SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
(AUTONOMOUS)

(Affiliated to Bharathidasan University, Tiruchirappalli)

Accredited by NAAC-An ISO 9001:2015 Certified Institution

SUNDARAKKOTTAI, MANNARGUDI–614016.

TAMILNADU, INDIA.

M.Sc., MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM - LEARNINIG OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(For the candidates admitted in the academic year 2023-2024)

CHOICE BASED CREDIT SYSTEM

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. Our College has moved to CBCS and implemented the grading system.

OUTCOME-BASED EDUCATION (OBE)
LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The expected learning outcomes are used as reference points that would help to formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general guidance for articulating the essential learnings associated with programmes of study and courses with in a programme, maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility and provide higher education institutions an important point of reference for designing

teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

Some important aspects of the Outcome Based Education

Course: is defined as a theory, practical or theory cum practical subject studied in a semester.

Course Outcomes (COs): are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

Programme: is defined as the specialization or discipline of a Degree.

Programme Outcomes (POs): Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

Some important terminologies repeatedly used in LOCF.

Core Courses (CC): A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Specific Elective Courses (DSE): Elective course may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective (DSE). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

Generic Elective Courses: An elective course chosen generally from an **unrelated discipline/subject,** with an intention to seek exposure is called a Generic Elective. Generic Elective courses are designed for the students of other disciplines. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Non Major Elective (NME): A student shall choose at least two Non-major Elective Courses (NME) from outside his/her department.

Skill Enhancement Courses (SECs): These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic programme. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge**.**

Field Study/Industrial Visit/Case Study: It has to be completed during the fifth semester of the degree programme. Credit for this course will be entered in the fifth semester's marks statement.

Internship: Students must complete internship during summer holidays after the fourth semester. They have to submit a report of internship training with the necessary documents and have to appear for a viva-voce examination during fifth semester. Credit for internship will be entered in the fifth semester's mark statement.

Extra Credit Courses: In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTELetc.

Postgraduate Programme:

Programme Pattern: The Post Graduate degree programme consists of **FIVE** vital components. They are as follows:

Part –A	:	Core Course (Theory, Practicals) Core Industry Module, Core Project
Part-B (i)	:	Elective courses
Part-B (ii)	:	Non Major Elective, Skill Enhancement course, Professional Competency course
Part-B (iii)	:	Internship
Part –C	:	Extension activity

EXAMINATION

Continuous Internal Assessment (CIA):

PG - Distribution of CIA Marks

Passing Minimum: 50 %

Assignments – 3 = 30%

Tests- 3(Best 2 out of 3) = 50%

Seminar=10 %

Attendance= 10 %

Question Paper Pattern
Part A: includes two subsections

Part A 1 (10X1=10 marks)
One word question/ Fill in/ Match the following/True or False/ Multiple Choice Questions
Two Questions from Each unit

Part A 2(5X2=10 marks)
Short Answers
One question from Each unit
Total Marks - 20

Part B: (5X5=25 marks)
Paragraph Answers
Either/ or type, One Question from each unit

Part C: (10X3=30)
Essay Type Answers
Answer 3 out of 5 Questions
One Question from each unit

Part A: K1 Level
Part B: K2, K3 and K4 Level
Part C: K5 and K6 Level

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S.No.	Level	Parameter	Description
1	K1	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/ Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis/Creating	The learner creates a new product or point of view

WEIGHTAGE of K –LEVELS IN QUESTION PAPER

(Cognitive Level) K-LEVELS →	Lower Order Thinking			Higher Order Thinking			Total
	K1	K2	K3	K4	K5	K6	
END SEMESTER EXAMINATIONS (ESE)	20	25			30		**75**
Continuous Internal Assessment (CIA)	20	25			30		**75**

QUESTION PATTERN FOR END SEMESTER EXAMINATION/ Continuous Internal Assessment

PART		MARKS
PART –A I. (No choice ,One Mark) **TWO** questions from each unit **II.** (No choice, Two Mark) **ONE** question from each unit	(10x1=10) (5x2=10)	**20**
PART –B (Either/ or type,5-Marks) **ONE** question from each unit	(5x5=25)	**25**
PART –C (3 out of 5) (10Marks) **ONE** question from each unit	(3x10=30)	**30**
	Total	**75**

BLUE PRINT OF QUESTION PAPER FOR END SEMESTER EXAMINATION								
DURATION: 3.00 Hours.								**Max Mark :75**
K-LEVELS		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
PART								
PART –A	(One Mark, No choice) (10x1=10)	10						**10**
	(2-Marks,Nochoice) (10x2=20)	10						**10**
PART –B	(5-Marks)(Either/or type) (5x5=25)		5	10	10			**25**
PART –C	(10 Marks)(3 out of 5) (3x10=30)					20	10	**30**
Courses having only **K5,K6** levels, K5 level- 3 Questions, K6 level- 2 Questions **(One K6 level question is compulsory)**								
	Total	**20**	**05**	**10**	**10**	20	10	**75**

EVALUATION

GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

Grade Point Average (GPA) will be calculated from the first semester onwards for all semester. From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by semester Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) , respectively. These two are calculated by the following formulae:

$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{I=1}^{n} C_i}$	$WAM(\text{Weighted Average Marks}) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{I=1}^{n} C_i}$
Where, C_i is the Credit earned for the Course i G_i is the Grade Point obtained by the student for the Course i M_i is the marks obtained for the course i and n is the number of Courses **Passed** in that semester.	

CGPA: Average GPA of all the Courses starting from the first semester to the current semester.

CLASSIFICATION OF FINAL RESULTS:

i. The classification of final results shall be based on the CGPA, as indicated in Table-2.

ii. For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as 'Outstanding'. Similarly the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99 and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective programmes as 'Excellent', 'Very Good', 'Good', and 'Above Average' respectively.

iii. Absence from an examination shall not be taken an attempt.

