B.Sc., MICROBIOLOGY

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS – LOCF)

(For the candidates admitted in the academic year **2024-2025)**

SYLLABUS

PROGRAMME CODE: 3USMIC

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE

(AUTONOMOUS)

(Affiliated to Bharathidasan University, Tiruchirappalli)

Accredited by NAAC-An ISO 9001:2015 Certified Institution

SUNDARAKKOTTAI, MANNARGUDI – 614 016

TAMIL NADU, INDIA.

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B.Sc., MICROBIOLOGY

CHOICE BASED CREDDIT SYSTEM– LEARNING OUTCOMES BASED CURRICULUM FRAME WORK (CBCS–LOCF)

(For the candidates admitted in the academic year 2024–2025)

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 have 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 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 programme are being offered by the college. Ability Enhancement Compulsory Courses "AECC" are the courses based upon the content that leads to Knowledge enhancement especially in Communicative English and other soft skills.

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, NPTEL etc.

Undergraduate Programme:

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

Part -I : Languages (Tamil / Hindi / French / Sanskrit)

Part-II : General English

Part-III: Core Course (Theory, Practicals, Generic Elective courses , Discipline Specific Elective courses , Compulsory and Optional Allied courses, Project)

Part-IV: Non Major Elective, Foundation Course, Ability Enhancement Compulsory Course, Value Education, Environmental studies, Skill Enhancement Courses/ Soft Skills, Internship / field visit / industrial visit/ Case Study), Professional Competency Course

Part –V

Extension activity, Gender studies

EXAMINATION

Continuous Internal Assessment (CIA):

UG - Distribution of CIA Marks

Passing Minimum: 40 %

Assisgnment-3	=	30%
Test-2	=	50%
Seminar	=	10%
Attendance	=	10%

Question Paper Pattern

Part A:

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 Questions 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 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** questions from each unit	(5x5 =25)	25
PART -C (3 out of 5) (10 Marks) **ONE** question from each unit	(3x10 =30)	30
	Total	**75**

BLUE PRINT OF QUESTION PAPER FOR SEMESTER EXAMINATION							
DURATION: 3. 00 Hours.							**Max Mark : 100**
K- LEVELS	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total**
PART							**Marks**
PART –A (One Mark, No choice) (10x1 =10)	10						10
(2-Marks, No choice) (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) Courses having only **K5,K6** levels, K5 level- 3 Questions, K6 level- 2 Questions **(One K6 level question is compulsory)**					20	10	30
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 twoare calculated by the following formulae:

$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{I=1}^{n} C_i}$	$WAM\,(Weighted\ Average\ Marks) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{I=1}^{n} C_i}$
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) For each of the first three parts, there shall be separate classification on the basis of CGPA, as indicated in Table-2.

ii) For the purpose of declaring a candidate to have qualified for the Degree of Bachelor of Arts/Science/Commerce/Management as Outstanding/Excellent/Very Good/Good/Above Average/Average, the marks and the corresponding CGPA earnedby the candidate in Part-III alone will be the criterion, provided the candidate has secured the prescribed passing minimum in the all the Five parts of the Programme.

iii) Grade in Part –IV and Part-V shall be shown separately and it shall

not be taken into account for classification.

iv) A Pass in PART- V will be mandatory although the marks will not count for the calculation of the CGPA.

v) Absence from an examination shall not be taken an attempt.

Table-1: Grading of the Courses - UG

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
40 and above and below 50	5	C
Below 40	0	RA

Table- 2: Grading of the Courses - PG

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
Below 50	0	RA

Table-3: 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
4.00 to 4.99	C	Average
Below 4.00	RA	Re-appearance

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 B.Sc.,DEGREE PROGRAMMES

PO No.	Programme Outcomes (*Upon completion of the B.Sc. Degree Programme, the Undergraduate will be able to)*
PO-1	**Disciplinary knowledge**: Demonstrate comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate program of study in Bachelor of Science.
PO-2	**Critical thinking, Problem Solving and Reflective thinking:** think critically about the issues and identify, critically analyze and solve problems from the disciplines of concern using appropriate tools and techniques and the knowledge, skills and attitudes acquired and extrapolate the same to real life situations; show critical sensibility to life experiences, with self awareness and reflexivity of both self and society.
PO-3	**Analytical & Scientific Reasoning:** evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints; critically evaluate ideas, evidence, and experiences from an open minded and reasoned perspective.
PO-4	**Research-related Skills:** develop a sense of capability for relevant/appropriate inquiry and asking questions, synthesize, articulate and report results and to recognize and predict cause and effect relationships, define problems, formulate and establish hypothesis, analyze and interpret and draw conclusions from data, execute and report the results of an experiment or investigation.
PO-5	**Digital literacy and Effective Communication:** use ICT in a variety of learning situations and **s**peak, read, write and listen clearly in person and through electronic media in English and in one or more Indian languages, and make meaning of the world by connecting people, ideas , books, media and technology; efficiently communicate thoughts and ideas in a clear and concise manner.
PO-6	**Individual and Team Work:** effectively accomplish tasks individually as well as work effectively and respectfully as member or leader with diverse teams, facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interest so for a common cause and work efficiently as a member of a team.
PO-7	**Multicultural Competence and Social Interaction:** 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.
PO-8	**Awareness of Ethical issues, Human values and Gender Issues:** 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 and understand the value of relationship between self and the community and aware of the various issues concerning women and society.
PO-9	**Awareness of Environment and Sustainability:** understand the impacts of technology and business practices in societal and environmental contexts, and sustainable development.
PO-10	**Self directed and Lifelong learning:** acquire knowledge and skills, including learning "how to learn", that are necessary for participating in learning activities throughout life and to engage in independent and life-long learning in the broadest context of socio-technological changes.

