & Mc Cartney Practical Medical Microbiology. (14thEdition). Elsevier, New Delhi. ISBN-10:0443047219/ ISBN-13-978-0443047213.
2. Tille P.M. (2021). Bailey and Scott's Diagnostic Microbiology. (15thEdition). Elsevier. ISBN: 9780323681056.
3. Jawetz E., Melnick J. L. and Adelberg E.A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.

Reference Books:

1. Mukherjee K. L. (2000). Medical Laboratory Technology. Vol.1-3. (2ndEdition).Tata McGraw-Hill Education. ISBN-10:0074632604.
2. Sood R.(2009). Medical Laboratory Technology–Methods and Interpretations. (6th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.ISBN:9788184484496.

Web Resources:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Apply Laboratory safety procedures and hospital waste disposal strategies.	K3
CO2	Collect various clinical specimens, handle, preserve and process safely.	K2
CO3	Identify the causative agents of diseases by conventional and molecular methods following standard protocols.	K3
CO4	Assess the antimicrobial susceptibility pattern of pathogens.	K4
CO5	Trace the sources of nosocomial infection and recommend control measures.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**L**	**S**	**M**	**-**	**-**	**-**	**S**	**M**	**-**
CO2	**S**	**M**	**-**	**L**	**M**	**S**	**-**	**-**	**M**
CO3	**-**	**S**	**-**	**-**	**S**	**M**	**-**	**S**	**-**
CO4	**-**	**M**	**-**	**S**	**-**	**S**	**-**	**M**	**S**
CO5	**S**	**M**	**L**	**S**	**M**	**S**	**-**	**-**	**M**

S - Strong, M – Medium, L – Low

Semester: II	Course Code: 23PMBCE402	Hours/Week: 4	Credit: 3

COURSE TITLE: ELECTIVE - IV NANOBIOTECHNOLOGY

Course Overview:

1. This course provides basic overview of nano materials and their applications.
2. This course begins with a review of various types of nano materials and an introduction to general terminologies.
3. Metal nanoparticles have been found to be dominant compounds affecting fungal diseases both in humans and plants.
4. Nanobiotechnology is a new field of science that introduces special physicochemical and biological properties of nanostructures and their applications in various areas such as medicine and agriculture.

Learning Objectives:

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

Unit - I	Introduction Nano-technology	12 Hours

Introduction to nano-biotechnology, Nano size-changing phenomena at nano-scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials), based on realization of their applications of nanomaterials (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, microemulsion 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 in Drug delivery	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, nano sensors in detection of pathogens, Treatment of surface water, ground water, Waste water contaminated by toxic metal ions organic and inorganic solutes and microorganisms.

Text Book(s):

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

Reference Books:

1. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
2. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley
3. Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Inter science.

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Employ knowledge in the field of Nano biotechnology for development.	K1
CO2	Identify various applications of nanomaterial in the field of medicine and environment.	K2
CO3	Examine the prospects and significance of Nano biotechnology	K3
CO4	Identify recent advances in this area and create a career or pursue research in the field.	K4
CO5	Design non-toxic nanoparticles for targeted drug delivery	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	**S**	**-**	**-**	**M**	**-**	**S**	**-**	**S**	**M**
CO2	**S**	**-**	**M**	**-**	**S**	**-**	**S**	**-**	**S**
CO3	**S**	**M**	**S**	**-**	**-**	**M**	**-**	**M**	**-**
CO4	**S**	**-**	**S**	**M**	**S**	**-**	**M**	**-**	**S**
CO5	**S**	**S**	**M**	**S**	**S**	**-**	**M**	**S**	**S**

S - Strong, M – Medium, L – Low

Semester: II	**Course Code: 23PBTNME1**	**Hours/Week : 5**	**Credit: 2**

COURSE TITLE: NON MAJOR ELECTIVE COURSE - GENE MANIPULATION TECHNOLOGY

Course Overview:

1. The course starts with understanding of basic organization and structure of genome.
2. It gives a brief overview on different DNA strand breaks and their repair mechanism.
3. It introduces learners to theoretical basics of genetic engineering and discusses it's limitations in tackling genetic problems of animals and plants.
4. Genetic engineering (also called genetic modification) is a process that uses laboratory-based technologies to alter the DNA makeup of an organism.