Table- 1: Grading of the Courses

Marks Range	Grade Point	Corresponding Grade
90 and above	**10**	**O**
80 and above and below 90	**9**	A+
70 and above and below 80	**8**	**A**
60 and above and below 70	**7**	**B+**
50 and above and below 60	**6**	**B**
Below50	**NA**	**RA**

NA- Not Applicable, RA- Reappearance

The candidates performance in every current semester is indicated by **Semester Grade Point Average (SGPA)** and from the second semester onwards, the continuous performance including previous semester/s is indicated by **Cumulative Grade Point Average (CGPA)**

Table-2: Final Result

CGPA	Corresponding Grade	Classification of Final Result
9.00 and above	**O**	**Outstanding**
8.00 to 8.99	A+	**Excellent**
7.00 to 7.99	**A**	**Very Good**
6.00 to 6.99	**B+**	**Good**
5.00 to 5.99	**B**	**Above Average**

***** The candidates who have passed in the first appearance and within the prescribed duration of the PG Programme are eligible. If the candidate's Grade is O/A+ with more than one attempt, the performance is fixed as "Very Good"

VISION

Empowering the women students with quality education on utility of microbes, microbial processes, products, to make them academics and entrepreneurs to serve for the welfare of society.

MISSION

- To initiate, promote, develop, sustain quality and innovative research using sophisticated instruments in the field of Microbiology.
- To motivate the students so as to exploit the potentiality of microbes and microbial processes for the betterment of the society

PROGRAMME OUTCOMES FOR M.Sc.,DEGREE PROGRAMMES

PO.No	Programme Outcomes (*Upon completion of the M.Sc.,Degree Programme, the Post graduate will be able to)*
PO-1	**Disciplinary Knowledge**: demonstrate in-depth knowledge and understanding of theories, policies, and practices in one or more disciplines that form a part of a Post Graduate program of study in Master of Science.
PO-2	**Critical Thinking and Problem Solving**: apply analytic thought to a body of knowledge, analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence, identify relevant assumptions or implications, formulate coherent arguments, critically evaluate practices, policies and theories by following scientific approach to knowledge development: solve problems and extrapolate the same to real life situation
PO-3	**Information/digital literacy and Communication Skills:** use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data: communicate thoughts and ideas analytically and effectively in writing and orally using appropriate media, and present complex information in a clear and concise manner to different groups.
PO-4	**Research-related skills:** conduct independent inquiry in a chosen scientific discipline, demonstrate sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesizing and articulating; recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; plan, execute and report the results of an experiment or investigation.
PO-5	**Scientific reasoning and Reflective Thinking:** analyse, interpret and draw conclusions from quantitative/qualitative data and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; critically and sensibly evaluate life experiences, with self awareness and reflexivity of both self and society.
PO-6	**Multidisciplinary Approach, Innovation and Entrepreneurship:** propose novel ideas of interdisciplinary approach in providing better solutions and new ideas for the sustainable developments; identify opportunities, entrepreneurship vision and use of innovative ideas to create value and wealth for the betterment of the individual and society.
PO-7	**Moral and ethical awareness/reasoning:** embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work, demonstrate the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work.
PO-8	**Self directed Learning:** work independently, identify appropriate resources required for a project, and manage a project till completion.
PO-9	**Lifelong Learning:** engage in continuous learning for professional growth and development, acquire knowledge and skills, adapt to changing environment and to changing trades and demands of work place through knowledge/skill development/reskilling.
PO-10	**Multicultural Competence, Social Interaction and Effective Citizenship:** understand the values and beliefs of multiple cultures, global perspectives, engage and interact respectfully with diverse groups and elicit views of others, mediate disagreements and help reach conclusions in group settings, and demonstrate empathetic social concern and equity centred national development

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO No.	Program Specific Outcomes **(M.Sc., Microbiology)**
PSO1	**Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
PSO2	**Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations
PSO3	**Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
PSO4	**Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
PSO5	**Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit

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CHOICE BASED CREDIT SYSTEM - LEARNINIG OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted form the academic year 2023-2024)

ELIGIBILITY: A candidate who is a graduate of this University or any recognized University in B.Sc., with Biotechnology/ Biochemistry/ Botany/ Zoology/ Microbiology/ Bioinformatics/ Biology/ Life sciences/ B.Sc., with Biological Sciences as one of the subjects (B.E / B.Tech in Biotechnology) B.Pharm / B.Sc., Agriculture/ B.Sc., Horticulture.

Sem	Part	Nature of the Course	Course Code	Title of the Paper	Ins. Hrs/ Week	L	T	P	S	Credit	Exam Hours	Marks		Total
												CIA	ESE	
I	Part A	Core Course -I	P23MB101	General Microbiology and Microbial Diversity	6	4	1	-	1	5	3	25	75	100
		Core Course- II	P23MB102	Immunology, Immunomics and Microbial Genetics	6	4	1	-	1	5	3	25	75	100
		Core Practical-I	P23MB103P	Practical Pertaining CCI and CCII	6	2	-	4	-	3	3	25	75	100
	Part B (i)	Elective Course – I	P23MBE11A/ P23MBE11B/ P23MBE11C	Forensic Science/ Health Hygiene/ Microalgal Technology (Among the three choices anyone can be chosen by the student)	5	4	1	-	-	3	3	25	75	100
		Elective Course – II	P23MBE12A/ P23MBE12B/ P23MBE13C	Bioinstrumentation/ Herbal Technology and Cosmetic Microbiology / Essentials of Laboratory Management and Biosafety (Among the three choices anyone can be chosen by the student)	5	4	1	-	-	3	3	25	75	100
	Part B (ii)	Non Major Elective - I			2	2	-	-	-	2	3	25	75	100
	TOTAL				**30**	**20**	**4**	**4**	**2**	**21**	-	-	-	**600**
II	Part A	Core Course- III	P23MB204	Medical Bacteriology and Mycology	6	4	1	-	1	5	3	25	75	100
		Core Course -IV	P23MB205	Medical Virology and Parasitology	6	4	1	-	1	5	3	25	75	100
		Core Practical - II	P23MB206P	Practical Pertaining CCIII and CCIV	6	2	-	4	-	3	3	25	75	100
	Part B (i)	Elective Course – III	P23MBE23A/ P23MBE23B/ P23MBE23C	Epidemiology/ Clinical Diagnostic Microbiology/ Bioremediation (Among the three choices anyone can be chosen by the student)	5	4	1	-	-	3	3	25	75	100