PROGRAMME SPECIFIC OUTCOME (PSO) FOR B.Sc.,DEGREE PROGRAMMES

PSO No.	Program Specific Outcomes (B.Sc., Microbiology)
PSO1	**Placement :** Prepare the students in all disciplines like agriculture, industry-medical, pharma, dairy, hotel, food and food processing, immunologicals, cosmetics, vermitechnology and water treatment for effective and respectful placement.
PSO2	**Entrepreneur :** To create effective entrepreneur 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 that comply with good laboratory practices, following ethical values, leading the organization towards growth and development.
PSO4	**Contribution to society:** To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

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CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS – LOCF)
(For the candidates admitted in the academic year 2024 – 2025)
ELIGIBILITY: A Pass in 10+2 with Biology as one of the core subjects

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	L	T	P	S	Credit	Exam Hours	Marks		Total
												CIA	ESE	
I	I	Language Course-I	U24LC101	Pothu Tamil-1 Tamil Illakiya Varalaru - 1	6	5	1	-	-	3	3	25	75	100
	II	English Language Course-I	U24ELC101	General English – I	6	5	1	-	-	3	3	25	75	100
	III	Core Course-I	U24MB101	Fundamentals of Microbiology	5	4	1	-	-	5	3	25	75	100
		Core Practical-I	U24MB102P	Fundamentals of Microbiology	4	1	-	3	-	4	3	25	75	100
		Allied Course-I	U24ABC101	General Biochemistry	3	2	1	-	-	2	3	25	75	100
		Allied Practical-I	U24ABC102P	General Biochemistry	2	-	-	2	-	--	--	---	--	--
	IV	Non Major Elective -I	U24NMEMB11		2	2	-	-	-	2	3	25	75	100
		Foundation Course	U24FCMB11	Introduction to Microbial World	2	2	-	-	-	2	3	25	75	100
				TOTAL	**30**	**21**	**4**	**5**		**21**	-	-	-	**700**
II	I	Language Course-II	U24LC202	Pothu Tamil-II Tamil Illakiya Varalaru - 2	6	5	1	-	-	3	3	25	75	100
	II	English Language Course-II	U24ELC202	General English –II	6	5	1	-	-	3	3	25	75	100
	III	Core Course-II	U24MB203	Microbial Physiology	5	4	1	-	-	5	3	25	75	100
		Core Practical –II	U24MB204P	Microbial Physiology	4	1	-	3	-	4	3	25	75	100
		Allied Course-II	U24AMB201	Bioinstrumentation	3	2	1	-	-	2	3	25	75	100
		Allied Practical I	U24ABC102P	General Biochemistry	2	-	-	2	-	2	3	25	75	100
	IV	Non Major Elective -II	U24NMEMB22		2	2	-	-	-	2	3	25	75	100
		Skill Enhancement Course-I	U24SEMB21	Biofertilizer Technology	2	2	-	-	-	2	3	25	75	100
				Total	**30**	**21**	**4**	**5**	**-**	**23**	-	-	-	**800**
	I	Language Course-III		Pothu Tamil-III Tamizhga Varalarum	6	5	1	-	-	3	3	25	75	100

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	L	T	P	S	Credit	Exam Hours	Marks		Total
												CIA	ESE	
III				Panpadum										
	II	English Language Course-III		General English –III	6	5	1	-	-	3	3	25	75	100
	III	Core Course-III		Bacteriology and Mycology	5	4	1	-	-	5	3	25	75	100
		Core Practical –III		Bacteriology and Mycology	4	1	-	3	-	4	3	25	75	100
		Allied Course-III		Medical Laboratory Technology	3	2	1	-	-	2	3	25	75	100
		Allied Practical –II		Medical Laboratory Technology	2	-	-	2	-	--	--	--	--	--
	IV	Skill Enhancement Course –II		Organic farming Practices	2	2	-	-	-	2	3	25	75	100
		Skill Enhancement Course –III		Algal Technology	2	2	-	-	-	2	3	25	75	100
				TOTAL	**30**	**21**	**4**	**5**	**-**	**21**		-	-	**700**
IV	I	Language Course-IV		Pothu Tamil-IV Tamizhlum Ariviyalum	6	5	1	-	-	3	3	25	75	100
	II	English Language Course-IV		General English –IV	6	5	1	-	-	3	3	25	75	100
	III	Core Course- IV		Immunology	5	4	1	-	-	5	3	25	75	100
		Core Practical - IV		Immunology	4	1	-	3	-	4	3	25	75	100
		Allied Practical- II		Medical Laboratory Technology	2	-	-	2	-	2	3	25	75	100
		Allied Course- IV		Food Processing Technology	3	2	1	-	-	2	3	25	75	100
	IV	Skill Enhancement Course –IV		Biopesticides	2	2	-	-	-	2	3	25	75	100
		Skill Enhancement Course –V		Vermitechnology	2	2	-	-	-	2	3	25	75	100
				TOTAL	**30**	**21**	**4**	**5**	**-**	**23**	-	-	-	**800**
V	III	Core Course –V		Virology and Parasitology	6	5	1	-	-	5	3	25	75	100
		Core Course –VI		Environmental and Agriculture Microbiology	5	4	1	-	-	4	3	25	75	100
		Core Course-VII		Molecular Biology and Microbial Genetics	5	4	1	-	-	5	3	25	75	100
		Core Practical- V		Practical CC V and CC-VI	4	-	-	4	-	4	3	25	75	100
		Elective Course -I		Recombinant DNA Technology/ Biostatistics/Veterinary Microbiology	4	3	1	-	-	3	3	25	75	100
		Elective Course -II		Biosafety and Bioethics/ Research Methodology/	4	3	1	-	-	3	3	25	75	100