Learning Objectives:

1. Purposes of GM crops generally include resistance to certain pests, diseases, or environmental conditions, or resistance to chemical treatments
2. Genetic modification of crops is to enhance its nutritional value, as seen in the case of golden rice.
3. Gene technologies have many uses in areas such as: agriculture – introducing pest or disease resistance, improving drought tolerance, or improving nutritional value of a crop. animal health – producing animal medicines and vaccines.
4. Genetic engineering aims to modify the genes to enhance the capabilities of the organism beyond what is normal.
5. Uses of genetic modification include cancer treatments, medicine production, brewing yeast, and agriculture.

Unit - I	Gene Transfer Techniques	07 Hours

Basics of Gene Manipulation Technology Restriction Enzymes. Cutting and Joining Reactions- Vectors- Selection of Recombinants. Agarose Gel Electrophoresis-Southern Blotting Hybridization Autoradiography-PCR- Native Page- SDS-Page2D Gel Electrophoresis- Western Blotting.

Unit - II	Constructions of DNA	07 Hours

Constructions of DNA Libraries, Vectors Used In the Construction of CDNA and Genomic DNA Libraries, Chromosome Walking- Positive Selection and Subtractive Hybridization Preparation Of (BAC/YAC Library).

Unit - III	Gene Sequencing	07 Hours

Genome Sequencing and Transcriptomics Sanger's Sequencing. Whole Genome Shot gun Sequencing- Comparative Genome Sequencing. Transcriptome Analysis- DNA Microarray Expression of Recombinant Proteins.

Unit - IV	Pharmacology of Protein	07 Hours

Protein Engineering & Pharmaceutical Products Site, Directed Mutagenesis- Protein Analysis, Therapeutic Protein- Vaccines.

Unit - V	Gene Cloning Techniques	07 Hours

Applications of Gene Cloning. Creating Transgenic Animals and Plants- Reporter Genes Animal Cloning. Gene expression in plants Biosafety and Bioethics.

Text Book(s):

1. Kaushik. B.D. Deepak Kumar. Shamim. Md. 2019. Biofertilizers and Biopesticides in Sustainable Agriculture. 1st Edition. Apple Academic Press. USA.
2. Aneesa Padiniakkara. Aparna Thankappan, Fernando Gomes Souza. Jr. Sabu Thomas. 2018. Biopolymers and Biomaterials. CRC press, USA.
3. A text book on Molecular Biotechnology by Glick.

Reference Books:

1. An Introduction Gene Cloning And Manipulation- Howe.C
2. Molecular Cloning: A Laboratory Manua l (3- Volume Set)-Sambrook J. et al.

3. T.A. Brown 1995. Gene Cloning and Introduction.

Thiel 2002. Biotechnology Nucleic Acids to Protein: A Laboratory Project. Tatamcgraw. Hill

4. Desmond S. T. Nicholl, an Introduction To Genetic Engineering 3 rd Edition.

R. W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.

5. Genetic Engineering Principles And Methods By Setlow, Jane K. (VOLUME 24)

Bernard R Glick and Jack .J. Pasternack, 1994, Molecular Biotechnology, ASM Press.

Web Resources:

1. https://journals.asm.org/doi/10.1128/JCM.02592-20
2. https://www.sciencedirect.com/science/article/pii/S2221169116309509
3. https://www.ncbi.nlm.nih.gov/books/NBK20370/

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Understand the basics of Basics of Gene Manipulation Technology	K1
CO2	Apply the knowledge to create Constructions of DNA Libraries Constructions of DNA Libraries.	K3
CO3	Acquire adequate knowledge in the use of Genome Sequencing and Transcriptomics	K3
CO4	Evaluate the benefits of Protein Engineering & Pharmaceutical Products	K4
CO5	Analyze the importance of Gene Cloning& Applications of Gene Cloning	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	M	-	S	L	-	S	-	S
CO2	M	M	S	-	S	M	M	S	-
CO3	S	-	M	L	M	S	L	S	S
CO4	-	S	L	S	-	L	M	S	-
CO5	S	S	M	M	M	S	-	-	S