Sem	Part	Nature of the Course	Course Code	Title of the Paper	Ins. Hrs/ Week	L	T	P	S	Credit	Exam Hours	Marks		Total
												CIA	ESE	
		Elective Course – IV	P23MBE24A/ P23MBE24B/ P23MBE24C	Bioinformatics/ Nanobiotechnology/ Clinical Research and Clinical Trials (Among the three choices anyone can be chosen by the student)	5	4	1	-	-	3	3	25	75	100
	Part B (ii)	Non Major Elective - II			2	2	-	-	-	2	3	25	75	100
	Part B (iii)	Internship/Industrial Activity			-	-	-	-	-	-	-			-
	TOTAL				**30**	**20**	**4**	**4**	**2**	**21**	-	-	-	**600**
III	Part A	Core Course- V		Soil and Environmental Microbiology	6	4	1	-	1	5	3	25	75	100
		Core Course- VI		Recombinant DNA Technology and Biotechnology	6	4	1	-	1	5	3	25	75	100
		Core Practical- III		Practical Pertaining CCVand CCVI	6	2	-	4		3	3	25	75	100
		Core Industry Module		Fermentation Technology and Pharmaceutical Microbiology	5	4	1	-	-	3	3	25	75	100
	Part B (i)	Elective Course – V		Biosafety, Bioethics and IPR/ Toxinology/ Water Conservation and Water Treatment (Among the three choices anyone can be chosen by the student)	5	4	1	-	-	3	3	25	75	100
	Part B (ii)	Skill Enhancement Course		Microbial Quality Control and Testing	2	2	-	-	-	2	3	25	75	100
	Part B (iii)	Internship/Industrial Activity				-	-	-	-	2		-	-	
	TOTAL				**30**	**20**	**4**	**4**	**2**	**23**	**-**	**-**	-	**600**
IV	Part A	Core Course- VII		Food and Dairy Microbiology	5	4	-	-	1	5	3	25	75	100
		Core Course- VIII		Research Methodology and Biostatistics	5	4	-	-	1	5	3	25	75	100
		Core Practical-IV		Practical Pertaining CCVII and CCVIII	6	2	-	4		3	3	25	75	100
		Core Project		Project with Viva Voce	8	-	2	6		7	-	25	75	100
	Part B (i)	Elective Course – VI (Industry / Entrepreneurship)		Bioenergy/ Marine Microbiology/ Life Science for Competitive Examinations (Among the three choices anyone can be chosen by the student)	4	4	-	-	-	3	3	25	75	100
	Part B (ii)	Professional Competency Course		Entrepreneurship in Biobusiness	2	2	-	-	-	2	3	25	75	100
	Part C			Extension Activity	-	-	-	-	-	1	-	-	-	-
	TOTAL				**30**	**16**	**2**	**10**	**2**	**26**	-	-	-	**600**
				GRAND TOTAL	**120**	**78**	**12**	**16**	**14**	**91**				**2400**
	Extra Credit			MOOC/SWAYAM/NPTEL		-	-	-	-	**2**	-	-	-	-
				Value added Courses (At least one per Year)		-	-	-	-	**2**	-	-	-	-

L-Lecture T-Tutorial P-Practical S-Seminar

Credit Distribution for M.Sc., Microbiology

S.No	Course Details	Credit
Part A	Core Course[8 Courses X 5 Credits]	40
	Core Practical [4 Courses X 3 Credits]	12
	Project Work with Viva Voce	7
	Core Industry Module [1Course X 3 Credits]	3
Part B (i)	Elective Course [6 Courses X 3 Credits]	18
Part B (ii)	Non Major Elective [2 Courses X 2 Credits]	4
	Skill Enhancement Course [1 Course X 2 Credits]	2
	Professional Competency Course [1 Course X 2]	2
Part B (iii)	Internship	2
Part C	Extension Activity	1
	Total Credit	**91**

Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components of Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

NON MAJOR ELECTIVE (NME) OFFERED BY THE DEPARTMENT

Semester	Part	Course	Course Code	Title of the Paper
I	Part B (ii)	NME-I	P23NMEMB11	Vermitechnology
II		NME-II	P23NMEMB22	Organic farming and Biofertilizer Technology

EXTRA CREDIT COURSE -VALUE ADDED COURSE OFFERED BY THE DEPARTMENT

Semester	Course	Course Code	Title of The Paper
I	VAC-I	P23MBVA1	Microbial Kitchen Gardening
II	VAC-II	P23MBVA2	Food Adulteration in every day life

Semester: I- CC-I: General Microbiology and Diversity

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code:P23MB101**

UNIT-I: **(18 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: **(18 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: **(18 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: **(18 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: **(18 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 / halotolerance - Applications of halophiles. Conservation of Biodiversity.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.
2. Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions
3. Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.
4. Create aseptic conditions by following good laboratory practices
5. Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications

TEXT BOOKS

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.