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	L	T	P	S	Credit	Exam Hours	Marks		Total
												CIA	ESE	
				Bioinformatics										
		Internship/ Industrial visit/ Field visit		Internship/ Industrial visit/ Field visit	-	-	-	-	-	2	-	-	-	-
		EVS		Environmental Studies	2	2	-	-	-	2	3	25	75	100
					30	**21**	**5**	**4**	**-**	**28**		-	-	**700**
VI	III	Core Course -VIII		Food, Dairy and Probiotic Microbiology	6	5	1	-	-	4	3	25	75	100
		Core Practical –VI		Environmental and Agriculture Microbiology, Food, Dairy and Probiotic Microbiology	6	5	1	-	-	4	3	25	75	100
		Core Project		Project with viva- voce/ Group Project	5	-	1	4	-	5	3	25	75	100
		Elective Course-III		Pharmaceutical Microbiology/ Bioinoculants/Cell Biology	4	3	1	-	-	3	3	25	75	100
		Elective Course-IV		Entrepreneurship and Bio-Business/ Antimicrobial Agents/ Fermentation Technology	4	3	1	-	-	3	3	25	75	100
	IV	Value Education		Value Education	2	2	-	-	-	2	3	25	75	100
		Professional competency Course		Microbial Quality Control and Testing	2	2	-	-	-	2	3	25	75	100
	V	Gender Studies		Gender Studies	1	1	-	-	-	1	3	25	75	100
		Extension activity		Extension activity	-	-	-	-	-	1	-	-	-	-
	TOTAL				**30**	**21**	**5**	**4**	**-**	**25**	-	-	-	**800**
	GRAND TOTAL				**180**	**127**	**25**	**28**		**141**	-	-	-	**4500**
	Extra Credit			MOOC/SWAYAM/NPTEL	-	-	-	-	-	**2**	-	-	-	**-**
				Value added Courses (At least one per Year)	-	-	-	-	-	**2**	-	-	-	**-**

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

NON MAJOR ELECTIVE OFFERED BY THE DEPARTMENT

Semester	Part	Course	Course Code	Title of the Course
I	IV	NME -I	U24NMEMB11	Mushroom Technology
II		NME -II	U24NMEMB22	Entrepreneurial Microbiology

Credit Distribution for B.Sc., Microbiology

S.No	Part	Subject	No. of Courses	Total Credits
1.	I	Language Course	4	12
2.	II	English Language Course	4	12
3.	III	Core Course –Theory	8	38
4.		Core Practical	6	24
5.		Core -Project	1	5
6.		Allied Course- Theory	4	08
7.		Allied Course Practical	2	4
8.		Elective Course	4	12
9.	IV	Non-Major Elective	2	04
10		Foundation Course	1	02
11		Skill Enhancement Course	5	10
12		Internship/ Industrial visit/ Field Visit	1	02
13		Environmental Studies	1	02
14		Value Education	1	02
15		Professional Competency Course	1	02
16	V	Gender Studies	1	01
17		Extension Activity	1	01
Total			**47**	**141**

SEMESTER -I

Semester: I- CC-I: Fundamentals of Microbiology

Ins. Hours / Week: 5 **Course Credit: 5** **Course Code: U24MB101**

UNIT- I **(15 Hours)**

History and Evolution of Microbiology, Classification – Three kingdom, Five kingdom, Six kingdom and Eight kingdom. Microbial biodiversity: Introduction to microbial biodiversity-ecological niche. Basic concepts of Eubacteria, Archaebacteria and Eucarya. Importance of Biodiversity and Conservation of Biodiversity.

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

General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between Prokaryotic and Eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.

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

Bacterial culture media and pure culture techniques. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques. Maintenance and Preservation methods for pure culture.

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

Microscopy – Simple, Bright field, Dark field, Phase contrast, Fluorescent, Electron microscope – Transmission Electron Microscope(TEM) & Scanning Electron Microscope (SEM) , Confocal microscope and Atomic Force Microscope(AFM). Stains and staining methods.

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

Sterilization–Moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – Membrane filter and Disinfection, Antiseptic and Antimicrobial agents.

Total Lecture Hours – 75

COURSE OUTCOME

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

1. Study the historical events that led to the discoveries and inventions and understand the Classification of Microorganisms.
2. Gain Knowledge of detailed structure and functions of prokaryotic cell organelles.
3. Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
4. Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.
5. Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.

TEXT BOOKS

1. Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby College Publishing, St Louis, United States
2. Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw – Hill, New York.
3. Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.
4. Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson, New Jersey
5. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International edition, New York
6. Jeffrey C. Pommerville, (2023), Fundamental of Microbiology, 12th Edition, Jones and Bartlett Publisher, Inc, New Delhi.

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MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1	2								3			3	3
CO2	1	2		3						3	2		3	
CO3	1		2	3		2			2	3		3	3	
CO4			2	3					2			3	3	
CO5			2	3		2				3			3	3

Strong -3; Medium -2; Low - 1

Semester: I- CC-II: Practical –I- Fundamentals of Microbiology

Ins. Hours / Week: 4 **Course Credit: 4** **Course Code:U24MB102P**

- Safety practices in Microbiological laboratory
- Handling and Maintenance of compound microscope.
- Cleaning of Glassware, preparation of cleaning solutions and culture media
- Handling of laboratory instruments – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow, Incubators, Colony counter, Centrifuge, pH meter, Colorimeter and Spectrophotometer
- Use of common laboratory glass wares: Test tubes, culture tubes, screw capped tubes, Petri plates, Pipettes, micropipettes, Erlenmeyer flask, glass spreader, Durham's tube and inoculating needles
- Staining of bacteria by simple staining, Gram's staining and Negative staining.
- Staining of fungi by Lactophenol cotton blue.
- Measurement of size of microbes – Micrometry.
- Enumeration of bacterial numbers by Viable count (Plate count) and Total count (Haemocytometer count)
- Pure culture techniques - Streak plate, Pour plate and Spread plate.
- Test for motility of bacteria – Hanging drop method.
- Isolation of bacteria, algae, fungi and cyanobacteria from natural sources
- Observation of permanent slides to study the structural characteristics of algae
- (*Anabena, Nostoc, Spirulina, Oscillotoria*), fungi (*Pythium, Rhizopus, Saccharomyces, Penicillium, Aspergillus, Agaricus*) and protozoa (*Entamoeba histolytica and Plasmodium spp*.).

COURSE OUTCOME

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

1. Practice sterilization methods; learn to prepare media and their quality control.
2. Learn streak plate, pour plate and serial dilution and pigment production of microbes.
3. Understand Microscopy methods, Different Staining techniques and Motility test.
4. Observe culture characteristics of microorganisms.
5. Study on Microbial Diversity using Hay Infusion Broth-Wet mount

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2. Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications, Chennai.
3. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sunciararaj. T, Chennai.
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5. R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing, Delhi.
6. Shukla Das and Rumpa Saha, 2024, Microbiology Practical Manual, CBS Publishers and Distributors Pvt. Ltd, Chennai.