S - Strong, M – Medium, L - Low

Semester: III	Course Code: 23PM BCT05	Hours/Week:5	Credit: 5

COURSE TITLE: CORE VII - SOIL AND ENVIRONMENTAL MICROBIOLOGY

Course Overview:

1. Soil microbiology governs nutrient processing and recycling in soil, and also affects the decomposition of organic matter in soil, soil salinity and soil acidity, thereby impacting soil fertility and crop health.
2. This class provides a general introduction to the diverse roles of microorganisms in natural and artificial environments.
3. It will cover topics including: cellular architecture, energetics, and growth;
4. evolution and gene flow; population and community dynamics; water and soil microbiology; biogeochemical cycling

Learning Objectives:

1. Explain the role of microorganisms in soil fertility.
2. Discuss the benefits of interactions among soil microbes and acquire awareness about Microbes as bio fertilizer sand bio control agents.
3. Create awareness. About components of environment, environmental pollution, and Detection methods.
4. Acquire in depth knowledge about solid and liquid waste treatments.
5. Develop knowledge about organic matter degradation, bioremediation, and the environment risk assessment.

Unit - I	Soil Microbiology	20 Hours

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of major group of microorganisms in soil, Quantification of soil micro flora, role of microorganism in soil fertility, Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation, Chemistry and Genetics of BNF, Phytopathology and Disease cycle of Plant pathogens, Tikka, Citrus canker, Types of plant disease symptoms, Structural and Inducible biochemical defenses, Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Planti bodies, Phenolics, Phytoalexins.

Unit - II	Biofertilizers And Biocontrol Agents	20 Hours

Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria, symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non-Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs, Biofertilizers and Biocontrol agents, Types, benefits and application, Advantages, Social and environmental aspects, Btcrops, golden rice.

Unit - III	Components Of Environment	15 Hours

Hydrosphere, lithosphere, atmosphere, biosphere–definitions with examples, Energy flow in the ecosystem, Carbon cycles, Nitrogen cycles, Sulfur cycles, Phosphorous cycles, Physical factors affecting distribution of microorganisms in various environments, Predisposing factors for Environmental diseases – infectious (water and air borne), pollution related, spread and control of these diseases, Treatment and safety of drinking (potable) water, methods to detect potability of water samples, Space microbiology, Microbiological research in space environment.

Unit - IV	Waste Management	15 Hours

Solid waste , Types – management, Factors affecting solid waste generation rates, Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process, Quality assessment of decontaminated matters and other biological effluents, Biological reference standards, Utilization of Solid Waste as Food, Feed and Fuel, Composting, Vermicomposting, Bio manure and Biogas production, E waste management.

Unit - V	Biodegradation	20 Hours

lignin , cellulose, hemicellulose, pectin, common pesticides, herbicides (2,4-D) and pesticides (DDT), heavy metals, Biodegradation of Xenobiotics, Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers, Biodegradation of Hydrocarbons, Biodeterioration of Textiles and Leather, Pollution Control Bodies, Environmental laws in India, Environmental impact assessment, EIA guidelines, US Environment protection Agency norms

Text Book(s):

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

Reference Books:

1. Pepper I. L. Gerba C.P. and Gentry T.J.(2014).Environmental Microbiology (1st Edition). Academic Press, Elsevier.
2. Bitton, G. (2011).Waste water Microbiology. (4th Edition). Wiley-Blackwell.
3. Bridgewater L. (2012). Standard Methods for the Examination of Water and Waste water. American Public Health Association.
4. Shrivastava A.K. (2003). Environment Auditing. A.P.H. Publishing Corporation.