2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.

3. Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6th Edition). McGraw - Hill company, New York.

4. White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.

5. Dubey R.C. and Maheshwari D. K. (2009). Textbook of Microbiology. S. Chand, Limited.

REFERENCE BOOK(S)

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

3. Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California.
4. Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2nd Edition). Books / Cole Thomson Learning, UK
5. Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15th Edition). Pearson.

E-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

Semester: I- CC-II: Immunology, Immunomics and Microbial Genetics

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code: P23MB102**

UNIT-I: **(18 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: **(18 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: **(18 Hours)**

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO and 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, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - 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, immuno-tolerance, immuno-potentiation, Immunomodulation. Role of cytokines,

lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants. Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology

UNIT-IV: (18 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: (18 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.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity.
2. Justify the significance of MHC molecules in immune response and antibody pro
3. Analyze genomic DNA of prokaryotes and eukaryotes.
4. Summarize gene transfer mechanisms for experimental study.

TEXT BOOKS

1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.
2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.
3. Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10th Edition). Elsevier
4. Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.
5. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd.

REFERENCE BOOK(S)

1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.
2. Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell.
3. Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4th Edition). Wiley-Blackwell.
4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.
5. Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.

E-RESOURCES

1. https://www.ncbi.nlm.nih.gov/books/NBK279395/
2. https://med.stanford.edu/immunol/phd-program/ebook.html
3. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Semester: I- CP-I: Practical Pertaining CCI and CCII

Ins. Hours / Week: 6 **Course Credit: 3** **Course Code: P23MB103P**

UNIT-I: **(18 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: **(18 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: **(18 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– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID) Immuno-electrophoresis and staining of precipitin lines- Rocket immuno electrophoresis and counter current immuno electrophoresis.

UNIT-IV: **(18 Hours)**

Preparation of lymphocytes from peripheral blood by density gradient centrifugation.

urification of immunoglobulin– Ammonium Sulphate Precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex.

UNIT-V: **(18 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.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Apply microscopic techniques and staining methods in the identification and differentiation of microbes.
2. Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.
3. Perform and evaluate immunological reactions to aid diagnosis.
4. Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques
5. Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis

TEXT BOOKS

1. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.

2. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (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 BOOK(S)

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.

2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.

3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.

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

E-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-fall-2005/pages/lecture-notes/
4. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Semester: I- EC-I- Forensic Science

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE11A**

UNIT-I: **(15 Hours)**

Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist

UNIT-II: **(15 Hours)**

Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.

UNIT-III: **(15 Hours)**

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

UNIT-IV: **(15 Hours)**

DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.

UNIT-V: **(15 Hours)**

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

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Identify the scope and need of forensic science in the present scenario.
2. Plan for the organizational setup and functioning of forensic science laboratories
3. Analyze the biological samples found at the crime scene.

4. Perform extraction and identification of DNA obtained from body fluids.
5. Discuss the concept of forensic toxicology

TEXT BOOKS

1. Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN- 10:8190113526 / ISBN-13:9788190113526.

2. James S. H. and Nordby, J. J. (2015) Forensic Science: An Introduction to Scientific and Investigative Techniques. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.

3. Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.

4. Sharma B.R (2020) Forensic science in criminal investigation and trials. (6th Edition)Universal Press.

5. Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12th Edition).Pearson Press.

REFERENCE BOOK(S)

1. Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, New York. ISBN:0-8493-8122-3.

2. Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3rd Edition). CRC Press, New York. ISBN-10:1498720196.

3. Lincoln, P.J. and Thomson, J. (1998). (2nd Edition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.

4. Val McDermid (2014). Forensics. (2nd Edition). ISBN 9780802125156.

5. Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2nd Edition). CRC Press.

E-RESOURCES

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

Semester: I- EC-I- Microalgal Technology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE11B**

UNIT-I: **(15 Hours)**

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

UNIT-II: **(15 Hours)**

Cultivation of freshwater and marine microalgae - Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting of microalgae biomass.

UNIT-III: **(15 Hours)**

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

UNIT-IV: **(15 Hours)**

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

UNIT-V: **(15 Hours)**

Microalgae as feed stock for production of biofuels - Carbon-neutral fuels. Lipid-rich algal strains - *Botryococcus braunii*. Drop-in fuels from algae - hydrocarbons and biodiesel,

bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Biocrude synthesis from microalgae. Integrated biorefinery concept. Life cycle analysis of algae biofuels.

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Acquire knowledge in the field of microalgal technology and their characteristics
2. Identify the methods of algal cultivation and harvesting.
3. Recognize and recommend the use of microalgae as food, feed and fodder.
4. Promote microalgae in phycoremediation.
5. Compare and critically evaluate recent applied research in these microalgal applications.

TEXT BOOKS

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

REFERENCE BOOK(S)

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

E-RESOURCES

1. https://www.classcentral.com/course/algae-10442
2. https://onlinecourses.nptel.ac.in/noc19_bt16/preview

3. https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46
4. https://nptel.ac.in/courses/103103207
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae

Semester: I- EC-I- Health and Hygiene

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE11C**

UNIT-I: **(15 Hours)**

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

UNIT-II: **(15 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: **(15 Hours)**

Physical health, physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief. International control of health, WHO. Personal hygiene, Sun bathing, Colon Hygiene. Health destroying habits and addictions - Pan, supari, ganja, drinking, smoking, tea and coffee.

UNIT-IV: **(15 Hours)**

Mental hygiene - factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adulthood and old age. Mental health occupational hazards.

UNIT-V: **(15 Hours)**

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

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Identify factors affecting health and health habits.

2. Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.
3. Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.
4. Explore Mental hygiene and maintain emotional stability
5. Participate in health education programmes

TEXT BOOKS

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

REFERENCE BOOK(S)

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

E-RESOURCES

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

Semester: I- EC-II- Bioinstrumentation

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE12A**

UNIT-I: **(15 Hours)**

Basic laboratory Instruments. Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation co-efficient; Principles, methodology and applications of differential, rate zonal and density gradient centrifugation - Applications in determination of molecular weight.

UNIT-II: **(15 Hours)**

General principles of chromatography - Chromatographic Performance parameters; Types- Thin layer chromatography, Paper Chromatography, Liquid chromatography (LPLC &HPLC), Adsorption, ion exchange, Gel filtration, affinity, Gas liquid (GLC). Flash Chromatography and Ultra Performance convergence chromatography. Two dimensional chromatography. Stimulated moving bed chromatography (SEC).

UNIT-III: **(15 Hours)**

Electrophoresis: General principles - moving boundary electrophoresis - electrophoretic mobility – supportive materials – electro endosmosis – types (horizontal, vertical and two dimensional electrophoresis) - Principle and applications - paper electrophoresis, Serum electrophoresis, starch gel electrophoresis, Disc gel, Agarose gel, SDS – PAGE, Immuno electrophoresis. Blotting techniques -Southern, northern and western blotting.

UNIT-IV: **(15 Hours)**

Spectroscopic techniques: Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer, NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH. Biophysical methods: Analysis of biomolecules by Spectroscopy UV/visible.

UNIT-V: **(15 Hours)**

Radioisotopic techniques: Principle and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, auto radiography and its applications. Commonly used isotopes in biology, labeling procedures and safety aspects.

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Make use of the laboratory instruments- laminar air flow, pH meter, centrifugation methods, biosafety cabinets following SOP.
2. Apply chromatography techniques in the separation of biomolecules.
3. Perform molecular techniques like mutagenesis and their detection.
4. Estimate molecules in biological samples by adopting UV spectroscopic techniques.
5. Cultivate organisms anaerobically

TEXT BOOKS

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

REFERENCE BOOK (S)

1. Pavia D. L. (2012) Spectroscopy (4th Edition). Cengage.
2. Skoog A. and West M. (2014). Principles of Instrumental Analysis. (14th Edition). W.B.Saunders Co., Philadephia.
3. Miller J. M. (2007). Chromatography: Concepts and Contrasts (2nd Edition) Wiley-Blackwell.

4. Gurumani N. (2006). Research Methodology for Biological Sciences. (1st Edition) MJP Publishers.
5. Ponmurugan P. and Gangathara P. B. (2012). Biotechniques. (1st Edition). MJP Publishers.

E-RESOURCES

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

Semester: I- EC-II- Herbal Technology and Cosmetic Microbiology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE12B**

UNIT-I: **(15 Hours)**

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

UNIT-II: **(15 Hours)**

Collection and authentication of selected Indian medicinal plants: *Emblica officinalis, Withania somnifera, Phyllanthus amarus, Tinospora cordifolia, Andrographis paniculata, Piper longum, Ocimum sanctum, Azardirchata indica, Terminalia chebula, Allium sativum*. Preparation of extracts- Hot and cold methods. Preparation of stock solutions.

UNIT-III: **(15 Hours)**

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

UNIT-IV: **(15 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: **(15 Hours)**

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

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Identify the applications of Indian medicinal plants in treating diseases.
2. Identify and authenticate herbal plants.
3. Evaluate the antimicrobial activity of medicinal plants
4. Describe the role of microorganisms and their metabolites in the preparation of cosmetics.
5. Validate procedures and biosafety measures in the mass production of cosmetics.

TEXT BOOKS

1. Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.

2. Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN:8178330911.

3. Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.

4. Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3rd Edition). CRC Press. ISBN:9780429113697

5. Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press.ISBN-10:0849337135.

REFERENCE BOOK(S)

1. Indian Herbal Pharmacopoeia (2002). Vol. I &II Indian Drug Manufacturers Association, Mumbai.

2. British Herbal Pharmacopoeia.(1990).Vol.I. British Herbal Medicine Association.ISBN: 0903032090.

3. Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (2nd edition). Saujanya Books, Delhi.ISBN-10:81-900788-5-2/8190078852. ISBN-13:978-81-900788-5-6/9788190078856.

4. Turner R. (2013). Screening methods in Pharmacology. Elsevier. ISBN:9781483264233.

5. Cupp M. J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp. 85-93). M. J. Cupp. Humana Press.Totowa, NJ, USA. ISBN-10:1617371904.

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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
5. https://pubmed.ncbi.nlm.nih.gov/15156038/

Semester: I- EC-II- Essentials of Laboratory Management and Biosafety

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE12C**

UNIT-I: **(15 Hours)**

Introduction to the laboratory and laboratory hazards - General laboratory facilities – Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan.

UNIT-II: **(15 Hours)**

Common hazards in laboratory: Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling - Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Potential ignition sources in the lab. Stages of Fire. Fire Extinguishers. Fire Response.

UNIT-III: **(15 Hours)**

Prevention and First aid for laboratory accidents. Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.

UNIT-IV **(15 Hours)**

Biosafety - Historical background. Blood borne pathogens (BBP) and laboratory - acquired infections. Introduction to biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms. Recommended biosafety. Levels for infectious agents and infected animals. Risk groups with examples - Risk assessment. Safety levels. Case studies - Safe working, hand hygiene. Laboratory instruments, packing, sending,

transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization.

UNIT-V **(15 Hours)**

Biosafety regulations and guidelines. Centers for disease control and prevention and the National institutes of health. Occupational safety and health administration. Recombinant DNA advisory committee(RDAC), Institutional biosafety committee(IBSC), Review committee on genetic manipulation(RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines.