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2. Dubey RC and Maheswari DK (2004). Practical Microbiology 1st Edition, S.Chand& Company Ltd., New Delhi.
3. Kannan N (2003). Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, New Delhi.
4. Rajan S and Selvi Christy (2011). Experimental procedures in life sc1ences. Anjana Book House, publishers and distributors, Chennai.

5. James G Cappuccino and Natalie Sherman (2004). Microbiology: A laboratory manual. Sixth edition, Published by Pearson Education, New Delhi.
6. Kannan N (1996). Laboratory Manual in General Microbiology. First edition, Palani Paramount Publications, Palani. Tamil Nadu.
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2. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
3. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
4. https://microbiologyinfo.com/top-and-best-microbiology-books/
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MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1			2	3	2	2				3			3	3
CO2	1	2	2	3		2				3	2		3	3
CO3	1	2	2	3		2				3	2		3	3
CO4	1			3						3			3	3
CO5	1	2	2	3				2			2	3	3	3

Strong -3; Medium -2; Low - 1

Semester: I- AC-I: General Biochemistry

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code:U24ABC101**

UNIT-I: Carbohydrates (14 Hours)

Definition, sources, classification, structure and Functions of Carbohydrate: Monosaccharides, Disaccharides and Polysaccharides. General properties with reference to glucose, anomer, epimer, enantiomer and mutarotation. Biological importance of carbohydrate.

UNIT- II: Aminoacids and Proteins (14 Hours)

Definition, Structure and properties of amino acids, classification based on structure and chemical nature. Essential and non-essential amino acids. Proteins - Definition, classification based on shape, solubility, chemical composition. Structure: Primary, Secondary, tertiary and quaternary. Properties and functions.

UNIT-III: Lipids (14 Hours)

Definition, sources, structure, properties, classification (simple lipids, compound lipids– glycolipids, phospholipids, sphingolipids and derived lipids - steroids) and functions of lipids. Fatty acids- Definition, structure, classification– saturated fatty acids, unsaturated fatty acids. Essential and non-essential fatty acids.

UNIT-IV: Nucleic acids (14 Hours)

Definition, bases, nucleotides and nucleosides, phosphodiester linkage. Structure of nucleosides, nucleotides. DNA double helical structure. A, B and Z forms of DNA and its functions. Types, structure and functions of RNA (mRNA, tRNA, rRNA). Difference between DNA and RNA

UNIT- V: Vitamins (14 Hours)

Definition, source, classification, structure, daily requirement, deficiency manifestation and biological significances of fat soluble vitamins - A, D, E, K and water soluble vitamins-ascorbic acid, thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, folic acid and cyanocobalamin.

Total Lecture Hours- 60

COURSE OUTCOME

The students should be able to,

1. Analyze the chemical and biochemical properties of biomolecules
2. Evaluate the structure and functions of carbohydrate

3. Understand the relationship between biological molecules and human health
4. Realize the classification, structure and importance of amino acids and proteins.
5. Illustrate the role and function of vitamins.

TEXT BOOK(S)

1. Linda Kelly De Bruyne and Kathryn Pinna. (2023). Nutrition for Health and Health Care (Mind Tap Course List), 7th Edition, Cengage Learning publisher, USA.
2. Jain JL, Sunjay Jain and Nitin Jain. 2018. Fundamentals of Biochemistry. Updated edition. 2020. S.Chand Publishers, New Delhi.
3. RituSingh and RajeevGoyal.2020. Illustrated Reviews Biochemistry (SAE). Wolterskluwer Publisher
4. Poonam Agarwal. 2020. Review of Biochemistry. 5th Edition. CBS Publishers.
5. Deb AC. 2016. Fundamentals of Biochemistry. 7th edition, NCBA Publishers,New Delhi.
6. Vasudevan DM. 2018. Biochemistry. 9th edition. Aypee Brothers Medical Publishers

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1. Peter. J. Kennelly, Kathleen M. Botham and Victor W. Rodwell. (2023). Harper's Illustrated Biochemistry, 32nd Edition, McGraw Hill publishers, Noida.
2. David L. Nelson and Michael M. Cox. 2017. Lehninger Principles of Biochemistry. 7th edition. WH Freeman Publishers.
3. Berg, JM.TymoczkoJL and. Stryer. 2019. Biochemistry. 9th edition. WH. Freeman Publishers.
4. Anders Liljas. 2019. Textbook of Structural Biology. 2nd edition. World Scientific Publishers.
5. Satyanarayana Uand. Chakrapani. U2020. Biochemistry. 5th Updated Edition. Elsevier Publishers.
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4. https://drive.google.com/file/d/10C4EYN0Sv2LPI9ZzhoV-

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1		2	3		2		2	2	3	2	3	3	3
CO2	1		2	3		2		2	2	3	2	3	3	3
CO3	1		2	3		2		2	2	3	2	3	3	3
CO4	1		2	3		2		2	2	3	2	3	3	3
CO5	1		2	3		2		2	2	3	2	3	3	3

Strong -3; Medium -2; Low - 1

Semester: I- AC-II: Allied Practical –I- General Biochemistry

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:U24ABC102P**

1. Qualitative analysis of Carbohydrates –Glucose, Fructose, Galactose, Maltose, Lactose and Sucrose.
2. Qualitative analysis of Amino acids-Tyrosine, Tryptophan, Histidine, Arginine, Proline, Phenyl Alanine, Methionine and Cystine
3. Qualitative analysis of Proteins- Egg Albumin, Gelatin and Caesin.
4. Qualitative analysis of Lipids- Gingelly oil and Coconut oil
5. Qualitative analysis of Nucleic acids- DNA and RNA
6. Quantitative estimation of glucose by Benedict's method
7. Quantitative estimation of Ascorbic acid-2,6-Dichlorophenol Indophenol dye method (from biological sample)
8. Quantitative estimation of Amino acid by formal titration

COURSE OUTCOME

The students should be able to,

1. Explore the nature of carbohydrate and amino acids
2. Acquire knowledge in the qualitative analysis of biomolecules
3. Analysis of protein and lipids by qualitative and quantitative methods
4. Attain skills on estimation of sugar by Benedict's method
5. Evaluate the reactions of biomolecules

TEXT BOOK(S)

1. Anil Kumar, Sarika Garg and Neha Garg. 2012. Biochemical Tests – Principles and Protocols. 1st Edition. Vinod Vasishtha Viva Publishers.
2. Jayaraman J. 2011. Manuals in Biochemistry. 1st Edition. New Age International Publishers.
3. Sadasivam S and Manickam VA. 2006. Biochemical methods. 3rd Edition. New Age international Publishers.