Web Resources:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes: Upon successful completion of this course, the student will be able to:		
COs	**Statements**	**Bloom's Level**
CO1	Depict diversity and significance of soil microbes and predict the Role of microbes in biological nitrogen fixation.	K1
CO2	Utilize the knowledge of microbial interactions, with beneficial Application of bio fertilizers for sustainable agriculture and benefits of bio pesticides.	K2
CO3	Explain the different types of microorganisms in water. Identify the causes of water pollution and the methods for quality assessment of Water and control of water borne diseases.	K3
CO4	Apply knowledge about waste treatments and microbial decomposition and bio-remediation process in environmental Cleanup.	K3
CO5	Plan a clear approach on environmental issues. Control pollution and explain protection laws to public.	K5
K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create		

Mapping (COs vs POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	**S**	**-**	**S**	**S**	**S**	**M**	**S**	**-**	**S**
CO2	**S**	**M**	**S**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**S**	**M**	**S**	**-**	**-**	**M**
CO4	**S**	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**--**
CO5	**S**	**M**	**-**	**S**	**-**	**S**	**-**	**-**	**S**

S - Strong, M – Medium, L – Low

Semester: III	Course Code: 23PMBCT06	Hours/Week: 6	Credit: 5

COURSE TITLE: CORE VIII - MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Course Overview:

1. Biological processes are controlled by different types of molecules such as cell signaling, replication, transcription, protein expression and development. Apart from these aspects, molecular biology theory leads to the development of several diagnostic methods and recombinant DNA technology.
2. Basics understanding of central dogma of molecular biology involving replication, transcription and translation. In addition, we will discuss about structure and function of cells, their manipulation and exploitation using molecular biology tools.
3. Discussion about mutagenesis and repair mechanism. Approaches for Genome Editing and gene silencing.
4. At the end we will discuss the role of molecular biology to develop different types of techniques, cloning and over-expression of foreign protein in expression system.

Learning Objectives:

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

Unit - I	DNA Replication	20 Hours

DNA replication – modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, rRNA and t-RNA. Ribosomes. Genetic Code and Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications.

Unit - II	Gene Regulation and Expression	20 Hours

Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems - repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations - base substitutions, frame shift, deletion insertion, duplication, inversion. Silent, conditional and lethal mutation. Chemical mutagenesis. Repair of DNA damage. Photo reactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test).

Unit - III	Tools and Methods in Gene Cloning	20 Hours

Tools and methods in gene cloning. Restriction endonucleases – nomenclature, classification and characteristics – DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques - electroporation, microinjection, protoplast fusion and micro particle bombardment. Screening for recombinants. Gene cloning vectors for prokaryotes and eukaryotes – cloning properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z), Phage Vectors (M13and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors - Expression of foreign genes in bacteria, animal, plant, algae and fungi – merits and demerits.

Unit - IV	Genomic DNA and cDNA Library	20 Hours

Genomic DNA and cDNA library - Construction and Screening. Substrative hybridization for tissue specific DNA libraries. Techniques in genetic engineering Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) – Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking, Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array. Protein engineering and techniques Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. Protein folding, protein sequencing, protein crystallization. Applications of protein engineering.

Unit - V	Plant Biotechnology	20 Hours

Plant biotechnology - constituents and concepts of sterilization - preparation, isolation and selection of explant. Suspension cell culture, callus culture, protoplast isolation, culture & fusion.

Anther and pollen culture for production. Animal biotechnology – equipment and media used for animal cell culture technology. Primary and established cell line culture and culture media.

Applications of animal cell cultures. Serum protein media viability and cytotoxicity. Applications of Genetic Engineering - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy - Germline and Somatic Cell Therapy - Ex-vivo Gene Therapy. In-vivoGene Therapy. Vectors in Gene Therapy-Viral and Non-Viral Vectors. Transgenic Plants.

Text Book(s):

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.

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/

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Analyze, demonstrate and appreciate DNA replication and protein synthesis.	K4
CO2	Investigate the types of mutation and its impact on microbes. Illustrate various strategies on gene cloning	K2
CO3	Analyze, modify and characterize DNA modifying enzymes.	K4
CO4	Illustratively assess the molecular techniques for DNA and protein analysis.	K4
CO5	Adopt the applications of Genetic Engineering in the field of agriculture and medicine towards scientific research.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**S**	**-**	**S**	**S**	**M**	**L**	**M**	**S**	**S**
CO2	**-**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**-**
CO3	**S**	**-**	**S**	**S**	**M**	**M**	**M**	**S**	**S**
CO4	**-**	**S**	**S**	**S**	**M**	**M**	**-**	**S**	**S**
CO5	**-**	**-**	**S**	**S**	**M**	**M**	**M**	**S**	**S**