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Employ skills on laboratory safety and avoid laboratory accidents.
2. Prevent laboratory hazards by practicing safety strategies.
3. Practice various first aid procedures during common laboratory accidents.
4. Ensure biosafety strategies in laboratory.
5. Recognize the importance of biosafety guidelines.

TEXT BOOKS

1. Sateesh M. K. (2013). Bioethics and Biosafety, IK International Pvt Ltd. ISBN : 8190675702.

2. Muthuraj M. and Usharani B. (2019). Biosafety in Microbiological Laboratories. (1sr Edition). Notion Press. ISBN 10: 1645878856

3. Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services. (2016). (5th Edition). Lulu.com.

4. Kanai. L. Mukherjee. (Medical Laboratory Technology(4th Edition). CBS Publishers

5. Ramakrishnan (2012). Manual of Medical Laboratory Techniques. JP brothers.

REFERENCE BOOK(S)

1. World Health Organization, Biosafety programme management. (2010). (4th Edition). WHO Publications.

2. Rashid N. (2013). Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1st Edition).

3. Dayuan X. (2015). Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, ISBN-10 : 1842657917
4. Ochei J. Kolhatkar(2000). A. (Medical Laboratory Science – Theory and Practice. ISBN; 13:978-0074632239.
5. Lynne S. Garcia. Clinical Laboratory Management (2nd Edition). ASM Press

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1. https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf
2. https://ucanapplym.s3.ap-south-1.amazonaws.com/RGU/notifications/E_learning/0nline_study/PG-SEM-IV-Biosafety%20regulation.pdf
3. https://consteril.com/biosafety-levels-difference/
4. https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf
5. https://www.who.int/publications/i/item/9789240011311

Semester: I- NME-I- Vermitechnology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:P23NMEMB11**

UNIT-I: **(6 Hours)**

Introduction to Vermiculture - Definition, classification, history, economic importance- In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure. Its role in the bio transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.

UNIT-II: **(6 Hours)**

Earthworm Biology and Rearing - Key to identify the species of earthworms. Biology of *Eisenia fetida.* a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

UNIT-III: **(6 Hours)**

Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.

UNIT-IV: **(6 Hours)**

Vermicomposting - Trouble Shooting-Temperature-Aeration- Acidity- Pests and Diseases-

Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method- migration method. Packing & Nutritional analysis of vermicompost.

UNIT-V: (6 Hours)

Applications of Vermiculture - Vermiculture Bio-technology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Verm wash- vermicompost tea-vermi meal-enriched vermicompost-pelleted vermicompost.

Total Lecture Hours - 30

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Compare and contrast the uses of vermicompost to the soil.
2. Recommend different species of earthworms after acquiring knowledge on its biology
3. Design the vermicomposting process.
4. Assess the Best Practices of Vermicomposting
5. Recommend the applications of vermicompost to different soils and for different crops.

TEXT BOOKS

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

REFERENCE BOOK(S)

1. Roy D. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
2. Kumar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New Delhi.

3. Lekshmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.

4. Edwards CA, Arancon NQ ShermanRL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1st edn.CRC Press.

5. Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1st edn. Orient longman.

E-RESOURCES

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

SEMESTER –II

Semester: II- CC-III– Medical Bacteriology and Mycology

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code:P23MB204**

UNIT-I: **(18 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: **(18 Hours)**

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

UNIT-III: **(18 Hours)**

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

UNIT-IV: **(18 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: **(18 Hours)**

Dimorphic fungi causing Systemic mycoses, *Histoplasma, Coccidioides, Sporothrix, Blastomyces.* Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing

secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Collect, transport and process of various kinds of clinical specimens.
2. Analyze various bacteria based on morphology and pathogenesis.
3. Discuss various treatment methods for bacterial disease.
4. Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents
5. Apply various immunodiagnostic method to detect fungal infections.

TEXT BOOKS

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.

2. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.

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

4. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology, (4th Edition). Wiley Publishers.

5. Chander J. (2018). Textbook of Medical Mycology. (4th Edition). Jaypee brothers Medical Publishers.

REFERENCE BOOK(S)

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

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

E-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/

Semester: II- CC-IV Medical Virology and Parasitology

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code: P23MB205**

UNIT-I: **(18 Hours)**

General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).

UNIT-II: **(18 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: **(18 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: **(18 Hours)**

Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba,* Aerobic and Anaerobic amoebae, *Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania,* and *Trypanasoma.*

UNIT-V: **(18 Hours)**

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia Solium, T. Saginata, T. Echinococcus*. Trematodes – *Fasciola Hepatica, Fasciolopsis Buski, Paragonimus, Schistosomes*. Nematodes - *Ascaris,*

Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides and *Wuchereria*. Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti-protozoan drugs.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Cultivate viruses by different methods and aid in diagnosis. Perform purification and viral assay
2. Investigate the symptoms of viral infections and presumptively identify the viral disease.
3. Diagnose various viral diseases by different methods.(serological, conventional and molecular)
4. Educate public about the spread, control and prevention of parasitic diseases.
5. Identify the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.

TEXT BOOKS

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.

2. Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.

3. Rajan S. (2007). Medical Microbiology. MJP publisher.

4. Paniker J. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi.

5. Arora, D. R. and Arora B. B. (2020). Medical Parasitology. (5th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

REFERENCE BOOK(S)

1. Carter J. (2001). Virology: Principles and Applications (1st Edition). Wiley Publications.

2. Willey J., Sandman K. and Wood D. Prescott's Microbiology. (11th Edition). McGraw Hill Book.

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

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

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

E-RESOURCES

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

Semester: II- CP-II: Practical Pertaining CCIII and CCIV

Ins. Hours / Week: 6 **Course Credit: 3** **Course Code: P23MB206P**

UNIT-I: **(18 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: **(18 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: **(18 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: **(18 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-VI: (18 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.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Collection of different clinical samples, transport, culture and examination.
2. Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.
3. Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.
4. Perform antibiotic sensitivity tests and compare with the standard tests.
5. Screening of industrially important microbes for metabolite production.