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1. Homie DJ. and Peck H. 2003. Analytical Biochemistry. 1st edition, Longman group – Rastogic CBS Publishers, Mumbai
2. Keith Wilson and John Walker. 2015. Principles and Techniques of Practical Biochemistry.

6th Edition, Cambridge University Press Publishers, London
3. Sergio Caroli and Zyula. 2017. Analytical Techniques for Clinical Chemistry, 1 st edition, John Wiley & Sons Inc Publishers, United States.

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3. https://dspace.cuni.cz/bitstream/handle/20.500.11956/111493/Clinical_biochemistry-pdf.pdf?sequence=1&isAllowed=y
4. https://dspace.cuni.cz/bitstream/handle/20.500.11956/111493/Clinical_biochemistry-pdf.pdf?sequence=1&isAllowed=y
5. https://www.e-booksdirectory.com

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1	2	2	3		2		2		3	2	3	3	3
CO2	1	2	2	3		2		2		3	2	3	3	3
CO3	1	2	2	3		2		2		3	2	3	3	3
CO4	1	2	2	3		2		2		3	2	3	3	3
CO5	1	2	2	3		2		2		3	2	3	3	3

Strong -3; Medium -2; Low - 1

Semester: I- NME-I: Mushroom Technology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:U24NMEMB11**

UNIT- I:

Introduction and Definition of a Mushroom, General characteristics, Classification, Structure and Life cycle of Mushroom.

UNIT- II: **(2 Hours)**

Nutritional value of Mushroom- Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins, Medicinal value of mushrooms. Poisonous mushrooms and edible mushrooms.

UNIT- III: **(2 Hours)**

Cultivation Technology: Infrastructure, equipment and substrates required for mushroom cultivation: Spawns - types and preparation of spawn, Mushroom bed preparation. Compost technology in mushroom production.

UNIT- IV: **(2 Hours)**

Cultivation of important mushrooms - General process for the cultivation of *Agaricus bisporus*, *Pleurotus ostreatus* and *Volvariella volvaceae*. Important sanitation conditions during various stages of mushroom cultivation. Pests and Pathogens of mushrooms and their management.

UNIT- V: **(2 Hours)**

Storage of Mushrooms- Long and Short-term storage. Foods/recipes from mushrooms. Mushroom research centers or farms - National and regional level. Marketing of mushrooms in India and world. Value addition in Mushroom.

Total Lecture Hours - 30

COURSE OUTCOMES:

At the end of the course, learners will be able to:

1. Draw out the importance of mushrooms and their applications in health and neutraceuticals.
2. Explain their beneficial and erratic role during human consumption.
3. List out the substrates employed in mushroom cultivation and sketch out the methods for improvement.
4. Gain knowledge on mushroom cultivation and troubleshoot the problems in mushroom cultivation
5. Evaluate the storage and preservation method of Mushroom.

REFERENCES:

TEXT BOOKS

1. Paul Stamets, J.S. and Chilton, J.S. 2004. Mushroom cultivation A practical guide to growing mushrooms at home, Agarikon Press.
2. Tewan and Pankaj Kapoor S.C. 1993. Mushroom cultivation. Mittal Publication. Delhi.
3. Marimuthu P *et al.,* 1991. Oyster Mushrooms. Dept. of Plant pathology, TNAU, Coimbatore.
4. Nita Bahl. 1988. Hand book of Mushrooms, 2nd Edition, Vol I & II.
5. Shu Fing Chang, Philip G. Miles and Chang, S.T. 2004. Mushrooms Cultivation, nutritional value, medicinal effect and environmental impact. 2nd ed., CRC press.

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1. Tavis Lynch, 2018. Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home. Quarto Publishing. USA.
2. Kaul, T.N. and B. L. Dhar, 2007. Biology and Cultivation of Edible Mushrooms. Westville Publishing House. New Delhi, 240pp
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4. Delcaire, J.R., 1978. Economics of cultivated mushrooms. In The Biology and Cultivation of Edible Mushrooms, Chang, S.T. and H.A. Hayes, ed., Academic Press. Inc. New York. 726-793.
5. Dewhurst, M., 2002. Phase III –the future? The Mushroom J. 626, 17-18.
6. Bhalla, T.C., Sharma, N.N., Sharma, M., 2007. Production of Metabolites, Industrial Enzymes, Amino Acids, Organic Acids, Antibiotics, Vitamins and Single Cell Proteins. National Science Digital Library, India.
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4. https://cropbag.in/mushroom-cultivation-complete-guide/

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1		2	3				2	2			3	3	3
CO2		2	2	3			2	2	2	3			3	3
CO3		2	2	3				2	2	3		3	3	3
CO4	1	2	2	3					2	3		3	3	3
CO5		2	2	3				2	2	3	2	3	3	

Strong -3; Medium -2; Low - 1

Semester: I- FC-I: Introduction to Microbial World

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:U24FCMB11**

UNIT- I: (6 Hours)

Scope and origin of Microbiology. Microorganisms Introduction – Bacteria,Archaea, Algae, Fungi, Protozoa and Viruses.

UNIT – II: Basic techniques in Microbiology (6 Hours)

Beneficial and harmful microorganisms. Microscope and its operations. Preparation of media – Liquid and Solid media.