S - Strong, M – Medium, L – Low

Semester: III	Course Code : 23PMB CP03	Hours/Week: 6	Credit: 5
COURSE TITLE: CORE IX - PRACTICAL III			

Course Overview:

1. Recombinant DNA technology involves using enzymes and various laboratory techniques to manipulate and isolate DNA segments of interest.
2. Besides supporting the growth of various biological systems, soil and soil microbes serve as a best medium for plant growth. Soil fauna & flora convert complex organic nutrients into simpler inorganic forms which are readily absorbed by the plant for growth.
3. Environmental Microbiology provides an overview of microorganisms in the environment, including occurrence, abundance and distribution.
4. Apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems.

Learning Objectives:

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

Unit - I	Artificial Transformation	20 Hours

Artificial Transformation, Detection of Antibiotic resistant mutants, Identification of mutants by replica plating method.

Unit - II	Western Blotting	15 Hours

Amplification of DNA by PCR, Western blotting – Demonstration, Southern blotting – Demonstration.

Unit - III	Microbiological Analysis of Water	15 Hours

Detection of Water hardness , Microbiological analysis of water A) Total Heterotrophic Count B) Test for indicative organisms 1) MPN 2) Membrane Filtration, Physical, chemical, assessment of water Physical - Color, pH, Chemical - alkalinity, acidity, DO, BOD, COD, Enumeration of

bacteria and fungi from air – Air sampler Isolation of free-living nitrogen fixers from soil and Rhizobium from root nodules of leguminous plants. Isolation and enumeration of phosphate-solubilizing bacteria from soil.

Unit - IV	Preparation of Bio fertilizers	20 Hours

Preparation of Biofertilizers and testing the efficiency of prepared bio fertilizers R: S ratio of soil microbes, Estimation of soil enzymes- urease and phosphatase Study of phylloclade microflora by leaf impression method, Isolation of cellulose degrading bacteria Preparation of a vermicompost, Isolation of VAM fungi from soil Isolation of plant pathogen – Alternaria & Curvularia spps. Cultivation of edible mushroom from solid waste. Cultivation of Azolla.

Unit - V	Plant Infections	20 Hours

Visual examination, observation, and identification of some common plant infections. To test Koch postulates using plant pathogens, Collection of 5 herbarium specimens of infected leaves.

Text Book(s):

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

Reference Books:

1. Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
2. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
3. Dale J. W., Schantz M. V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd.

4. Pepper I., Gerba C. and Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual. (2nd Edition). Academic Press, Elsevier.
5. Yates M.V., Nakatsu C.H., Miller R.V. and Pillai, S.D. (2016). Manual of Environmental Microbiology. (4th Edition). Wiley.

Web Resources:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Utilize various molecular techniques for gene manipulation and detection of mutants.	K1
CO2	Undertake novel research with techniques like PCR and blotting analysis.	K2
CO3	Assess the microbial quality of water and air and relate the results to standards.	K3
CO4	Synthesize biofertilizers and vermicompost. Cultivate mushrooms using solid waste.	K4
CO5	Identify various plant pathogens.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	-	-	L	S	M	S	-	M	S
CO2	-	M	S	S	M	S	S	M	S
CO3	M	-	M	-	S	S	M	S	M
CO4	M	-	M	S	M	-	S	L	M
CO5	-	-	-	-	M	L	M	-	-

S - Strong, M – Medium, L – Low

Semester: III	Course Code: 23PMBCT07	Hours/Week: 6	Credit: 4

COURSE TITLE: CORE – X INDUSTRY MODULE - FERMENTATION TECHNOLOGY AND PHARMACEUTICAL MICROBIOLOGY

Course Overview:

1. This course emphasizes the application of biological and engineering principles to problems involving microbial, mammalian, and biological/biochemical systems.
2. The aim of the course is to review fundamentals and provide an up-to-date account of current knowledge in biological and biochemical technology.
3. The lectures will emphasize and place perspectives on biological systems with industrial practices. This course has made some major additions, modifications, and revisions in the course topics and course contents over the past few years.
4. In recognition of the increasing number of attendees from non-pharmaceutical industries, the instructors are balancing the course to provide equal emphasis on mammalian and microbial technologies.