TEXT BOOKS

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

REFERENCE BOOK(S)

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
2. Chart H. (2018). Practical Laboratory Bacteriology. CRC Press
3. Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.

4. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22nd Edition.Cambridge University Press
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders

E-RESOURCES

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

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
(AUTONOMOUS)
SUNDARAKKOTTAI, MANNARGUDI–614016.
(For the Candidates admitted in the academic year 2023-2024)
DEPARTMENT OF MICROBIOLOGY
M.Sc., MICROBIOLOGY

Semester: II- EC-III: Epidemiology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE23A**

UNIT-I: **(15 Hours)**

Fundamentals of epidemiology - Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission - Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - Factors, routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis

UNIT-II: **(15 Hours)**

Tools of Epidemiology - Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology - Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies - Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.

UNIT-III: **(15 Hours)**

Epidemiological aspects of diseases of national importance - Background to communicable and non-communicable diseases. Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Mucor mycosis, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.

UNIT-IV: **(15 Hours)**

Mechanisms of Antimicrobial resistance - Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Hospital acquired infections - Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of *Pseudomonas, Acinetobacter, Clostridium difficile,* HBV, HCV, Rotavirus, *Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and management of nosocomial infections

UNIT-V: **(15 Hours)**

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

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Apply the knowledge acquired on concepts of epidemiology to clinical and public health environment
2. Plan various strategies to trace the epidemiology.
3. Plan the control of communicable and non-communicable diseases
4. Analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management
5. Employ National control programs related to Communicable and Non-Communicable diseases with the public.

TEXT BOOKS

1. Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of Epidemiology in Public Health Practice., (3rd Edition). CDC.

2. Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.

3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.

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

5. Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology.5th edn. Blackwell Scientific Publishers.

REFERENCE BOOK(S)

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

E-RESOURCES

1. https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en
2. https://hal.archives-ouvertes.fr/hal-00902711/document
3. https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/
5. https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_outbreaks.pdf

Semester: II- EC-III: Clinical and Diagnostic Microbiology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE23B**

UNIT-I: **(15 Hours)**

Microbiology Laboratory Safety Practices -General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.

UNIT-II: **(15 Hours)**

Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.

UNIT-III: **(15 Hours)**

Diagnosis of microbial diseases - Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.

UNIT-IV: **(15 Hours)**

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

UNIT-V: **(15 Hours)**

Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Apply Laboratory safety procedures and hospital waste disposal strategies
2. Collect various clinical specimens, handle, preserve and process safely

3. Identify the causative agents of diseases by conventional and molecular methods following standard protocols.
4. Assess the antimicrobial susceptibility pattern of pathogens.
5. Trace the sources of nosocomial infection and recommend control measures.

TEXT BOOKS

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi. ISBN-10:0443047219 / ISBN-13-978-0443047213.

2. Tille P. M. (2021). Bailey and Scott's Diagnostic Microbiology. (15th Edition). Elsevier. ISBN:9780323681056.

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

4. Mukherjee K.L. (2000). Medical Laboratory Technology.Vol. 1-3. (2nd Edition). Tata McGraw-Hill Education. ISBN-10:0074632604.

5. Sood R. (2009). Medical Laboratory Technology – Methods and Interpretations. (6th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN:9788184484496.

REFERENCE BOOK(S)

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Yolken R.H. (2003). Manual of Clinical Microbiology. (8th Edition). American Society for Microbiology, Washington, DC. ISBN:1-555810255-4.

2. Bennett J. E., Dolin R. and Blaser M. J. (2019). Principles and Practice of Infectious Diseases. (9th Edition). Elsevier. EBook ISBN:9780323550277. Hardcover ISBN:9780323482554.

3. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7th Edition. Hodder Arnold Publication. ISBN-10:0340554231 / ISBN-13:9780340554234.

4. Koneman E.W., Allen S. D., Schreckenberg P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378.

5. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1 / ISBN-10:0-521-67631-2.

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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

Semester: II- EC-III: Bioremediation

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE23C**

UNIT-I: **(15 Hours)**

Bioremediation - process and organisms involved. Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.

UNIT-II: **(15 Hours)**

Microbes involved in aerobic and anaerobic processes in nature. Water treatment - BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.

UNIT-III: **(15 Hours)**

Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents.

UNIT-IV: **(15 Hours)**

Microbial leaching of ores - process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.

UNIT-IV: **(15 Hours)**

Phytoremediation of heavy metals in soil - Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic

amendments in multi metal contaminated mine sites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.
2. Distinguish microbial processes necessary for the design and optimization of biological processing unit operations
3. Identify, formulate and design engineered solutions to environmental problems.
4. Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.
5. Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting *Rhizobacteria* in phytoremediation.

TEXT BOOKS

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications.
2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.
3. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2nd edition, CRC Press
4. Liu, D.H.F and Liptak, B.G (2005). Hazardous Wastes and Solid Wastes, Lewis Publishers.
5. Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJP Publishers

REFERENCE BOOK(S)

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1st Edition). Apple Academic Press.
2. Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.
3. Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.

4. Atlas, R.M & Bartha, R. (2000). Microbial Ecology. Addison Wesley Longman Inc.
5. Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1st edition. I.K. International Publishing House Pvt. Ltd

E-RESOURCES

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

Semester: II- EC-IV: Bioinformatics

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE24A**

UNIT-I: **(15 Hours)**

Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNIT-II: **(15 Hours)**

Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.