UNIT- III: (6 Hours)

Sterilization methods - Autoclave and Hot air oven. Laminar air Flow, pH meter.Colony counter.

UNIT- IV (6 Hours)

Staining- Smear preparation. Simple and Gram's staining. Wet mount technique.

UNIT –V: (6 Hours)

Economic importance of bacteria, algae, fungi and protozoa.

Total Lecture Hours - 30

COURSE OUTCOMES

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

1. Recall the milestones in Microbiology and characteristics of microorganisms
2. Identifythe components of microscopes, functions and its applications
3. Acquire skills on basic instruments in microbiology
4. Identify the microbes using staining techniques
5. Analyse the economic importance of microbes

TEXT BOOKS

1. Ananthanarayan R. and Paniker's. (2013). Text book of Microbiology. University Press (9th edition), Hyderabad.
2. David, B.D., Delbecco,. R., Eisen, H.N and Ginsburg, H.S .(1990). Microbiology 5th Edition. Harper and Row, New York.
3. Dubey H.C. (2009). Introduction to Fungi. Vikas publishing pvt. Ltd, New Delhi.
4. Dubey R.C and Maheswari D.K. (2010).A Text Book of Microbiology. S Chand, New Delhi.
5. Nagamani, B.(2018). General Microbiology and Microbial Physiology Margham Publication, Chennai
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3. Cappuccino and Sherman, (2012). Microbiology – A Laboratory Manual. 7thedition, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
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4. http://www.wales.nhs.uk/sitesplus/888/agordogfen/149787
5. http://ecoursesonline.iasri.res.in/course/view.php?id=108
6. https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-cultivation-andgrowth/microbial-cultivation

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1								2	3	2			3
CO2	1	2	2		2		2			3			3	3
CO3		2	2	2					2	3	2	3	3	
CO4			2	2						3		3	3	
CO5			2				2	2		3	2	3	3	

Strong -3; Medium -2; Low - 1

SEMESTER -II

Semester: II: CC-III – Microbial Physiology

Ins. Hours / Week: 5 **Course Credit: 5** **Course Code: U24MB203**

UNIT- I: (15 Hours)

Physiology of Microbial growth: Batch – Continuous - Synchronous cultures. Growth Curve and measurement method (Turbidity, Biomass and Cell count). Control of microbial growth.

UNIT-II: (15 Hours)

Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth.

UNIT-III: (15 Hours)

An overview of Metabolism - Embden Meyerhoff Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.

UNIT-IV: (15 Hours)

Photosynthesis - An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.

UNIT-V: (15 Hours)

Bacterial reproduction - Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.

Total Lecture Hours - 75

COURSE OUTCOME

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

1. Describe microorganisms based on nutrition
2. Know the concept of microbial growth and identify the factors affecting bacterial growth.
3. Explain the methods of nutrient uptake.
4. Explore about the anaerobic and aerobic energy production.
5. Elaborate on the process of bacterial photosynthesis and reproduction

TEXT BOOKS

1. Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridg, London
2. RajapandianK.(2010). Microbial Physiology, PBS Book Enterprises , Chennai India.
3. MeenaKumari. S. (2006).Microbial Physiology, Chennai 1st Edition MJP Publishers, Chennai.
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1. Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.
2. Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.
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2. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutritionhttps://onlinecourses.swayam2.ac.in/cec20_bt14/preview
3. http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf
4. https://www..frontiersin.org.microbial-physiology-and-metabolism

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1								2	3			3	3
CO2	1	2	2	3									3	3
CO3	1	2	2	3				2	2				3	3
CO4		2			2	2	2		2			3	3	
CO5	1		2	3						3	2		3	

Strong -3; Medium -2; Low - 1

Semester: II- CP-IV: Practical –II – Microbial Physiology

Ins. Hours / Week: 4 **Course Credit: 4** **Course Code:U24MB204P**

- Effect of temperature and pH on growth of microorganisms.
- Effect of carbon and nitrogen sources on growth of *E.coli*
- Effect of salt on growth of *E. coli*
- Motility of bacteria by Hanging drop method
- Study and plot the growth curve of *E. coli* by turbidometric method
- Measurement of growth by cell number using Haemocytometer.
- Detection of amino acids by paper chromatography.
- Acid and gas production from carbohydrates
- Demonstration of fermentation of lactose
- Starch hydrolysis.
- Gelatin hydrolysis.
- Detection of Catalase production by microorganisms.
- Urease test
- Isolation and culturing of photosynthetic bacteria
- Demonstration of fermentation of glucose using Kuhne's fermentation vessel.

COURSE OUTCOME

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

1. Describe growth of bacteria based on the suitable environmental conditions
2. Demonstrate motility of bacteria by hanging drop method
3. Explain Starch and gelatin hydrolysis methods
4. Describe isolation of photosynthetic bacteria
5. Elaborate fermentation of glucose using Kuhne's fermentation vessel

TEXT BOOKS

1. James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York

2. Kannan. N (1996).Laboratory manual in General Microbiology. Palani Publications, Chennai
3. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sunciararaj. T, Chennai.
4. Gunasekaran. P (2007). Laboratory manual in Microbiology. New age international publisher, Darya Ganj
5. Elsa Cooper (2018). Microbial Physiology: A Practical Approach. Callisto Reference publisher, Berkeley, California
6. Ram Reddy S.M and Reddy S.M, 2023, Microbiology a Laboratory Manual, 4th Edition, Scientific Publishers, Tamil Nadu.

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1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
2. Brock T. D. and Madigan M.T., (2017). Biology of Microorganisms, Prentice hall of India Pvt. Ltd, New Delhi.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
5. Karp G (2010). Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc, US.
6. Lansing M. Prescott, John P.Harley, Donald A.Klein (2002).Microbiology, 5th edition. WCB Mc Graw Hill, New york.
7. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
8. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons Press, Worth Publishers, New Delhi.
9. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
10. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

11. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

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1. https://sites.google.com/site/microbial physiologyoddsem/teaching-contents
2. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4. https://www.studocu.com/microbial-physiology-practicals
5. https://www.agr.hokudai.ac.jp/microbial-physiology

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1		2	3				2	2	3			3	3
CO2	1	2	2	3					2	3			3	3
CO3	1	2	2	3									3	
CO4	1	2	2	3					2	3			3	3
CO5		2	2	3						3		3	3	

Strong -3; Medium -2; Low - 1

Semester: II- AC-III: Bioinstrumentation

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code:U24AMB102P**

UNIT- I: **(9 Hours)**

Basic instruments: pH meter, Centrifuge- Preparative, Analytical and Ultra centrifuge. Laminar Air Flow, Autoclave**,** Hot Air Oven and Incubator. Micrometry.

UNIT- II: **(9 Hours)**

Beer Lambert's law - Colorimeter and its applications. Spectrophotometer-Principle and its applications. Types of Spectrophotometer- UV – Visible Spectophotometer, Atomic Absorption Spectrophotometer.

UNIT-III: **(9 Hours)**

Haemocytometer, Haemoglobinometer, Semi Auto analyzer, Muffle Furnace, Soxhlet apparatus.

UNIT- IV: **(9 Hours)**

Chromatographic Techniques: Paper, Thin Layer, Column, High Performance liquid Chromaography (HPLC) and Gas Chromatography (GC). Electrophoretic Techniques: Agarose gel Electrophoresis. Polyacrylamide Gel Electrophoresis.

UNIT- V: **(9 Hours)**

Biosensors and Bioreactor - Principle and its applications. Polymerase Chain Reaction (PCR) and its applications. Gel documentation. Care and Maintenance of Laboratory Instruments.

Total Lecture Hours - 45

COURSE OUTCOME

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

1. Gain knowledge about the basic instruments.
2. Compare the principle of Colorimeter and Spectrophotometer.
3. Analyse the biomolecules using instruments.

4. Understand the need and applications of chromatography and electrophoretic techniques .
5. Comprehend the principle and applications of Biosensor, Bioreactor and Polymerase chain reaction.

TEXT BOOKS

1. Jayaraman J (2011). Laboratory Manual in Biochemistry, 2nd Edition. Wiley Eastern Ltd., New Delhi .
2. Ponmurugan. P and Gangathara PB (2012). Biotechniques.1st Edition. MJP publishers, Chennai
3. Veerakumari, L (2009).Bioinstrumentation- 5 th Edition -.MJP publishers, Chennai
4. Upadhyay, Upadhyay and Nath (2002). Biophysical chemistry – Principles and techniques 3rd Edition. Himalaya publishing home, Chennai
5. Chatwal G and Anand (1989). Instrumental Methods of Chemical Analysis. S.Himalaya Publishing House, Mumbai.
6. Priyanka Pandey, (2023).A text book of Bioinstrumentation, Walnut Publication, Kolkata.

REFERENCE BOOK(S)

1. Rodney.F.Boyer (2000). Modern Experimental Biochemistry, 3rd Edition. Pearson Publication, Kolkatta

2. SkoogA.,WestM (2014). Principles of Instrumental Analysis – 14th Edition W.B.SaundersCo., Philadephia.

3. N.Gurumani. (2006). Research Methodology for biological sciences- 1st Edition – MJP Publishers, Chennai

4. Wilson K, and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology.7th Edition. Cambridge University Press, London

5. Webster, J.G. (2004). Bioinstrumentation- 4th Edition - John Wiley & Sons (Asia) Pvt. Ltd, Singapore.

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1. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction-types- uses-and-other-details-with-diagram/12489
2. https://study.com/academy/lesson/what-is-chromatography-definition-typesuses.html
3. https://www.watelectrical.com/biosensors-types-its-working-andapplications/
4. http://www.wikiscales.com/articles/electronic-analytical-balance/ Page 24 of 75
5. http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	1	2	2	3						3	2	3	3	
CO2		2	2	3				2	2				3	3
CO3		2	2	3		2		2		3	2		3	3
CO4		2	2	3						3	2	3	3	
CO5	1		2	3				2	2	3	2	3	3	

Strong -3; Medium -2; Low - 1

Semester: II- NME-II: Entrepreneurial Microbiology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:U24NMEMB22**

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

Entrepreneur development, activity, Institutes involved, Government contributions to entrepreneur, risk assessment and characteristics of Entrepreneur.

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

Microbial cells as fermentation products – Baker's yeast, food and feed yeasts, bacterial insecticides, Algae, Enzymes as fermentation products - bacterial and fungal amylases, proteolytic enzymes.

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

Biofertilizer- chemical fertilizers versus biofertilizers, organic farming. *Rhizobium sp*., *Azospirillum sp*., *Azotobacter sp*., *Azolla* cultivation. Liquid Biofertilizers.

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

Single cell protein production – *Spirulina* and *Chlorella* as SCP. Production of industrial alcohol. Probiotics production.Yoghurt, Cheese production.

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

Patent and secret process, History of patenting, composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent. Patents in India and other countries.

Total Lecture Hours – 30 Hours

COURSE OUTCOME

After successful completion of the course, the students will learn about:

1. Understand the basics of Entrepreneurship.
2. Apply skills for the development of fermentation products.
3. Gain knowledge for the production of biofertilizer.
4. Formulate the techniques for the mass production of single cell protein.
5. Recall the process of patenting

TEXT BOOKS

1. Subba Rao NS (1997). Biofertilizer in Agriculture and Forestry, 3'd edition, Oxford &IBU Publications.
2. LE Cassida JR (2005). Industrial Microbiology. New Age International (P) Ltd., New Delhi.
3. Arora.2018. Entrepreneurial Development in India. Kalyani Publishers, Tamil Nadu.
4. Aneja, K.R. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, 6th Edition, New age International Publication. 5
5. Frazier WC and West Hoff DC (1988). Food Microbiology. Fourth edition, McGraw Hill, New Delhi
6. A.C. Shukla, (2023). Entrepneurship with Microorganisms (Developments in Applied Microbiology and Biotechnology, Academic Press Inc., New Delhi.

REFERENCE BOOK(S)

1. William Bygram and Andrew Zacharakis (2007) Entrepreneurship, John Willey & Sons.
2. Mellor Robert (2008) Entrepreneurship for Every One, SAGE Publications.
3. Venkataraman, G.S. (1972) Algal Biofertilizers and Rice Cultivation. Today and Tomorrow's Printers and Publishers, New Delhi.
4. Marks, G.C. and Koslowski, T.T (Eds.) (1973) Ectomycorrhizae, Academic Press. London.
5. Sandera, F.E., Mosse, B.,Tinke P.B. (1975) Endomycorrhizae, Academic Press, London.
6. Thompson, L. M., Fredrick. T. (1979) Soils and Soil Fertility, Tata Mc Graw-Hill Publishing Co., New Delhi.
7. Rao, N.S. (1980). Biofertilizers in Agriculture, Oxford and IBH Publishing Co. Pvt. Ltd., Bombay.

8. Rao, N.S. and Venkataraman Kannaiyan G.S. (1983) Biological N2 fixation. ICAR Publications, New Delhi.

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1. https://www.bio-fit.eu/upload/Bio-Fit-Book/EN/Bio-FIT_Book_EN.pdf
2. http://www.amm-mcrc.org/publications/Biofertilizers.pdf
3. http://www.normevents.fr/frd-9/biofertilizer-frankia.pdf
4. http://plantpath.osu.edu/sites/plantpath/files/imce/images/McSpaddenGardener/OEFFA%202014%20Biofertilizer.pdf
5. https://www.wpi.edu/Pubs/E-project/Available/E-project-030311-115831/unrestricted/English_Biofertilizers_Brochure.pdf
6. http://www.arvin-agri.com/Maghalat/GiyahPezeshki/Ipm/biopesticide.pdf

MAPPING WITH PROGRAM OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

CO	POs										PSOs			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1					2	2	2	2		3		3		3
CO2		2	2	3				2		3		3	3	
CO3	1	2	2	3			2	2	2	3		3	3	3
CO4	1	2	2					2	2	3		3	3	3
CO5	1					2	2		2	3		3	3	

Strong -3; Medium -2; Low - 1

Semester: II SEC-I- Biofertilizer Technology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code: U24SEMB21**

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

Introduction - History, importance and present status of different types of fertilizers and their application to crop plants. Importance of macro and micro nutrients. Biological fixation of nitrogen.

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

Cyanobacterial Biofertilizers - *Nostoc, Anabaena*, and *Scytonema* as biofertilizers; Symbiotic association with *Azolla*; Multiplication of blue green algae and its effect on rice yields. Bacterial biofertilizers - Free living forms: *Azotobacter, Azospirillum*; Symbiotic forms: *Rhizobium* - Legume Association; *Pseudomonas*- Non-legume association.

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

Fungal biofertilizers – Types of fungal biofertilizers, Arbuscular mycorrhizal association - *Glomus sp*., Actinomycetes as Biofertilizers – Actinorhiza, Actinorhizal associations - *Frankia sp.*

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

Biomanures - A general account of manures – Moulds; Composts Farm Yard Manure- Oil seed cakes - Castor and neem; Green leaf manures - Gyricidia, Sesbania and Crotalaria; Agro-industrial wastes - Poultry manure and saw-dust.

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

Liquid biofertilizer Production. Advantages of liquid biofertilizers. A combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays. Laboratory and field application; Cost analysis of biofertilizer.

Total Lecture Hours –30

COURSE OUTCOME

After successful completion of the course, the students will learn about:

1. Understand the importance and applications of the biofertilizers for a sustainable agriculture.
2. Acquire knowledge on cyanobacterial and bacterial biofertilizers
3. Develop the opportunities in bio-entrepreneur through the production of biofertilizers.
4. Formulate the organic fertilizers using natural waste
5. Evaluate the effect of field applications of biofertilizers

TEXT BOOKS

1. Manoj Kaushal, Ram Prasad, (2021). Microbial Biotechnology in Crop Protection, Springer, ISBN: 978-9811600487, US.
2. Kaushik, B.D., Deepak Kumar, Md. Shamim, (2020). Biofertilizers and Biopesticides in Sustainable Agriculture, Apple Academic Press, ISBN: 9781771887939, Canada.
3. Goyal, M.R., (2018). Sustainable Biological System for Agriculture, APP Apple Academic Press, ISBN: 978-1-77188-614-7, Canada.
4. Borkar, S.G., (2015). Microbes as Bio-fertilizers and their Production Technology (Woodhead Publishing India in Agriculture), WPI Publishing, ISBN: 9380308574, New Delhi.
5. Shagufta, (2012). Biofertilizer Technology, 1st Edition, Published at Delhi.

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1. Subba Rao, N.S., (1995). Soil Microorganisms and plant growth, Oxford and IBH, New York.
2. Totawat, K.L., Somani, L.L., Sharma, R.A., Maloo, S.R., (2004). Biofertilizer Technology, Agrotech Publishing Academy. Udaipur, Rajasthan.
3. Mathur, R., (2013). A text book of Entomology, Neha Publishers & Distributors. ISBN: 8187815648.
4. Thanuja Singh and Purohit, (2018). Biofertilizer Technology, Agrobios, India.

E-RESOURCES

1. https://www.bio-fit.eu/upload/Bio-Fit-Book/EN/Bio-FIT_Book_EN.pdf
2. http://www.amm-mcrc.org/publications/Biofertilizers.pdf
3. http://www.normevents.fr/frd-9/biofertilizer-frankia.pdf

4. http://plantpath.osu.edu/sites/plantpath/files/imce/images/McSpaddenGardener/OEFFA%202014%20Biofertilizer.pdf
5. https://www.wpi.edu/Pubs/E-project/Available/E-project-030311-115831/unrestricted/English_Biofertilizers_Brochure.pdf
6. http://www.arvin-agri.com/Maghalat/GiyahPezeshki/Ipm/biopesticide.pdf

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CO4	1	2		3				2	2	3		3	3	3
CO5	1	2		3				2	2	3		3	3	3

Strong -3; Medium -2; Low - 1