Learning Objectives:

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

Unit - I	Concepts and Design of Bioprocess	12 Hours

Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculums for fermentation process. Media for industrial fermentation - Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter preculture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

Unit - II	Design, Types and Construction of Fermenter	12 Hours

Fermenter – Design, types and construction, Instrumentation and control. Productivity. Yield coefficients. Heat production. Aeration and agitation. Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.

Unit - III	Downstream Processing	12 Hours

Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

Unit - IV	Overview of Pharmaceutical Microbiology	12 Hours

Overview of pharmaceutical microbiology - Ecology of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and noninjectable, ophthalmologic preparation, implants.

Unit - V	Production of Pharmaceutical Products and Quality Assurance	12 Hours

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

Text Book(s):

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

Reference Books:

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

Web Resources:

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

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes: Upon successful completion of this course, the student will be able to:		
COs	**Statements**	**Bloom's Level**
CO1	Develop microbial strains, carry out fermentation and recover the products of the process.	K1
CO2	Design fermenters according to needs for various products.	K2
CO3	Recover the end products of the fermentation process economically.	K3
CO4	Utilize the knowledge on pharmaceutical microbiology for industrial production of products.	K4
CO5	Produce therapeutic products from microbes employing technology and analyze the quality the products.	K4
K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create		

Mapping (COs vs POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	**S**	**-**	**-**	**S**	**M**	**L**	**M**	**S**	**S**
CO2	**-**	**S**	**S**	**M**	**-**	**-**	**S**	**-**	**-**
CO3	**S**	**-**	**M**	**S**	**M**	**M**	**M**	**S**	**S**
CO4	**-**	**S**	**S**	**-**	**-**	**S**	**-**	**-**	**S**
CO5	**S**	**-**	**S**	**S**	**M**	**M**	**M**	**S**	**S**

S - Strong, M – Medium, L - Low

Semester: III	Course Code:23PMBCE501	Hours/Week: 3	Credit:3
COURSE TITLE: ELECTIVE V - BIOSAFETY, BIOETHICS AND IPR			

Course Overview:

1. Biosafety issues refer to the procedures, policies, and principles to be adopted to safeguard the environment and the human population. I
2. It refers to the containment principles, strategies, and practices that are adopted to prevent exposure to pathogens and toxins.
3. This paper discusses the bioethics of intellectual property (IP) and intellectual property rights (IPR) applicable to biotechnology-based IP.
4. When we talk about bioethics we refer to the moral or ethical issues and when we talk about biosafety we refer to the safety rules which one should follow.

Learning Objectives:

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

Unit - I	Intellectual Property Rights	12 Hours

Different forms of Intellectual Property Rights , their relevance, importance to industry, Academia, Role of IPR's in Biotechnology, role of microorganism in soil fertility, Patent Terminology, Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non- disclosure agreements, Patent life and geographical boundaries, International organizations, IPR - Overview of WTO, WIPO, TRIPS, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries..

Unit - II	Process Involved in Patenting	12 Hours

Process involved in patenting, Patent Search, process of filing, PCT application, pre- grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), Patent mapping.

Unit - III	Patentability of biotechnology inventions	12 Hours

Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005), Biotechnological inventions as patentable subject matter, Territorial nature of patents, from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, Tentative harmonization efforts, Implications of setting up form world patent system.

Unit - IV	Introduction to Bioethics	12 Hours

Introduction to bioethics, need of bioethics, applications and issues related to bioethics, social and cultural issues, Bioethics and biodiversity, Conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders, Bioethics & GMO's, issues and concerns pertaining to genetically modified foods, food crops, organisms, Their possible health implications and mixing up with the gene- pool.

Unit - V	Bioethics in medicine	12 Hours

Bioethics in medicine , Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent, bioethics and cloning, permissions and procedures in animal cloning, human cloning, risks and hopes, Bioethics in research, stem cell research, human genome project, use of animals in research, human volunteers for clinical research, Studies on ethnic races, He Nurembergcod.

Text Book(s):

1. Usharani B., Anbazhagi S. and Vidya C.K. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN-101645878856
2. Satheesh M.K. (2009). Bioethics and Biosafety. (1st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703

3. Goe lD .and Parashar S. (2013). IPR, Biosaftey and Bioethics. (1st Edition). Pearson education: Chennai. ISBN-13: 978-8131774700
4. Raj Mohanjoshi. Biosafety and Bioethics. Wiley Publications.

Reference Books:

1. Nithyananda K.V. (2019) .Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
2. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN:PHI Learning Private Limited,
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: LexisNexis.

Tony Hope (2004). Medical Ethics: Avery Short introduction,. Oxford Publication.

Web Resources:

1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.
3. https://www.cdc.gov/training/quicklearns/biosafety/
4. https://bioethics.msu.edu/what-is-bioethics

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Perceive the adverse effects of toxin and its potential Role in research.	K1
CO2	Assess the toxicity, properties and mode of actions of microbial toxins.	K2
CO3	Explicate the mode of actions and their biological significance.	K3
CO4	Evaluate the toxicity level with the help of advanced techniques.	K4
CO5	Elucidate the various natures of application of toxic substances.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	-	S	S	S	M	S	-	S
CO2	S	M	S	-	-	-	-	-	-
CO3	-	S	-	S	M	S	-	S	M
CO4	S	-	-	-	-	-	M	-	-
CO5	S	M	-	S	-	S	-	M	S

S - Strong, M – Medium, L - Low

Semester: III	Course Code: 23PMBSEC02	Hours/Week: 6	Credit: 2

COURSE TITLE: SKILL ENHANCEMENT COURSE I - ORGANIC FARMING & BIOFERTILISERTECHNOLOGY

Course Overview:

1. Increase genetic diversity.
2. Promote more usage of natural pesticides.
3. Make sure the right soil cultivation at the right time.
4. Keep and build good soil structure and fertility.

Learning Objectives:

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

Unit - I	Organic and Chemical Farming	06 Hours

Organic farming – Definition, relevance. Biological nutrient management - Organic manures, vermicompost, green manure, organic residue, biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, bio pesticides etc. Organic and Conventional farming. Organic and Chemical farming – Comparison

Unit - II	Certification and Schemes	06 Hours

Certification and Schemes - Certification and Schemes. Organic certification in brief. Integrated farming system definition, goal, components. Factors affecting ecological balance. Land degradation. Soil health management. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes - NPOF, NPOF, NHM, HMNEH, NPMSH & F and RKVY.

Unit - III	Biofertilizers	06 Hours

Biofertilizers - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial bio fertilizers Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia

Unit - IV	Cyanobacterial bio fertilizers	06 Hours

Cyanobacterial biofertilizers- Anabaena, Nostoc, Hapalosiphonand fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, potassium solubilization

Unit - V	Production Technology	06 Hours

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

Text Book(s):

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

Reference Books:

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

Web Resources:

1. https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2. https://www.fao.org/organicag/oa-faq/oa-faq6/en
3. https://www.india.gov.in/topics/agriculture/organic-farming
4. https://agriculture.nagaland.gov.in/bio-fertilizer
5. https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCowIV2ZZLBR1o

Teaching Methodology: Videos, Audios, PPT, Role Play, Quiz, Field Visit, Seminar, Chalk & Talk, Lecturing, Case Study, Demonstration, Problem Solving, Group Discussion, Flipped Learning

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

COs	Statements	Bloom's Level
CO1	Produce biofertilizers and distinguish between organic and conventional farming.	K1
CO2	Plan a Complete Farm Business including marketing, operation and financial outline.	K2
CO3	Practice the application of microbial bio-fertilizers in large scales, thereby increasing soil fertility.	K3
CO4	Develop integrated farming for sustainable agriculture.	K4
CO5	Promote the quality of packaging, storage, increase shelf life, accelerate the bio efficacy of bio fertilizers as per BIS standards.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping (COs vs POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**M**	**-**
CO3	**-**	**-**	**-**	**S**	**S**	**S**	**-**	**-**	**-**
CO4	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**S**
CO5	**-**	**-**	**-**	**-**	**M**	**-**	**S**	**S**	**-**

S - Strong, M – Medium, L - Low