UNIT-III: **(15 Hours)**

Computational Protein Structure prediction – Secondary structure – Homology modelling-Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats-Molecular visualization tools.

UNIT-IV: **(15 Hours)**

Prediction of Properties of Ligand Compounds – 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds

UNIT-V: **(15 Hours)**

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

Total Lecture Hours - 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Access to databases that provides information on nucleic acids and proteins.
2. Invent algorithms for sequence alignment
3. Construct phylogenetic tree.
4. Predict the structure of proteins
5. Design drugs by predicting drug ligand interactions and molecular docking.

TEXT BOOKS

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

2. Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley-VCH.

3. Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4th Edition). Prentice-Hall of India Pvt.Ltd.

4. Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addision Wesley Longman Limited, England.
5. Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2nd edn.CBS Publishers, New Delhi.

REFERENCE BOOK(S)

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

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

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

Semester: II- EC-IV: Nanotechnology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE24B**

UNIT-I: **(15 Hours)**

Introduction to nanobiotechnology, Nano size-changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials),Class of nanomaterials and their applications. Need for nanomaterials and the risks associated with the materials.

UNIT-II: **(15 Hours)**

Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles

UNIT-III: **(15 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: **(15 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: **(15 Hours)**

Nanomaterials in diagnosis-Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.

Total Lecture Hours – 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Employ knowledge in the field of nanobiotechnology for development.
2. Identify various applications of nanomaterials in the field of medicine and environment.
3. Examine the prospects and significance of nanobiotechnology
4. Identify recent advances in this area and create a career or pursue research in the field.
5. Design non-toxic nanoparticles for targeted drug delivery.

TEXT BOOKS

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

REFERENCE BOOK(S)

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

5. Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press

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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

Semester: II- EC-IV: Clinical Research and Clinical Trails

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code: P23MBE24C**

UNIT-I: **(15 Hours)**

Introduction to Clinical Research: Clinical Research: An Overview, Different types of Clinical Research. Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Pharmacoepidemiology, Bioavailability, Bioequivalence, Terminologies and definition in Clinical Research. Drug Development Process: Drug Discovery Pipeline, Drug Discovery Process. Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV).

UNIT-II: **(15 Hours)**

Ethical Considerations and Guideline in Clinical Research: Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Belmont report. International Conference on Harmonization (ICH)-Brief history of ICH, Structure of ICH & ICH Harmonization Process, Guidelines for Good Clinical Practice. Regulation in Clinical Research-Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.

UNIT-IV: **(15 Hours)**

Clinical Trial Management: Key Stakeholders in Clinical Research, Ethics Committees and Institutional Review Board, Responsibilities of Sponsor. Responsibilities of Investigator, Protocol in Clinical Research Clinical Trial Design, Project Planning Project Managements - Informed Consent, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding. Essential Documents in clinical research -IB, ICF, PIS, TMF, ISF, CDA & CTA.

UNIT-IV: **(15 Hours)**

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

UNIT-V: **(15 Hours)**

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

Total Lecture Hours – 75

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Apprehend the Drug Development process and different phases of clinical trials.
2. Recognize the ethics and regulatory perspectives on clinical research trials activities.
3. Accentuate about clinical trials management concepts and documentation process.
4. Accomplish quality assurance and quality control to ensure the protection of human subjects and the reliability of clinical trial results.
5. To nurture skills recitation to commercial start up and industriousness

TEXT BOOKS

1. Gallin J. I., Ognibene F. P. and Johnson L. L. (2007). Principles and Practice of Clinical Research. (4th Edition). Elsevier, 2007.ISBN-10: 0128499052

2. Friedman L. M., Furberg C. D. and Demets D. (1998). Fundamentals of Clinical Trials, Vol: XVIII. (3rd Edition). Springer Science & Business Media.

3. Hulley S. B., Cummings S. R., Browner W. S., Grady D. G. and Newman T. B. (2013). Designing Clinical Research. (4th Edition). Jaypee Medical. ISBN-13: 978-1608318049.

4. Reed,G. (2004). Prescott and Dunn's Industrial Microbiology, 4th edn, CBS publication and distributors.

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

REFERENCE BOOK(S)

1. Friedman L.M., Fuberge C.D., DeMets D. and Reboussen, D.M. (2015). Fundamentals of Clinical Trials, Springer.
2. Browner W. S., (2012). Publishing and Presenting Clinical Research. (3rd Edition). Lippincott Williams and Wilkins.
3. Rondel R. K., Varley S. A. and Webb C. F. (2008). Clinical Data Management. (2nd Edition). Wiley
4. Peppler, H.J. and Pearl Man, D. (1979). Fermentation Technology, Vol 1 & 2, 2nd Edition Academic Press, London.
5. E1-Mansi, E.M.T., Bryce, C.F.A., Demain, A.L. and Allman,A.R. (2007). Fermentation Microbiology and Biotechnology. 2nd Edition, CRC press, Taylor and Francis Group.

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

Semester: II- NME-II: Organic Farming and Biofertilizer Technology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:P23NMEMB22**

UNIT-I: **(6 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: **(6 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: **(6 Hours)**

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

UNIT-IV: **(6 Hours)**

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

UNIT-V: **(6 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.

Total Lecture Hours – 30

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Produce biofertilizers and distinguish between organic and conventional farming.
2. Plan a Complete Farm Business including marketing, operation and financial outline.
3. Practice the application of microbial bio-fertilizers in large scales, thereby increasing soil fertility
4. Develop integrated farming for sustainable agriculture
5. Promote the quality of packaging, storage, increase shelf life, accelerate the bio efficacy of bio fertilizers as per BIS standards

TEXT BOOKS

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

REFERENCE BOOK(S)

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

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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-KndCowIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE