MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI– 627 012

TAMILNADU,INDIA

M.Sc. MICROBIOLOGY

(FOR AFFILIATED COLLEGES)

CURRICULUM

REVISED BASED ON REGULATIONS ON CHOICE BASED CREDIT SYSTEM (CBCS, 2015 - 16) FOR PG DEDGREE PROGRAMS

(Effective from the academic year 2021-2022 onwards)

MANONMANIAM SUNDARANAR UNIVERSITY

ABHISHEKAPATTY, TIRUNELVELI– 627 012, TAMILNADU,INIDA

M.Sc. MICROBIOLOGY (CBCS PATTERN)

FOR AFFILIATED COLLEGES

(EFFECTIVE FROM THE ACADEMIC YEAR 2021-2022 ONWARDS)

REGULATIONS OF SYLLABUS

Vision

To provide quality education to reach the un-reached.

Mission of the University

- To conduct research, teaching and outreach programs. To improve conditions of human living.
- To create an academic environment that honors women and men of all races, caste, creed, cultures and atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity.
- To offer a wide variety of off- campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the work place. To serve as catalyst for economic and cultural development.
- To provide quality/inclusive education, especially for the rural and un-reached segments of the economically downtrodden students including women, socially oppressed and differently abled.

VISION AND MISSION OF THE DEPARTMENT

VISION

To support the designing of the process and production of products related to microbiology associated with the development of nation by imparting theory and practical knowledge.

MISSION

Generation of post graduates in microbiology especially from rural backgrounds with values, high standards and skills to cater to the needs of the national and international demands.

PREAMPLE: -

The PG Microbiology programme aims to make the student proficient in the field of Microbiology through the transfer of knowledge in the classroom as well as in the laboratory. The students will be encouraged to participate in discussions and deliver seminars on some topics. In the laboratory the student will first learn good laboratory practices and then get hands-on training on basic microbiological technique. The student will participate in field trips to industries that will facilitate his/her understanding of the practical aspects of the programme and to provide exposure to the Industrial production and gain employment. The Post Graduate (PG) degree in M.Sc., Microbiology creates wider opportunities in Educational, Research, Industrial, Medical and Environmental and Pharmaceutical sectors.

ABOUT THE PROGRAMME

Microbiology- a branch of life science dealing about microbes and their applications is a fusion of various areas of biology. Knowledge on microbiology is vital to understand the evolution of biology, various normal bioprocess driving the earth's quality and survival, natural resources sustainability and welfare living being. The scope of the course spreads its wings in Pharmacy, Medicine, Clinical research, Agriculture, Dairy industry, Environmental, Water industry, Nanotechnology &Chemical technology, Space etc., .

The M.Sc. Microbiology programme offered by Manonmaiam Sundaranar University is of two years' duration and is divided into four semesters. The CBCS syllabus of the programme has been revised for the year 2021-2022 based on the communication of The Chairman, University Grants Commission (UGC) has in his letter D.O.No.F.1- 1/2015 (CM) dated 8th January, 2015. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments, course project, field work, extension activities, industrial and institutional visits, field visits and internship / Training.

Every student doing PG in Microbiology will undertake a total 27 courses with 90 credits for total of 2500 marks.

2. COURSE DETAILS

Every student admitted to PG course shall undertake 27 courses, off which, 13 core theory courses, 2 elective theory courses, 8 practical courses , 1 Field work course, 1 Internship, 1 Industrial and Institutional Visit and 1 project course,. All the theory and practical courses will include Course Project (Core Course Project (CCP), Elective Course Project (ECP), Core Course Field Work (CCFW) and Elective Course Field Work (ECFW). The course project / Course Field work could be evaluated internally by allocating marks from internal marks allotted for the concerned. Practical Course Project (PCP) and Practical Course Field Work (PCFW) also follows same strategy.

3. COURSE REGULATION AND SYLLABUS COURSE OBJECTIVES

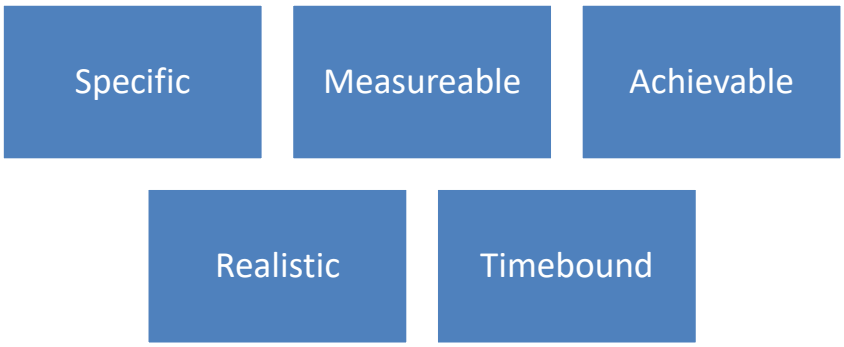
The course objectives for M.Sc. Microbiology are as follows:

a. To provide the students a rock solid foundation with an in-depth knowledge and scientific applications of microbiology in variegated fields.
b. To generate a level of confidence, instill an analytical mind, create an aptitude for creativity and critical thinking towards an independent research work and leadership quality.
c. To provide a platform for intellectual curiosity towards scientific development in the field of microbial technology.
d. To enable in them the levels of self-reliance in the emerging fields of industrial development through self-sustenance.
e. Provide a foundation for an interdisciplinary work which should support the students seeking entry to every industry.
f. Provide a base line exposure to multi-scientific fields of Microbiology / Biotechnology / Immunology / Genetics / Molecular Biology / Environmental Sciences / Physiology / Clinical Sciences on par with Zoology and Botany

course so that they can handle students at secondary and higher secondary levels at schools / colleges with an advanced knowledge on lessons incorporated in school / college texts.

4. COURSE OUTCOMES (COs)

For every course (Theory /Practical / Field Work / Internship / Industrial and Institutional Visit / Project etc.,), the course contents are fabricated in such way to have Course outcomes based on SMART principles



5. CREDITS

The term credit is used to describe the quantum of syllabus for various programmes in term of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The total number of credits for a master's programme is 90.

Assignment of Credits and Hours @

	Core / Elective Theory Lecture	**Practical**	**Field Work / Internships /Industrial and Institutional Visit**	**Project**
1 Credit	1 Hour	2 Hours	2 Hours	2 Hours

@ Regulations of choice based credit system for PG Programmes

6. ELIGIBILITY FOR ADMISSION TO THE CORUSE AND EXAMINATION

Candidates shall be admitted to the course provided if he / she has obtained a bachelor's degree in science in Microbiology / Biotechnology / Advanced Zoology and Animal Biotechnology / Plant science and Biotechnology / Zoology / Botany / Biochemistry / Biology / Life Science / Nutrition and Dietetics / B.S.M.S. / B.A.M.S. / B.U.M.S. / B.Sc., in MLT / B.E or B.Tech in Biotechnology / Bioengineering / Bio medical sciences / B.Sc., in Nursing / Genetics / Agriculture / Industrial Microbiology /Immunology / Molecular biology / Environmental Science / Virology / Bioinformatics or any other degree with Ancillary (Allied) in any one of the life sciences / that may be considered as equivalent top by the ManonmaniamSundaranar University.

7. QUALIFICATION NORMS FOR THE APPOINTMENT OF ASSISTANT PROFESSOR

Candidates fulfilling the following conditions shall be appointed as Asst. Professor.

i) A M.Sc., / M.Phil degree in Microbiology / Applied Microbiology discipline (55% minimum) with Ph.D. or UGC-NET/ SLST / SLET.

To encourage the students to update their knowledge about latest developments especially in practical part of microbiology through digital platforms such as SWAYAM – MOOC, marks could be given through internal evaluation. A minimum of two courses in any of the fields, which he / she likes could opt during the two years period (One course / Year). 6 Marks should be given from internal evaluation of practical.

8. SKILL DEVELOPMENT COURSES (SDCs)

8.1 FIELD WORK

For students, field work studies create opportunities for first-hand experiences that encourage critical thinking, long-term retention, transfer potential, positive attitudes towards science, appreciation for nature, and increased scientific curiosity. Cognitive development and motivation are also enhanced when students are active participants in the planning of the field study and in the activity itself. To enjoy the above benefits by students, Field work has been introduced in the First semester with 2 credits (3 Hours / Cycle) to address microbes based problems and solution in the local area.

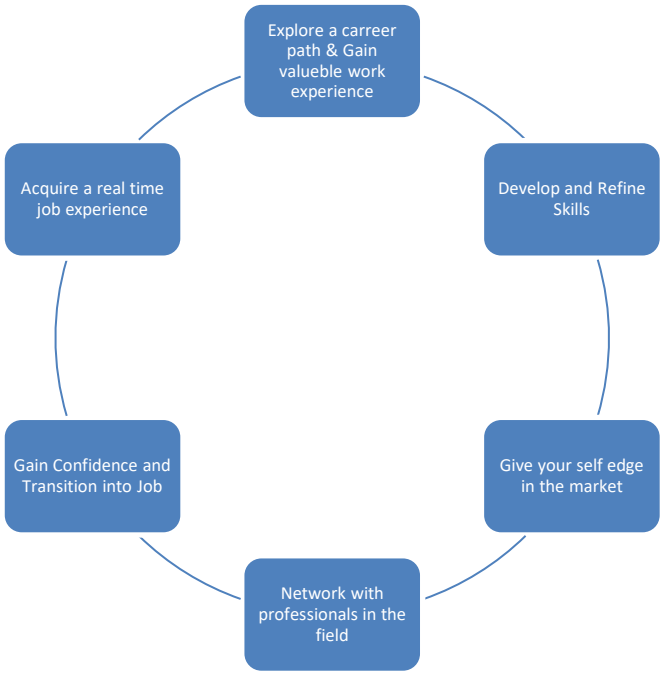
Evaluation

Student shall submit their report (Minimum of 5 pages focusing field work, excluding front page, declaration, certificate etc.,).

The evaluation will be done at the end of the first semester by both external and internal examiners for a maximum marks of 25.

8.2 INTERNSHIP

To strengthen and elevate the professional skills of students, Internship (Part Time / Full Time) is incorporated with 2 credits (3 Hours / Cycle) in second semester. An Internship for a minimum of 45 hours should be completed by every student.



Evaluation

Student shall submit their report (10 pages focusing internship, excluding front page, declaration, certificate etc.,) individually.

The evaluation will be done at the end of the second semester by both external and internal examiners for a maximum marks of 25.

8.3 INDUSTRIAL AND INSTITUTIONAL VISIT

To give exposure about scope and developments in the field of Microbiology for students, Industrial / Institutional visits is included in the third semester with 1 credit (2 Hours / Cycle). It helps the students to make themselves aware of the demands in the fields, expectations of the concerned and the qualifications to be developed in them. Understanding the societal needs, current status and market potential will explore the possibilities of becoming an entrepreneur. Staff accompanying the students should be given non-remunerative OD for such visits.

Evaluation

Student shall submit their report (10 pages focusing Industrial and Institutional, excluding front page, declaration, certificate etc.,) individually.

The evaluation will be done at the end of third semester by both external and internal examiners for a maximum marks of 50.

9. SKILL DEVELOPMENT COMPONENT - ONLINE COURSES

Students are encouraged to update their knowledge about latest developments especially in practical part of microbiology and its allied fieldsthrough digital platforms such as SWAYAM – MOOC / NPTEL.

This will help the students of remote areas to be aware of latest developments in the concerned field, to interact with eminent professors / personalities from the best

institution / industries and to get access to the best educational content at very practical and economical way.

Evaluation

Marks shall be given through internal evaluation. A minimum of two courses in any of the fields, which he / she likes could be opt during the two years period. 6Marks / course should be given from internal evaluation of practical.

Regarding Online courses are concerned, full liberty is given to the students for the selection of the course. Staff can assist the students in selection of course according to their potential of students.

10. MEDIUM OF INSTRUCTION AND EXAMINATION

The medium of instruction as well as examination will be in English

Theory examination

The external evaluation will be based on the examination to be conducted by the university at the end of each semester.

Practical examination

Practical examinations will be conducted at the end of every semester.

11. EVALUATION

A. Each course carries an internal component

B. There is a pass minimum of 50% for P.G. external and overall components

Theory: External : internal Assessment = 75:25

Practical: External : Internal Assessment = 50:50

C. Internal Assessment

Regarding the internal assessment, 25 marks are allocated in the following manner

COMPONENTS	MARKS
The average of the best two tests from the 3 compulsory tests (Off line / Online Tests)	15 Marks
Quiz /Presentation /Seminar /Assignment	05 Marks
CCP, ECP, CCFW & ECFW	05 Marks
Total	25 Marks

Note: Each test will be of one hour duration

D. Course Project / Field work

1. Every Core / Elective course and Practical will have a course (Mini) project / field work in all the semesters
2. It could be done individually by the students related to social issues pertaining to the area
3. Student could be permitted to go for the collection of samples / data along with staff members
4. Maximum of a five page scientific report should be submitted

E. Internal marks for practical shall be allotted in the following manner

COMPONENTS	MARKS
Experimental works and other lab oriented and knowledge enrichment activities	**12 Marks**
Record	10 Marks

Model test	20 Marks
PCP / PCFW	05 Marks
Field Work / Industrial and Institutional Visit Report / SWAYAM / MOOC / NPTEL ONLINE Courses	03 Marks
Total	50 Marks

F. Project work

Internal	**External**	**Total**
50 Marks	**50 Marks**	**100 Marks**

G. Distribution of Marks in Project Course

COMPONENTS	**MARKS**
Internal	20 Marks
Participation / Paper Presentation in National / International Seminar / Symposium / Publication of Research Article	05 Marks
Dissertation	25 Marks
Presentation	25 Marks
Viva-voce	25 Marks
Total	100 Marks

Note:

i) Student should carry out INDIVIDUAL PROJECTS only

ii) Project shall be allotted at the beginning of the IV semester.

iii) In house projects are encouraged.

iv) Students may be allowed to carry out the project work in other research institutes.

v) Faculty members of the respective colleges must serve asguides
vi) Co- guides from the other institutions may be allowed.
vii) Project report evaluation will be done and Viva-voce will be conducted by both the external examiner and the guide at the end of the FOURTH SEMESTER itself.
viii) Dissertation in THREE copies have to be submitted 15 days before the actual schedule of the exam.
ix) Evaluation of dissertation has to be done by the external examiner(s) appointed by the University for 50 Marks.
x) Special weightage may be given for the students who publish their research work in recognised journal including online.

12. GRADING SYSTEM

A. The performance of the students are indicated by the SEVEN POINTS SCALE GRADING SYSTEMas per the UGC norms given below

GRADE	GRADE POINT	PERCENTAGE OF MARKS	PERFORMANCE
O	**9.5 and Above**	95-100	**Outstanding**
E	**8.5 and Above**	85-94	**Excellent**
D	**7.5 and Above**	+75-84	**Distinction**
A	**7.0 and Above**	70-74	**Very Good**
B	**6.0 and Above**	60-69	**Good**
C	**5.0 and Above**	50-59	**Average**
RA	**0**	Upto 49	**Re-Appear**

B. The overall performance level of the candidates will be assessed by the following formulae:

Cumulative weighted average of marks = $\frac{\sum(\text{marks} + \text{credits})}{\sum \text{credits}}$

Cumulative weighted average grade points = $\frac{\sum(\text{Gradepoints} \times \text{Credits})}{\sum \text{Credits}}$

13. QUESTION PAPER PATTERN – THEORY

SECTION	TYPE OF QUESTIONS	MARKS
Part –A	Multiple choice question (Two question from each unit) 5x2	1x10 = 10 Marks
Part – B	Internal choice questions (one question from each unit) 5x1	5x5 = 25 Marks
Part – C	Internal choice questions (one question from each unit) 5x1	8x5 = 40 Marks
	Total	**75 Marks**

14. QUESTION PAPER PATTERN – PRACTICAL

Practical time: 6 hours **Max. Marks: 50**

NO	COMPONENTS	MARKS
1	Major experiment	15 Marks
2	Minor experiment	10 Marks
3	Experimental procedure	05 Marks
4	Identification of spotters	10 Marks
5	Record	05 Marks
6	Viva-voce	05 Marks
	Total	50 Marks

Model Question Paper: -

QUESTION PAPER SETTING – INSTRUCTIONS TO QUESTION PAPER SETTERS

Outcome Based Education (OBC) is being followed in the University from 2022 – 2023 and different learning levels of students are assessed through Terminal Examinations in addition to Continuous Internal Assessment (CIA). Therefore, the question setters are required to go through this instruction manual and table showing the choice of action verbs

attached herewith while framing questions carefully and then set the questions for each paper accordingly.

* Question Paper Setters are required to give due weightage to the possible educational levels (viz., remembering, understanding, applying, analyzing, evaluating and creating) relevant to the course paper concerned.

* **Setters are expected to assess only one of Bloom's level in each question.**

* Remembering (K1) and understanding (K2) level Questions assessing of cognition should not exceed 50 percent of the total marks of a question paper

* **Section A consists of Ten MCQ questions Two from each unit.** The examiners are required to frame the questions testing to any one of Bloom's level **(K1 to K6).**

*** Section B consists of five questions** by providing alternate choice questions asked from each unit of the course without omitting any unit (K1 to K6)

* **Section C consists of Five questions** with alternate choice questions. Setters have to set one question from each unit of the syllabus. The alternative (a) and (b) of the same question number must adhere to one level of Bloom's Taxonomy.

* A table consisting of choice of possible Action Verbs is attached to be helpful to the Setters to decide the learning level of the assessment question designed.

* A column titled Course Outcome (CO) in the model question paper indicates the specific outcomes of each course which is to be assessed in the Terminal Examinations. Each course has a minimum of five COs relevant to the course.

The setters are required to map the Cos and Ks as per the correlation given in the curriculum

* The Model Question Paper shows the different learning levels identified for the questions present in the model question paper.

Knowledge	Level	Skills to be Assessed	Action Verb
Remembering	**K1**	**Ability of the Students** * To recall information like facts, conventions, definitions, technical terms, classifications, categories, etc, * To recall methodology and procedures, abstractions, principles and theories	List, define, tell, describe, choose, find, how, match, omit, relate, select, recite, tabulate, quote, show, recall, label, spell, what, which, why, name, who, when, where, etc.
Understanding	**K2**	**Ability of the Students**	Describe, explain, paraphrase,

		* To understand information * To interpret facts * To compare and contrast * To predict consequences * To translate knowledge into new context, etc.,	demonstrate, extend, differentiate, illustrate, outline, restate, associate, contrast, interpret, discuss, translate, etc.,
Applying	**K3**	**Ability of the Students** * To use information, methods, concepts, laws, theories in new situations * To solve problems using required skills or knowledge * To demonstrate correct usage of a method of procedure	Apply, identify, make use of, organize, plan, calculate, predict, solve, illustrate, demonstrate, determine, experiment with model, compute, utilize, show, examine, etc.,
Analyzing	**K4**	**Ability of the Students** * To break down a complex problem into parts * To identify the relationships and interaction between the different parts of complex problems * To identify the missing information, redundant information and contradictory information	Classify, outline, break down, categories, analyze, illustrate, infer, select, compare, contrast dissect, distinguish, divide, examine, inspect, etc.,
Evaluating	**K5**	**Ability of the Students** * To compare and discriminate between ideas * To assess the values of theories and presentations * To verify value of evidence * To recognize subjectivity * To make use of definite criteria for judgments	Assess, decide, choose, rank, grade, test measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate, agree, appraise, criticize, determine, disprove, estimate, influence, interpret, etc.,
Creating	**K6**	**Ability of the Students** * To use old ideas to create new ones * To combine parts to make new whole. * To generalize from given facts, relate knowledge from several areas, draw conclusions.	Adapt, build, change, combine, compose, construct, create, delete, derive, design, develop, elaborate, formulate, generate, improve, integrate, invent, maximize, minimize, modify, etc.,

*** It may be noted that, the verbs which are not exhaustive in the above table are associated with multiple Bloom's taxonomy level. The setters need to keep in mind that, it is the skill of the students they want to assess that will determine the contextual meaning of the verbs used in the assessment questions.**

Programme Outcomes (PO):

At the end of the programme, the student will be able to:

PO1	Appreciate the nuances of basic sciences to conceive innovative ideas to enrich the existing technology.
PO2	Build new perspectives to look at day to day activities from

	science point of view.
PO3	Take part in finding solutions for complex problems by applying appropriate techniques using modern scientific tools.
PO4	Understand the impact of science in matters pertaining to sociology, economics and environmental issues for sustainable development.
PO5	Comprehend the basic and advanced concepts in Science to acquire theoretical knowledge as well as practical skills.
PO6	Develop a research oriented learning that cultivates analytical and integrative critical thinking skills.
PO7	Improve sustainable learning at the individual and group level by making them to participate in online educational programmes / visiting industries and R & D organizations.

Programme Specific Outcomes (PSO):

At the end of the programme, the student will be able to:

PSO1	Acquire competent knowledge in fundamental and advanced concepts of Microbiology and its related fields and adapt them to recent technological development with confidence.
PSO2	Explore the impact of Microbiology and its related fieldsinAgriculture, Food Sector, Industrial, Health, Public Safety, Environment and Climate change and modern applications and its limitations.
PSO3	Promote observational, critical thinking, analytical, logical and comparative skills through online educational courses / course projects / fieldworks , internships to elevate the quality of students and make them competent at National / International level and to produce products of good quality and reliability.
PSO4	Employ relevance of Microbiology in the social context with clear insight.

PSO5	Acquire knowledge to create sustainability and attempt new projects for quality enhancement in health and environment.
PSO6	Enhance logical thinking and adopt new technologies for developing innovative methods to deal with natural and man-made issues.
PSO7	Develop scientific temper to undertake research using appropriate methodology and to emerge as an entrepreneur with Micro (biological) background.

15. PROGRAMME EDUCATIONAL OUTCOMES (PEOs)	
PEO1	To Impart basic and advanced Knowledge prevailing Currently Among the different branches of Microbiology including new arrivals.
PEO2	To enable and instill in students an in-depth knowledge on various fields of applications of high utility prevailing industries and research organizations.
PEO3	To inculcate and improve analytical, reasoning, logical, critical thinking, confidence, communication skills among students in addition to give them a real time experience in fields / Industries to understand their responsibilities and commitment through skill development programmes
PEO4	To imbibe and infuse the radiance of Self-confidence in independent research work with ethics
PEO5	To ensure a fair knowledge on the current technological developments as to enable them from employment view point in the newly emerging fields of research and industrial advancements and for the betterment of society at large.

16. PROGRAMME OUTCOMES (POs)	
PO1	Appreciate the nuances of basic sciences to conceive innovative ideas to enrich the existing technology.
PO2	Build new perspectives to look at day to day activities from science point of view.

PO3	Take part in finding solutions for complex problems by applying appropriate techniques using modern scientific tools.
PO4	Understand the impact of science in matters pertaining to sociology, economics and environmental issues for sustainable development.
PO5	Comprehend the basic and advanced concepts in Science to acquire theoretical knowledge as well as practical skills.
PO6	Develop a research oriented learning that cultivates analytical and integrative critical thinking skills.
PO7	Improve sustainable learning at the individual and group level by making them to participate in online educational programmes / visiting industries and R & D organizations.

17. PROGRAMME SPECIFIC OUTCOMES **(PSOs)**	
PSO1	Acquire competent knowledge in fundamental and advanced concepts of Microbiology and its related fields and adapt them to recent technological development with confidence.
PSO2	Explore the impact of Microbiology and its related fields in Agriculture, Food Sector, Industrial, Health, Public Safety, Environment and Climate change and modern applications and its limitations.
PSO3	Promote observational, critical thinking, analytical, logical and comparative skills through online educational courses / course projects / fieldworks , internships to elevate the quality of students and make them competent at National / International level and to produce products of good quality and reliability.
PSO4	Employ relevance of Microbiology in the social context with clear insight.
PSO5	Acquire knowledge to create sustainability and attempt new projects for quality enhancement in health and environment.

PSO6	Enhance logical thinking and adopt new technologies for developing innovative methods to deal with natural and man-made issues.
PSO7	Develop scientific temper to undertake research using appropriate methodology and to emerge as an entrepreneur with Micro (biological) background.

MANONMANIAM SUNDARANAR UNIVERSITY

Tiruunelveli – 627012, INDIA

M.Sc., Microbiology (Colleges)

SEMESTER SYSTEM WITH CREDITS (CBCS PATTERN)

SYLLABUS

(SCHEME OF EXAMINATION)

(EFFECTIVE FROM THE ACADEMIC YEAR 2021-2022 ONWARDS AND THEREAFTER)

SEM	NO	STATUS	COURSE TITLE	Course Code	CONTACT HOURS/ WEEK (30)	CREDITS (90)	CCP / ECP/ CCFW/ ECFW PCP /PCFW	EH	CIA αβγδ	ESE	TOTAL
FIRST	1	Theory / Core	General Microbiology & Diversity		4	4	+	3	25	75	100
	2	Theory /Core	Biochemistry		4	4	+	3	25	75	100
	3	Theory /Core	Physiology &Metabolism		4	4	+	3	25	75	100
	4	Theory / Elective	Biochemical techniques and instrumentation		3	3	+	3	25	75	100
	5	SDC	Field Work		3	2	-	-	-	25	025
	6	Practical	Practical – I		6	3	-	6	25	75	100
	7	Practical	Practical – II		6	3	-	6	25	75	100
S	8	Theory /Core	Molecular Biology		4	4	+	3	25	75	100

SECOND	9	Theory /Core	Immunology		4	4	+	3	25	75	100
	10	Theory /Core	Virology		4	4	+	3	25	75	100
	11	Theory / Elective	Biodegradation and remediation		3	3	+	3	25	75	100
	12	SDC	Internship		3	2	-	-	-	25	025
	13	Practical	Practical – III		6	3	-	6	25	75	100
	14	Practical	Practical – IV		6	3	-	6	25	75	100
THIRD	15	Theory /Core	Bioinformatics and Biostatistics		4	4	+	3	25	75	100
	16	Theory /Core	Medical &Pharmaceutical Microbiology		4	4	+	3	25	75	100
	17	Theory /Core	Environmental & Agricultural Microbiology		4	4	+	3	25	75	100
	18	Theory /Core	Research Methodology		4	4	+	3	25	75	100
	19	SDC	Industrial and Institutional Visit		2	1	-	-	-	50	050
	20	Practical	Practical – V		6	3	-	6	25	75	100
	21	Practical	Practical – IV		6	3	-	6	25	75	100
FOURTH	22	Theory /Core	Food Microbiology		4	4	+	3	25	75	100
	23	Theory /Core	Fermentation &Industrial Microbiology		4	4	+	3	25	75	100
	24	Theory /Core	Biotechnology		4	4	+	3	25	75	100
	25	Project	Project		6	3	-	6	25	75	100
	26	Practical	Practical – VII		6	3	-	6	25	75	100
	27	Practical	Practical – VIII		6	3	-	6	25	75	100

SDC: Skill Development Course			
CCP: CORE COURSE PROJECT	**ECP**: ELECTIVE COURSE PROJECT	**CCFW**:CORE COURSE FIELD WORK	
ECFW: ELECTIVE COURSE FIELD WORK	**PCP:**PRACTICAL COURSE PROJECT	**PCFW:** PRACTICAL COURSE FIELD WORK	
EH: Exam Hours			
CIA$^{\alpha}$: Continuous Internal Assessment α SWAYAM MOOCS COURSE	**CIA$^{\beta}$**: Continuous Internal Assessmentβ SWAYAM NPTEL	**CIA$^{\gamma}$** : Continuous Internal Assessment γ FIELD WORK	**CIA$^{\delta}$**: Continuous Internal Assessment δ INDUSTRIAL VISIT AND INSTITUTIONAL VISIT
ESE: End Semester Evaluation			

First Year I Semester 1 Core - Theory Credits 4

GENERAL MICROBIOLOGY AND DIVERSITY	**SUB CODE: ZMBM11**

COURSE OBJECTIVES

1. *Understand and remember the historical aspects of Microbiology and Microorganisms and to analyse the roles of different taxonomical technical outputs and to evaluate the applications of modern methods.*
2. *Explain and relate the commonly used microscopic and staining techniques and transfer learnt techniques in needy places.*
3. *Describe and classify the diverse kinds of sterilization and media and discover the suitability of techniques and media to value samples.*
4. *Recognize and infer the biology of fungi and correlate different groups.*
5. *Recite and extract the features of algal and protozoan forms and connect the ecological significance to value its services for quality development.*
6. *Memorize the distribution and services of microbes and their related techniques to solve*

issues of ecology to develop sustainability.

7. *Enrich the studied concepts by understanding a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs)

On completion of the course, students will be able to

COURSE OUTCOMES	*COGNITIVE LEVELS*
CO1: Understand and remember the historical aspects of Microbiology and Microorganisms and to analyse the roles of different taxonomical technical outputs and to evaluate the applications of modern methods.	*K-1, K-2, K-4 & K-5*
CO2: Explain and relate the commonly used microscopic and staining techniques and transfer learnt techniques in needy places.	*K-1, K-2 & K-3*
CO3: Describe and classify the diverse kinds of sterilization and media and discover the suitability of techniques and media to value samples.	*K-1, K-2, K-3 & K-5*
CO4: Recognize and infer the biology of fungi and correlate different groups.	*K-1, K-2, & K-4*
CO5: Recite and extract the features of algal and protozoan forms and connect the ecological significance to value its services for quality development.	*K-1, K-2, K-4 & K-5*
CO6: Memorize the distribution and services of microbes and their related techniques to solve issues of ecology to develop sustainability	*K-1, K-3, & K-6*
CO7 Enrich the studied concepts by understanding a Core Course Project / Core Course Field Work	*K-1-K-6*

L T P C

4 0 0 4

Unit: I

Evolution of Microorganisms & Microbiology: Members of the microbial world, Microbial evolution, Microbiology & it's origin and microbiology today - Scope, history & development of Microbiology –Characterization, Classification (Haeckel, Whittaker and Carl Woese) and Identification of Microorganisms – Comparison of bacteria, archaea&eukarya – Introduction to taxonomy : phenotypic classification, phylogenetic classification, genotypic classification, taxonomic ranks – Techniques for determining microbial taxonomy & phylogeny: Classical & molecular characteristics - Genetic relationship - DNA homology -16S r RNA sequencing -

Phylogenetic tree - Bergey's manual of systematic bacteriology.

(14 L)

Unit: II

Microscopy – It's principles and applications: Bright and dark field, phase contrast, fluorescence microscopy, TEM and SEM - Staining methods :Gram's, acid-fast, capsule,flagella spore, metachromatic granules, nuclear,silverimpregnation&fungal staining.

(12 L)

Unit: III

Outline of microbial control methods - Methods of sterilization: Physical control methods: heat, filtration and radiation, chemical control agents: phenolics, alcohol, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases - biological control of microorganisms - Indicator microorganisms for sterilization methods -Cultivation of microorganisms - Culture media: chemical and physical, functional types: supportive media (Transport), enriched media,

selective media and differential media. Isolation of pure cultures: streak, spread and pour plate methods - Methods of preservation and maintenance of cultures – principle and applications of lyophilizer.

(14 L)

Unit: IV

Fungi: Mold – General characters, morphology, nutrition and metabolism – reproduction – Classification of Fungi (Characters of selected groups) – Oomycetes-Zygomycetes **–** Ascomycetes – Basidiomycetes – Deuteromycetes. Lichens: General characters and economic importance. (10 L)

Unit: V

Algae: Distribution, general characters, thallus and it's structure, nutrition and reproduction – Characters of selected groups – Blue green algae, Pyrrophyta, Euglenophyta, Chrysophyta, Phaeophyta and Rhodophyta. Protozoa: General characters, locomotion, nutrition, and reproduction – Characters of Sarcodina (*Entamoebahistolytica*) and Sporozoa (*Plasmodium*sp) **(10 L)**

TEXTBOOKS RECOMMENDED:

1. Bernard D. Davis., Renato Dulbecco., Herman N. Elsen and Harold S. Ginsberg. (1990). Microbiology (4th edition). J.B. Lippincott Company, New York.
2. Prescott L.M., Harley J.P. and Klein D.A. (2008). Microbiology (7th edition). McGraw Hill, New York.
3. Larry McKane and judykandel (1996). Microbiology - Essentials and Applications. (2nd edition). McGraw Hill, New York.
4. Madigan M.T., Martinko, J. IVI and parker J. Brock T.D. (1997). Biology of microorganisms. (8th edition. Prentice hall international Inc, London.
5. Nester, E.W., Roberts, C.V., and Nester, M.Y. (1995). Microbiology. A Human perspective. IWOA, USA.
6. Salle, A.J. (1996). Fundamental Principles of Bacteriology. (7th edition). Tata McGraw-Hill Publishing Company Ltd., New Delhi.
7. PelczarJr.,M.J., Chan E.C.S. and Kreig, N.R. (1993). Microbiology. McGraw Hill Inc., New York.
8. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. amd Painter, P.R. (1986). General Microbiology. MacMillan Education Ltd., London.
9. Starr, M.P., Stolp, H., Truper, H.C., Balows, A. and Schegel, H.C. (1991). The prokaryotes. A Handbook of Habitats, Isolation and Identification of Bacteria. Springer Verlag.
10. Tortora, Funke, Case Addison (2001). Microbiology – An Introduction – 7th edition, Wesley Longman Inc.
11. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
12. John L. Ingraham and Catherine A. Ingrahani (2000). Introduction to Microbiology. Books / Cole Thomas Learning, New York.
13. Talaro, K.P. and Talaro, A (1999). Foundations in Microbiology. WCP McGraw – Hill, NewYork.
14. Marimuthu, R. (2008). Microscopy and Micro techniques, MJP Publishers, Chennai.

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1. Holt, J.S. Kreig, N.R., Sneath, P.H.A. and Williams, S.T. (1994). Bergey's Manual of Determinative Bacteriology. (9th edition) – Williams & Wilkins, Balimore.
2. Brige E.A. (1992). Modern Microbiology – Wm C. Brown Publishers, Dubuque, U.S.A.

3. Goodfellow M. and O'Dennell A.C. (1994). Chemical methods in prokaryotic Systematics – John Wiley & Sons, New York.
4. Murray R.K., Granner M.D., Mayes P.A. and Rodewell V.W. (1990). Biochemistry – Prentice Hall International Inc., London.
5. Bryant D.A. (1994). The molecular Biology of Cyanabacteria. Kluwer Academic Publishers, London.
6. Gerhardt, P., Murray R. Ce., Wood, W.A. and Kreig, N.R. (ed) (1984). Methods for General and Molecular Bacteriology – American Society for Microbiology, Wahnington D.C.
7. Neidhardt, F.C. (ed) (1987). *Escherichia coli* and *Salmonella typhimurium* – Cellular and Molecular Biology (Vol.I). American Society for Microbiology, Washington D.C.
8. Hall, D.C. and Rao, K.K. (1995). Photosynthesis – Cambridge University Press.
9. Zubey C.L. Parson W.W. and vance D.E. (1994). Principles of Biochemistry – Wm.C. Brown Publishers, Oxford, England.
10. Mathews C.K. and Holde K.E.V. (1996). Biochemistry. The Benjamin / Cummings Publishing Company, Inc., New York.
11. Stryer L. (1995). Biochemistry. W.H. Freeman and Company, New York.

WEB RESOURCES:

1. https://www.microbe.net/resources/microbiology/web-resources/
2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php
3. guides.emich/immunology
4. http://oew.mit.edu/courses/.../hst-176-cellular-and molecular.
5. Immunology -fall-2005
6. https://serc.carleton.edu/microbelife/index.html
7. https://microbe.net/resources/microbiology-web-resources/
8. https://microbiologysociety.org/
9. https://open.umn.edu/opentextbooks/textbooks/404

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate

K-6	Create

First Year I Semester 2 Core - Credits 4

Theory

BIOCHEMISTRY	**SUB CODE: ZMBM12**

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	**POs**					**PSOs**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	3	2	3	3	3	2	2	3	2	3
CO2	1	2	1	1	1	2	1	1	1	2
CO3	2	3	2	3	2	3	2	2	2	2
CO4	2	3	3	2	2	3	2	2	2	2
CO5	1	3	1	1	1	3	2	1	2	2

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

COURSE OBJECTIVES

1. *Describe the types of carbohydrates along with their classification and evaluate their biological significance.*
2. *Identify the properties of lipids and their classification and value the biological importance of lipids.*
3. *Recognise and relate the characters of proteins and enzymes and analyze the factors influencing their activities.*
4. *Understand the properties of nucleic acid and type them, illustrate the structural aspects of biomolecules and judge their significance.*
5. *Identify the various techniques related to biochemistry and interpret their principle, uses and limitations and correlating different methods to grade their applications in diagnosis.*
6. *Quote the diverse biomolecules and citing their biological significance and to teach the techniques and analyze their values for evaluating functional status of systems.*
7. *To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs)

On completion of the course, students will be able to

COURSE OUTCOMES	*COGNITIVE LEVELS*
CO1. Describe the types of carbohydrates along with their classification and evaluate their biological significance.	*K-1, K-2 & K-5*
CO 2. Identify the properties of lipids and their classification and value the biological importance of lipids.	*K-1, K-2 & K-5*
CO 3. Recognise and relate the characters of proteins and enzymes and analyze the factors influencing their activities.	*K-1, K-2 & K-4*
CO 4. Understand the properties of nucleic acid and type them, illustrate the structural aspects of biomolecules and judge their significance.	*K-1, K-2, K-4 & K-5*
CO 5. Identify the various techniques related to biochemistry and interpret their principle, uses and limitations and correlating different methods to grade their applications in diagnosis.	*K-1, K-2, K-4 & K-5*
CO 6. Quote the diverse biomolecules and citing their biological significance and to teach the techniques and analyze their values for evaluating functional status of systems.	*K-1, K-2, K-3, K-4 & K-5*
CO 7 To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K-1 - K-6*

L T P C

4 0 0 4

Unit: I

Carbohydrates: Monosaccharide and their relationship – Structure of Sugars: steroisomerism and optical isomer of sugars. Reactions of aldehyde and ketone groups, ring structure, tautomeric forms, mutarotation and reactions of sugars in OH groups – Disaccharides – structure, occurrence and biological importance: Maltose, Sucrose, Lactose & Inversion of sucrose. Structural polysaccharides: Homopolysaccharides and Heteropolysaccharides and Mucopolysaccharides – Cellulose, Chitin, Inulin, Glycogen, Hyaluronic acid, Chondroitin sulfates, Heparin, Dermatan sulfate and Keratan sulfate. Blood group substances.

(14 L)

Unit: II

Lipids: Definition, detailed classification of lipids – Components of lipids: Fatty acids and Glycerals – Types of Fatty acids: Essential and Non Essential – Triglycerols – Properties, types and their functions: Phospholipids, Glycolipids, Lipoproteins and Steroids.

(10 L)

Unit: III

Elemental composition of protein, building blocks. Amino acids: classification based on their nature & requirements – selenocysteine – physical and chemical properties of amino acids - Peptide bond - classification, structure & properties of proteins: Functional, Solubility &Nutritional.Enzymes: Types based on their action - Mechanism of enzyme action – factors influencing enzyme action – Michaelis-Menton Hypothesis. A brief view over co- enzymes and Isoenzyme.

(14 L)

Unit: IV

Nucleic Acids - brief history - nucleotides: Components, Types, Tautomeric Forms, Nomenclature & analogs. Different forms, structure and functions of DNA & RNA. Chemicals & buffers used in Genetic material studies. (10 L)

Unit: V

Clinical Biochemistry Laboratory – Collection of Blood: Anticoagulants, Hemolysis & Preservation of Blood Specimens. Types of laboratory tests – Collection of urine – cerebrospinal fluid (CSF) – Quality control methods – Autoanalysis in clinical chemistry – Analysis in clinical biochemistry laboratory and reference values.

(12 L)

TEXTBOOKS RECOMMENDED:

1. Stryer, L. (Ed) (1995). Biochemistry W.H. Freeman and Company, New York.
2. Donald Voet and Judith voet. (1990). Biochemistry. John Wiley and Sons, New York.
3. Henry, R., Mahler and Eugene – H. Cerdesz (1966). Biological Chemistry. Harper Internationsl Edition, New York.
4. Hubert Stryer (1995). Biochemistry – Freeman and Company, New York.
5. Dawn B. Markus (1994). Biochemistry. Harwad – Publishing, New York.
6. William. J. Marshall and Stephan K. Bangert. (1995). Clinical Biochemistry – Metabolic and Clinical Aspects – Churchill Livingston, New York.
7. Harper's Biochemistry, prentice – Hall International, INC Singapore.
8. Zubey C.L., Parson, W.W. and Vans, D.E. (1994). Principles of Biochemistry, Wm C. Brown Publ., England.
9. Talaro. K.P. and Talaro, A. (1999). Foundations of Microbiology. WCP McGraw – Hill, New York.
10. Lehninger, Nelson and Cox (2002). Principles of Biochemistry CBS Publishing and Distributors.
11. Caldwell, D.R. (1995). Microbial Physiology and Metabolism, Wm. C. Brown Publishers, USA.
12. Lansing M. Prescott, John P. Harley and Donald A. Klein (2003). Microbiology (5th edition). McGraw – Hill Company, New York
13. Larry McKane and Judy Kandel (1996). Microbiology – Essentials and Applications. (2nd edition). McGraw – Hill Inc, New York
14. Moat, A.G and Foster J.W. (1998). Microbial Physiology (2nd edition). Jihn Wiley and Sons, New York.
15. PelczarJr.,M.J., Chan E.C.S. and Kreig, N.R. (1993). Microbiology. McGraw Hill Inc., New York.
16. Salle, A.J. (1996). Fundamental Principles of Bacteriology (7th edition). Tata McGraw Hill Publishing Company Limited, New Delhi.
17. White, D. (1995). The Physiology and Biochemistry of prokaryotes. Oxford University Press. Oxford, New York.
18. Madigan M.T., Martinko, J. IVI and parker J. Brock T.D. (1997). Biology of microorganisms. (8th edition. Prentice hall international Inc, London.

19. Nester, E.W., Roberts, C.V., and Nester, M.Y. (1995). Microbiology. A Human perspective. IWOA, USA.
20. Veerakumari L. (2006). Bioinstrumentation. MJP Publishers, Chennai.
21. MeenaKumari. S. (2006). Microbial Physiology. MJP Publishers, Chennai.
22. Christopher K. Mathews and Van Holde, K.E. (1996). Biochemistry (2nd edition). The Benjamin / Cummings Publishing Company.
23. David E. Metzler and Coral M. Metzler (2001). Biochemistry – The chemical reactions of living cell – Vol 1 and 2 (2nd edition). Harcourt / Academic Press, New York.
24. Donald Voet and Judith voet. (1995). Biochemistry. (2nd edition). John Wiley and Sons Inc., New York.
25. Freifelder D. (1996). Molecular Biology. (2nd edition). Narosa Publishing House, New Delhi.
26. Geofferey, L. and Zubey, C.L. (1998). Biochemistry (4th edition). Wm. C. Brown Publishers.
27. Jeremy M. Berg, John L. Tymoczko and LubertStryer (2002). Biochemistry (5th edition). W.H. Freeman and Company, New York.
28. LubertStryer (1995). Biochemistry (4th edition). W.H. Freeman and Company, New York.
29. Reginald, h., garret and Charles M. Grishm. (199*8). Biochemistry (2nd edition). Saundars College Publishing.
30. Thomas S. Devlin. (2002). Textbook mof Biochemistry with Clinical Correlations (5th edition). John Willey and Sons Inc. Publication, New York.
31. Trudy Mckee and James R.Mc. Kee (1999). Biochemistry – An Introduction (2nd edition). WCB McGraw – Hill, U.S.A.

WEB RESOURCES

1. https://onlinelearning.hms.harvard.edu/hmx/courses/biochemistry
2. https://openlearning.mit.edu/mit-faculty/residential-digital-innovations/online-resources-biochemistry-enhance-learning-well
3. https://nnlm.gov/data/guides/life-sciences/biochemistry
4. https://open.oregonstate.education/biochemfreeforall/chapter/introduction/
5. https://onlinecourses.swayam2.ac.in/cec19_bt02/preview

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	2	3	3	2	3	3
CO 2	3	2	2	2	2	3	3	2	3	3
CO 3	3	2	2	2	2	3	3	2	3	3
CO 4	3	3	2	2	2	3	3	2	3	3
CO 5	3	3	3	3	2	3	3	2	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year I Semester 3 Core - Theory Credits 4

PHYSIOLOGY AND METABOLISM	**SUB CODE: ZMBM13**

COURSE OBJECTIVES:

1. *Identify the different structural components of bacteria and to classify them based on that and relate their features of different microbial groups.*
2. *Recognize the different types of transport systems in microbes and compare their mechanism and limitations and analyse the metabolic pathways and to evaluate their biological significance.*
3. *Understand the principle of anaerobic respiration and fermentation and their classification. To teach bioluminescence andanalyse the effect of methanogenesis in global warming.*
4. *Understand the mechanism and types of photosynthesis and to analyse the features of pigments and appraise the role of microbes in oxygen generation and explain about N_2 fixers. To improve the ideas of diverse metabolic pathways and their impact*
5. *Explain the different types of culture methods and teach the factors affecting growth. Relate the different cultivation techniques and the effect of environment in spore formation.*
6. *Recite the biochemistry of cell wall and compare its components and analyse the effects of antibiotics in cell wall synthesis.*
7. *To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs)
On completion of the course, students would be able to

COURSE OUTCOMES	COGNITIVE LEVELS
CO1: Identify the different structural components of bacteria and to classify them based on that and relate their features of different microbial groups.	*K-1, K-2,& K-3*
CO2: Recognize the different types of transport systems in microbes and compare their mechanism and limitations and analyse the metabolic pathways and to evaluate their biological significance.	*K-1, K-2, K-4 & K-5*
CO3: Understand the principle of anaerobic respiration and fermentation and their classification. To teach bioluminescence andanalyse the effect of methanogenesis in global warming.	*K-1, K-2, K-3 & K-4*
CO4: Understand the mechanism and types of photosynthesis and to analyse the features of pigments and appraise the role of microbes in oxygen generation and explain about N_2 fixers. To improve the ideas of diverse metabolic pathways and their impact	*K-1, K-2, K-4 & K-5*
CO5: Explain the different types of culture methods and teach the factors affecting growth. Relate the different cultivation techniques and the effect of environment in spore formation.	*K-1, K-3 & K-4*
CO6: Recite the biochemistry of cell wall and compare its components and analyse the effects of antibiotics in cell wall synthesis.	*K-1, K-2 & K-4*
CO7: Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K-1- K-6*

L T P C

4 0 0 4

Unit: I

Extracellular components: Capsule, slime layer, sheath, flagella and pili – Structure & Functions. Cell wall & Cell membrane: Archae bacteria, Gram positive & Gram negative – Structure & Functions. Intracellular membranes – Structure & functions. Biosynthesis of PG layer. Cytoplasm and it's inclusions. Genetic materials: nucleoid

(12L)

Unit: II

Major nutritional types - Nutrients Transport: Simple, passive & facilitated diffusion, Active transport: symport&antiport, group translocation & iron transport - Introduction to metabolism - metabolic pathways like glycolysis, TCA cycle, EMP, ED &glyoxylate cycle. Respiration: Aerobic - ETS and it's components – oxidative & substrate level phosphorylation - Chemiosmosis theory.

(13L)

Unit: III

Anaerobic types of respiration – Nitrate, Sulphate respiration & diversity of anaerobic final electron acceptors. Fermentation: Alcoholic, lactic acid, propionic, mixed acid, butanediol, butyric acid, and methanogenesis - Pasteur effect.Bioluminescence.

(12L)

Unit: IV

Photophosphorylation:oxygenic and anoxygenic – Cyclic and acylic ETS, Photosynthetic and accessory pigments. Photosystems of purple sulphur, purple non-sulphur and green sulphur bacteria. Halobacterial photosynthesis – bacterial rhodopsin.

Nitrogen fixation: Symbiotic, asymbiotic and associative. Nitrogenase - mechanism of nitrogen fixation, heterocyst and *Nif* genes. (12L)

Unit: V

Bacterial growth: Binary fission, Growth curve, Auxenic, synchronous, asynchronous cultures.Batch, fed batch & continuous cultures: chemostat and turbidostat. Factors affecting growth: Physical, chemical and biological. Spore: endo and exospores. Endospore: structure, factors influencing sporulation, process of sporulation and a bird's eye view on spore genes.

(11L)

TEXTBOOKS RECOMMENDED:

1. Talaro. K.P. and Talaro, A. (1999). Foundations of Microbiology. WCP McGraw – Hill, New York.
2. Caldwell, D.R. (1995). Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.
3. Lansing M. Prescott, John P. Harley and Donald A. Klein (2003). Microbiology (5th edition). McGraw – Hill Company, New York
4. Larry McKane and Judy Kandel (1996). Microbiology – Essentials and Applications. (2nd edition). McGraw – Hill Inc, New York
5. Moat, A.G and Foster J.W. (1998). Microbial Physiology (2nd edition). Jihn Wiley and Sons, New York.
6. PelczarJr.,M.J., Chan E.C.S. and Kreig, N.R. (1993). Microbiology. McGraw Hill Inc., New York.
7. Salle, A.J. (1996). Fundamental Principles of Bacteriology (7th edition). Tata McGraw Hill Publishing Company Limited, New Delhi.
8. White, D. (1995). The Physiology and Biochemistry of prokaryotes. Oxford University Press. Oxford, New York.
9. Madigan M.T., Martinko, J. IVI and parker J. Brock T.D. (1997). Biology of microorganisms. (8th edition. Prentice hall international Inc, London.
10. Nester, E.W., Roberts, C.V., and Nester, M.Y. (1995). Microbiology. A Human perspective. IWOA, USA.
11. Mariappan C. (2010). A textbook of general microbial physiology, biochemistry and metabolism. Pooja Publishers, India.
12. MeenaKumari. S. (2006). Microbial Physiology. MJP Publishers, Chennai.
13. Jeremy M. Berg, John L. Tymoczko and LubertStryer (2002). Biochemistry (5th edition). W.H. Freeman and Company, New York.

WEBRESOURCES

1. https://www.classcentral.com/course/swayam-microbial-physiology-and-metabolism-19950
2. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview

3. https://nature.berkeley.edu/advising/majors/nutritional-sciences-physiology-metabolism
4. https://www.accessscience.com/content/bacterial-physiology-and-metabolism/069000

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	2	2	1	2	1	3	2	1	1	2
CO2	2	3	1	2	3	2	3	2	2	2
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	1	2	1	2	1	2	2	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year I Semester 1 Elective - Theory Credits 3

BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION	**SUB CODE: ZMBE11**

COURSE OBJECTIVES:

1. Explain the principle, types, uses and limitations of instruments like pH and photo absorption based and compare their efficacy to grade their friendliness
2. Recognize the principle of centrifugation and their types. Analyze their usefulness for separational studies.
3. Quote the methods of chromatography and compare their usefulness. Teach their limitations and evaluate their performance in biological studies.
4. Define the principle of electrophoresis and their types. Teach the method of usage and compare their performance and utility.
5. Describe advanced biochemical characterization techniques and compare their usefulness and to grade the usefulness of studied techniques.
6. Pivot a research friendly exposure with basic and advanced instruments to study the characters of biological samples for their classification and to assess their quality.
7. Enrich the studied concepts by undertaking an Elective Course *Project / Elective Course Field Work*

COURSE OUTCOMES (COs), ON COMPLETION OF THE COURSE, STUDENTS WILL BE ABLE TO

COURSE OUTCOMES	COGNITIVE LEVELS
CO1: Explain the principle, types, uses and limitations of instruments like pH and photo absorption based and compare their efficacy to grade their friendliness	*K-1, K-2 & K-5*
CO2: Recognize the principle of centrifugation and their types. Analyze their usefulness for separational studies.	*K-1, K-2 & K-4*
CO3: Quote the methods of chromatography and compare their usefulness. Teach their limitations and evaluate their performance in biological studies.	*K-1, K-2, K-3 & K-4*
CO4: Define the principle of electrophoresis and their types. Teach the method of usage and compare their performance and utility.	*K-1, K-2, K-3 & K-4*
CO5: Describe advanced biochemical characterization techniques and compare their usefulness and to grade the usefulness of studied techniques.	
CO6:Pivot a research friendly exposure with basic and advanced instruments to study the characters of biological samples for their classification and to assess their quality.	*K-1, K-2, K-3 & K-6*
CO7: Enrich the studied concepts by undertaking an Elective Course Project / Elective Course Field Work	

	K-1- K-6

L T P C

3 0 0 3

Unit: I

pH meter – titration curve and measurement – principles, laws of absorbtion and radiation, visible, ultraviolet, infrared and mass spectrophotometry – Absorption spectrum, flame photometry – principles of colorimetry, turbidometry and viscometry. (12 L)

Unit: II

Principles of centrifugation – centrifugation techniques - preparative and analytical methods, density gradient centrifugation – types of rotors – Safety aspects in the use of centrifuges. (10 L)

Unit: III

General principles and application of chromatography: Partition (Paper, Thin layer & Gas chromatography), Adsorption (column Chromatography), Ion exchange, Gel filtration, Affinity & High performance liquid chromatography. (13 L)

Unit: IV

Electrophoresis – horizontal and vertical – moving boundary, zone (paper and gel) electrophoresis – immuno electrophoresis – Rocket immuno electrophoresis – iso electric focusing –Applications of electrophoresis: AGE and SDS-PAGE. An overview on the analysis of bands: direct photometric scanning, staining methods, radiolabelling, autoradiography, enzyme assay, immunological methods, blotting & detection. (13 L)

Unit: V

Advanced instrumentation – IR spectroscopy, Raman spectroscopy, X ray Spectroscopy, NMR & AAS – principles, component structure and applications. An overview on radio isotopic technique. Detection and measurement of Radioactivity – Safety aspects of radio isotopic techniques

(12 L)

TEXTBOOKS RECOMMENDED:

1. Jayaramam . J. (1985) Laboratory Manual in Biochemistry. Wiley Eastern Ltd., New Delhi.
2. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
3. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
4. Keith Wilson and Walker. J. (2003). Practical Biochemistry – Cambridge University Press.
5. Veerakumari L. (2006). Bioinstrumentation. MJP Publishers, Chennai.

WEB RESOURCES

1. https://en.wikipedia.org/wiki/Chromatography
2. https://en.wikipedia.org/wiki/PH_meter
3. https://byjus.com/chemistry/uses-of-colorimeter/
4. https://byjus.com/chemistry/spectrophotometer-principle/
5. .https://www.researchgate.net/publication/277776146_20_Webster_J_G_ed_Bioinstrumentation_John_Wiley_Sons_New_York_2004
6. https://byjus.com/chemistry/types-of-electrophoresis/
7. https://en.wikipedia.org/wiki/Fourier-transform_infrared_spectroscopy#:~:text=Fourier%2Dtransform%20infrared%20spectroscopy%20(FTIR,over%20a%20wide%20spectral%20range.
8. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=83459&section=2.2#:~:text=IR%20spectroscopy%20detects%20the%20absorption,bond%20are%20not%20shared%20equally.
9. https://byjus.com/chemistry/infrared-spectroscopy/
10. https://lab-training.com/aas/
11. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	3	3	1	2	2	3	2	2	2	2
CO2	1	2	1	2	1	2	1	1	1	1
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	1	2	1	2	1	2	2	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year I Semester 1 Field Work Credits 2

FIELD WORK	**SUB CODE: ZMBT11**

COURSE OBJECTIVES

1. To enrich the concepts and facts learnt in class by comparing information and dataobtained from the real world.
2. To make the students to analyze, compare the problems learnt in class rooms and to find out practical solutions for the same from beneficiaries or / in natural environment
3. To improved critical thinking, strong reasoning, analytical skills .
4. To make the students aware of rights and responsibilities.
5. To achieve btter communication skill and high adaptability towards various career transitions.

COURSE OUTCOMES (COs)

On completion of the Field work,

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. Students Will find enrichment in the concepts and facts learnt in class by comparing information and dataobtained from the real world.	*K2, K4, K5 &K6*
CO2. Students will be able to analyze, compare the problems learnt in class rooms and to find out practical solutions for the same from beneficiaries or / in natural environment	*K3, K4, K5 &K6*
CO3. Students will have improved critical thinking, strong reasoning, analytical skills .	*K1, K4, K5 &K6*
CO4. Students will be made aware of rights and responsibilities.	*K2, K3, K5 &K6*
CO5.Students and staff will enjoy better	*K1, K-2,-K3 K5 &K6*

communication skill and high adaptability towards various career transitions.	

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For students, field work studies create opportunities for first-hand experiences that encourage critical thinking, long-term retention, transfer potential, positive attitudes towards science, appreciation for nature, and increased scientific curiosity. Cognitive development and motivation are also enhanced when students are active participants in the planning of the field study and in the activity itself. To enjoy the above benefits by students, Field work has been introduced in the First semester with 2 credits (3 Hours / Cycle) to address microbes based problems and solution in the local area.

Evaluation

Student shall submit their report (Minimum of 5 pages focusing field work, excluding front page, declaration, certificate etc.,).

The evaluation will be done at the end of the first semester by both external and internal examiners for a maximum marks of 25.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	3	3	2	2	3	3	3	1	3	3
CO2	3	2	2	2	3	3	3	2	3	3
CO3	3	2	2	2	3	3	3	1	3	3

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **I Semester** **Practical – I** **Credits 3**

PRACTICAL - I Lab in General Microbiology and Diversity	**SUB CODE:ZMBL11**

COURSE OBJECTIVES:

1. *To make the students aware of basic laboratory rules and regulations and ethics and the fundamental instruments used in microbiology labs*
2. *To carryout sterilization methods effectively*
3. *To perform microscopic,staining and wet mount studies*
4. *To prepare different types of media., sterilize and maintain*
5. *To inculcate the skills of microbial isolation, culture preservation and maintenance methods*
6. *To enrich the studied concepts by undertaking a Practical Course Project / Practical Course Field Work*

COURSE OUTCOMES (COS): ON COMPLETION OF THE FIELD WORK, STUDENTS WILL BEA ABLE TO

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. make the students aware of basic laboratory rules and regulations and ethics and the fundamental instruments used in microbiology labs	K-2, K-3,K-4 K-2, K-3,K-4, K-5
CO2. carryout sterilization methods effectively	K-2, K-3,K-4, K-5
CO3. perform microscopic,staining and wet mount studies	K-2, K-3,K-4, K-5
CO4. prepare different types of media., sterilize and maintain	K-2, K-3,K-4, K-5
CO5. inculcate the skills of microbial isolation, culture preservation and maintenance methods	*K1--K6*
CO6. enrich the studied concepts by undertaking a Practical Course Project / Practical Course Field Work	

L T P C

0 06 3

1. Laboratory precautions
2. Washing and cleaning of glasswares

3. Biological safety cabinets
4. Light microscopy
5. Wet mount technique
6. Hanging drop technique
7. Sterilization - principles and methods
    a. Moist heat
    b. Dry heat
    c. Filtration
8. Fumigation
9. Smear preparation
10. Counting bacterial / yeast cells using Haemocytometer
11. Simple staining
12. Negative staining
13. Gram's staining
14. Acid-fast staining (Ziehl-Neelson method)
15. Spore staining (Schaffer-Fulton method)
16. Capsule staining
17. Flagella staining
18. Preparation of liquid, solid and semi-solid media
19. Preparation of agar deeps, agar slants and agar plates
20. Preparation of basal, enriched, selective and enrichment media
21. Serial dilution technique
22. Plating techniques – pour plate and spread plate
23. Enumeration of bacteria – Soil and water samples
24. Cultural characteristics of microorganisms
25. Culture transfer techniques
26. Techniques of isolation of pure cultures – Streak plate method
27. Morphology of molds – Lactophenol cotton blue staining
28. Fungal slide culture technique

29. Submission of Practical Course Project (PCP)/ Practical Field Work Report (PCFW)

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (1996). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palan Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sunciararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4th edition). Butterwoths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology .Elseiver, Amsterdam
13. S.Rajan. (2012): Experimental Procedures in Life Sciences. Anjanaa Book House, Chennai 600107.

WEB RESOURCES

1. https://microbiologyinfo.com
2. https://microbenotes.com
3. https://www.onlinebiologynotes.com
4. http://universe84a.com
5. https://laboratoryinfo.com
6. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	3	3	2	2	3	3	3	1	3	3
CO2	3	2	2	2	3	3	3	2	3	3

CO3	3	2	2	2	3	3	3	1	3	3
CO4	3	3	2	2	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **I Semester** **Practical - II** **Credits 3**

PRACTICAL – II Lab in Biochemistry, Physiology and biochemical techniques and Instrumentation	**SUB CODE: ZMBL12**

COGNITIVE LEVELS:
K- 1 Knowledge, comprehension K-2 Application K -3 Analysis, synthesis, evaluation

COURSE OBJECTIVES

1. *To make the students aware of anaerobes cultivation*
2. *To inculcate the skills in students over physiological grouping of bacteria*
3. *To make the students to prepare buffers and its effective utilization*
4. *To make the students get acquainted with commonly practiced clinical tests and their reference values*
5. *To provide opportunities to visit scientifically significant locations to learn the skills, reliability and effectiveness needed for effective research and employment.*
6. *To enrich the studied concepts by undertaking a Practical Course Project / Practical Course Field Work*

COURSE OUTCOMES (COs), On completion of the Field work,

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. Students Will find enrichment in the concepts and facts learnt in class by comparing information and dataobtained from the real world.	K-1, K-3,K-4
CO2. Students will be able to analyze, compare the problems learnt in class rooms and to find out practical solutions for the same from beneficiaries or / in natural environment	K-2, K-3,K-4, K-6
CO3. Students will have improved critical thinking,	K-2, K-3,K-4, K-5

strong reasoning, analytical skills . CO4. Students will be made aware of rights and responsibilities. CO5.Students and staff will enjoy better communication skill and high adaptability towards various career transitions. CO6. To enrich the studied concepts by undertaking a Practical Course Project / Practical Course Field Work	K-2, K-3,K-4, K-5 K-2, K-3,K-4, K-5 *K1--K6*

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1. Cultivation of anaerobic microorganisms – Pyrogallol method &anaerobic jar.
2. Extracellular enzymatic activities of microorganisms (Utilization of gelatin, starch, casein and lipid).
3. Carbohydrate fermentation (Any one carbohydratesource)
4. Triple sugar iron test
5. IMVIC tests
6. H_2S test
7. Urease test
8. Nitrate reduction test
9. Catalase test
10. Oxidase test
11. Growth curve (turbidity method)
12. Total Erythrocyte Count
13. Total Leucocyte Count
14. Total Platelet Count
15. Haemoglobin estimation
16. Erythrocyte Sedimentation Rate (ESR)

17. Serum Cholesterol analysis (DEMO)
18. Estimation of urine albumin
19. Estimation of urine bile salts
20. Estimation of urine sugar
21. Reference values of biochemical tests
22. Preparation of buffers
23. Calibration of pH meter
24. Verification of Beer- Lambert's law (Colorimetry and Spectrophotometry)
25. Preparation of standard graph – Widely used Methods (Protein, DNA, RNA and Carbohydrates)
26. Separation of amino acids by paper chromatography
27. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (1996). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palan Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sunciararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4th edition). Butterwoths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.

12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology .Elseiver, Amsterdam
13. S.Rajan. (2012): Experimental Procedures in Life Sciences. Anjanaa Book House, Chennai 600107.

WEB RESOURCES

1. https://microbiologyinfo.com
2. https://microbenotes.com
3. https://www.onlinebiologynotes.com
4. http://universe84a.com
5. https://laboratoryinfo.com
6. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	2	2	2	3	3	3	1	3	3
CO3	3	2	2	2	3	3	3	1	3	3
CO4	3	3	2	2	3	3	3	1	3	3
CO5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

II Semester **4 Core – Theory** **Credits 4**

First Year

MOLECULAR BIOLOGY & GENETICS	**SUB CODE:**

COURSE OBJECTIVES:

1. *To make the students understand about the historical background and evidences to consider DNA as the genetic material*
2. *To inculcate a strong idea over DNA – A central Dogma of Cell and its related concepts.*
3. *To strengthen the knowledge of students on the molecular aspects of genetic materials*
4. *To enhance the understandability of students over gene expression and regulation mechanisms*
5. *To increase the passion of students over molecular biology research by teaching them about molecular techniques*
6. *To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs), ON COMPLETION OF THE COURSE,

COURSE OUTCOMES	**COGNITIVE LEVELS**
CO1: Students will have good clarity on the historical background and evidences to considerDNA as the genetic material	*K-1, K-2 & K-5*
CO2: Students will be made familiar about DNA as	

central dogma and its related concepts.	*K-1, K-2 & K-4*
CO3: Students will exhibit a strong knowledge on the molecular aspects of genetic materials	*K-1, K-2, K-3 & K-4*
CO4: Students will have a better understanding over gene expression and regulatory mechanisms	*K-1, K-2, K-3 & K-4*
CO5: Students will have an increased passionover molecular biology research after better learning of molecular techniques	*K-1, K-2, K-3 & K-6*
CO6: To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K1-K-6*

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Unit - I: DNA replication and repair

Identification of genetic material (Griffith, Avery and Hershey and Chase experiments). DNA replication - Meselson – Stahl experiment , Molecular mechanisms of DNA Replication – bidirectional and rolling circle replications. Differences in prokaryotic and eukaryotic replication. Plasmids – types, structure and replication. DNA repair – mechanism of excision repair, SOS repair, mismatch repair and photoreactivation. (14L)

Unit – II: Transcription and translation

Process of transcription – initiation, elongation – termination. Synthesis of mRNA in prokaryotes and eukaryotes. Synthesis of rRNA and tRNA. RNA processing – capping and polyadenylation. Genetic code, process of translation – initiation, elongation and termination. Signal sequences and protein transport. (12L)

Unit – III: Concept of Gene & Gene regulation

Organization of Gene in Prokaryotes and Eukaryotes - Introduction – Operon concept, *lac*,*trp* and *ara*operons, promoters and repressors. Regulation of gene expression – Transcriptional control – promoters, terminators, attenuators and antiterminators; Induction and repression; the *lac* operon – catabolite repression; Biosynthesis: *trp* operon – upstream activator sequences and enhancers, two component regulatory systems. Translational control – ribosome binding, codon usage, antisense RNA; post-transcriptional modifications – gene silencing – *RNAi*. (14L)

Unit - IV: Gene transfer mechanisms

Transformation – competence cells, regulation, general process; Transduction – general and specialized; Conjugation – *Hfr*, triparental mating, self transmissible and mobilizable plasmids, sex pili. (10L)

Unit – V: Transposable elements

Introduction - Discovery ofinsertion sequences, complex and compound transposons – T_{10}, T_5, and retroposon – Nomenclature- Insertion sequences – Mechanism – Transposons of *E.coli*, Bacteriophage and Yeast.

(10L)

TEXTBOOKS RECOMMENDED:

1. Watson, JD., Hopkins, N.H., Roberts J.W., Steitz J.A and Weiner, A.A.M. (1987). Molecular Biology of the gene. The Benjamin/Cummings Publishing Company.
2. Lewin, B. (2007). Genes IX Oxford University press, UK.
3. Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P., and Darnell, J. (1995). Molecular cell Biology. Scientific American Books.
4. Maloy, S.R., Cronan, Jr. J.E. and Freifelder, D. (1994). Microbial Genetics. Jones and Bartlett Publishers.
5. Freifelder, D. (1991). Molecular Biology. Narosa Publishing House.
6. Talaro, K.P. and Talaro, A (1999). Foundations in Microbiology. WCP McGraw – Hill, NewYork.
7. Jeyanthi, G.P. (2008). Molecular Biology. MJP Publishers, Chennai.

REFERENCES:

1. Friedberg EC, Walker GC, Siede W. (2005). DNA repair and mutagenesis. ASM press
2. James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann, Molecular Biology of the Gene, Fifth Edition
3. Rowland H. Davis, The Microbial Models of Molecular Biology: From Genes to Genomes.
4. Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002).
5. Modern Genetic Analysis, Integrating Genes and Genomes, 2nd edition, WH
6. Blackburn GM, Gait MJ. (1996). Nucleic acids in chemistry and biology. Oxford University press.
7. Malacinski GM and Freifelder D (1998) Essentials of Molecular Biology, 3rd edition, John and Bartlett Publishers.
8. Lewin B. (2018-2019). Genes XII. 12th Edition, Oxford University press
9. Maloy SR, Cronan Jr. JE, Freifelder D (1994). Microbial genetics. Jones and Bartlett publishers.
10. Singer M, Berg P. (1991). Genes and Genomes. University Science Books.
11. Stryer L. (2002). Biochemistry. 5th edition, W.H.Freeman and company.
12. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1998).
13. Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.
14. Eckstein F., and Lilley, D.M. (1992). Nucleic Acids and Molecular Biology – Springer – Verlag
15. Blackburn, C. M. and Gait M.J. (1996). Nucleic acids in HCemistry and biology – Oxford University Press.
16. Stryer L. (1995). Biochemistry, W.H. Freemand and Company.
17. Eckstein F, Lilley DM. (1996). Catalytic RNA – Springer – Verlag.
18. Frielderg EC, Walker GC, Siede W. (1995). DNA repair and mutagenesis, ASM Press
19. Gardner EJ, Simmons, MJ, Snustad DP (1991). Principles of Genetics. John Wiley and Sons, New York.
20. Singer M, Berg P. (1991). Genes and Genomes. University Science Books.

WEB RESOURCES

1. https://www.ndsu.edu/pubweb/~mcclean/plsc731/dna/dna3.htm

2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5474181/
3. https://www.atdbio.com/content/14/Transcription-Translation-and-Replication#:~:text=The%20process%20by%20which%20DNA,produce%20proteins%20is%20called%20translation.
4. https://www.shomusbiology.com/
5. https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookGENCTRL.html#:~:text=The%20operon%20model%20of%20prokaryotic,%2C%20regulator%2C%20and%20structural%20genes.
6. https://microbeonline.com/key-information-regarding-gene-transfer-mechanism-bacteria/
7. https://www.nature.com/scitable/topicpage/transposons-the-jumping-genes-518/#:~:text=Transposable%20elements%20(TEs)%2C%20also,Harbor%20Laboratory%20in%20New%20York.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	POs					PSOs				
	1	2	3	4	5	1	2	3	4	5

CO1	3	3	1	2	2	3	2	2	2	2
CO2	1	2	1	2	1	2	1	1	1	1
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	1	2	1	2	1	2	2	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **5 Core – Theory** **Credits 4**

IMMUNOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. *To make the students to understand the evolution of immune system and its components.*
2. *To teach very clearly about antigens, antibodies, and ag-ab reactions along with types of immune response*
3. *To increase the knowledge of students over hypersensitivity, tolerance, autoimmunity, immunosuppression and immunodeficiency diseases*
4. *To enlighten the knowledge of students over Monoclonal antibodies and their applications*
5. *To make students familiar about vaccinology and immunization schedule*
6. *To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs), ON COMPLETION OF THE COURSE, STUDENTS WILL BE ABLE TO

COURSE OUTCOMES	COGNITIVE LEVELS
1. Students will describe the evolution of immune system and components of immune system	*K-1, K-2, K-3 & K-6*
2. Students could illustrate antigens, antibodies, and ag-ab reactions in addition to immune response and its	*K-1, K-2 & K-5*

types **3. Students will have increased knowledge on hypersensitivity, tolerance, autoimmunity, immunosuppression and immunodeficiency diseases** **4. Students will be having elevated knowledge over Monoclonal antibodies and their applications** **5. Students will have a good idea over vaccinology and immunization schedule** **6. Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work**	*K-1, K-2 & K-4* *K-1, K-2, K-3 & K-4* *K-1, K-2, K-3 & K-4* *K-1- K-6*

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Unit: I

History and development of immunology - Phylogeny and ontogeny of immune systems. Immunity: Innate & Acquired. Infection. Pathogenicity. Virulence factors. Resistance. An over view on the cells of immune system. Phagocytosis. Inflammation. Organs & tissues of immune system. Clonal selection theory. Immune response: HIR & CMI. Cytokines.

(14 L)

Unit: II

Antigens and antibody – structure, types and functions. Antibody diversity: isotypes, allotypes and idiotypes. Biology of T & B cells. Major Histocompatibility Complex (MHC). Human Leucocyte Antigen (HLA). Complement pathways: classical, alternative &lectin.

(13 L)

Unit: III

Clinical immunology: serotyping. Agglutination. Precipitation. Complement fixation. Immunoblotting (Western blotting). Immunofluorescence. Immunodiffusion: SRID, ODD, RIEP &Immnoelectrophoresis. Flow cytometry. Radioimmune assay.

(13 L)

Unit: IV

Applied Immunology - Hypersensitivity - immediate & delayed type. Autoimmunity. Transplantation immunology. Tumor immunology. Immunological tolerance. Immnosuppression. Immuno deficiency diseases.

(10 L)

Unit: V

Monoclonal antibody: production & applications. Vaccination: types, principle & applications. Current basic immunization schedule –Indradanush – Corona vaccines

(10 L)

TEXTBOOKS RECOMMENDED:

1. Donald M. Weir and John Sterward (1993). Immunology (7th editoin). ELBS, London.
2. Hue Davis (1997). Introductory Immunology (1st edition). Chapman and Hall Publisher, London.
3. Ivan M. Roit (1998). Essential Immunology – Blackwell Scientific Publishers, London.
4. Paul (1998). Fundamental Immunology, (2nd edition). Raver Press, New Yoek.
5. Peter J. Delves and Ivan M. Roit (Eds) (1998). Encyclopedia of immunology – (2nd edition). Academic Press.
6. Ridklad, M. Aydl (1995). Immunology, (2nd edition), Baltimore, Hong Kong, NMS Publication.
7. Roit, J.M., Brostaff, J.J and male, D.K. (1996). Imunology (4th edition). C.V. Mosby Publisher, St. Loius.
8. Stewart Sell (2001). Immunology, immunopathology and immunity. (6th edition). ASM Press, USA.
9. Ajnanthanarayanan, R. and Panicxker, J. (2000). Textbook of Microbiology, orient Longmans.
10. Rajan, S. (2007). Medical microbiology, MJP Publishers, Chennai.
11. Fathimunisa Begum (2008). Monoclonal antibodies: The hopeful drugs. MJP Publishers, Chennai.
12. Kannan, I. (2007). Immunology. MJP Publishers, Chennai.

REFERENCES:

1. Stefan, H. and Kaufmann, E. (2002). Immunology of infectious diseases. ASM Press, USA.
2. Abbas, A.K., Lichtman, A.H. and Pober, J.S. (1994). Cellular and Molecular Immunology. (2nd edition). WB Saunders, USA.
3. Humphrey, J.H, and Wite, R.G. (1995). Immunology for students of Medicine, (5th edition) ELBS, London.
4. Weir, D.M. (1995). Experimental Techniques in Immunology. Blackwell Scientific Publishers, London.

WEB RESOURCES

1. https://www.shomusbiology.com/
2. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/11%3A_Immunology/11.01%3A_Overview_of_Immunity/11.1A%3A_Cells_and_Organs_of_the_Immune_System
3. https://www.immunology.org/public-information/bitesized-immunology/cells/helper-and-cytotoxic-t-cells#:~:text=There%20are%20two%20major%20types,virally%20infected%20cells%20and%20tumours.
4. https://primaryimmune.org/immune-system-and-primary-immunodeficiency
5. https://teachmephysiology.com/immune-system/immune-responses/hypersensitivity-reactions/#:~:text=Hypersensitivity%20reactions%20are%20an%20overreaction,may%20originate%20from%20the%20body.
6. https://www.immunology.org/public-information/bitesized-immunology/immune-dysfunction/autoimmunity-introduction
7. https://microbeonline.com/monoclonal-antibodies-types-and-applications/
8. http://www.nrhmhp.gov.in/content/immunisation

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze

K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	3	3	1	2	2	3	2	2	2	2
CO2	1	2	1	2	1	2	1	1	1	1
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	1	2	1	2	1	2	2	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **6 Core – Theory** **Credits 4**

VIROLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To teach the students about the history and detailed classification of viruses*
2. *To increase the knowledge of students over the morphology and genetics of viruses*
3. *To make the students aware of bacterial, plant and animal viruses*
4. *To introduce and strengthen the knowledge of students on special viruses*
5. *To elevate the passion of students over research in virology*
7. *To Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

COURSE OUTCOMES (COs), ON COMPLETION OF THE COURSE, STUDENTS WILL BE ABLE TO

COURSE OUTCOMES	COGNITIVE LEVELS

CO1: Students will have a clear vision over history and classification of viruses	*K-1, K-2 & K-4*
CO2: Students will have a good knowledge over the morphology and genetics of viruses	*K-1, K-2, K-3 & K-6*
CO3: Students will be aware of bacterial, plant and animal viruses	*K-1, K-2 & K-5*
CO4: Students will have an idea over special viruses	*K-1, K-2, K-3 & K-5*
CO5: Students will have enriched passionover research in virology	*K-1, K-2, K-3 & K-4*
CO6: Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K1-K6*

L T P C

4 0 0 4

Unit: I

Brief outline of virology: Discovery of virus; early development of virology – nomenclature – classificationand taxonomy of viruses - based on host, nucleic acids and structure; Evolution ofViruses.

(10L)

Unit: II

Bacterial viruses: ØX 174; T_4 ; M $_{13}$; Lambda and Mu; P_1 phages. Structuralorganization – lifecycle :lyitc and lysogenic - transcription - DNA replication and phage production - genetics of each phage.

(10L)

Unit: III

Plant viruses: TMV - general characters – morphology – structure – replication - RNA as theinitiator of infection; Cauliflower Mosaic Virus - a brief account. Transmission ofplant viruses - transmission by vectors - transmission without vectors. Commonviral diseases of crop plants - names of diseases, pathogens and symptoms, treatment, prevention and control -paddy, cotton, tomato and sugar cane.

(15L)

Unit: IV

Animal viruses: General characters, chemical and physical nature, life cycle, epidemiology,pathogenicity, disease caused and immunologic response of the following viruses:Myxo virus: Orthomyxo virus, Paramyxo virus; Herpes virus - HSV_1&HSV_2 ; Adenovirus and Adeno Associated Viruses;Tumour viruses of human- Corona and its related viruses

(15L)

Unit: V

Other viral types: Brief account of Cyanophages – mycophycophages – Insect viruses. Viroids,prions, satellite RNAs and virusoids. Antiviral agents and vaccines – differenttypes.

(10 L)

REFERENCES:

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2. Dimmock NJ, Primrose SB. (1994) Introduction to Modern Virology IV edition. Blackwell Scientific Publications, Oxford
3. Flint SJ, Enquist LW, King RM, Racaniell VR and Shalka AM (2000). Principles of Virology - Molecular Biology, pathogenesis and control, ASM Press, Washington DC.
4. Khan J.A, J.Dijkstra. Plant viruses as molecular pathogens. 2000. CBS publishers and Distributors. New Delhi
5. Maloy SR, Cronan Jr. JE, Freifelder D. (1994). Microbial genetics. Jones and Bartlett publishers.
6. Robert G. Welstar and Allan Garnoll. Encyclopaedia of Virology (1994). Vol I, II & III Academic Press inc. San Diego, CA 92101. Ed.
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8. Topley& Wilson's. (1990) Principles of Bacteriology, Virology and Immunity VIII edition Vol. IV Virology, Edward Arnold, London.
9. Alan, J. Cann. (1997). Principles of Molecular Virology. (2nd edition). Academic Press, California.
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12. Dimmock, N.J. and Primrose, S.B. (1994). Introduction to modern Virology. (4th edition). Blackwell Scientific Publications, Oxford.
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14. Maloy, S.R., Cronan, Jr. J.E. and Freifelder, D. (1994). Microbial Genetics. Jones and Bartlett Publishers.
15. Nicklin, J. Greame-Cook and Killington, R. (2003). Instant notes in Microbiology. (2nd edition). Viva Books Private Limited, New Delhi.
16. Robert. I. Krasner. (2002). The Microbial Challenge: Human Microbe Interactions. ASM Press, Washington.
17. Roger Hull (2002). Mathew's Plant Virology. (4th edition). Academic press. A Harcourt Science and Technology company, New York.
18. Tom parker, Leslie M. and Collie H. (1990). Topley and Wilson's principles of Bacteriology, Virology and Immunity (8th edition).
19. Bernard D. Davis., Renato Dulbecco., Herman N. Elsen and Harold S. Ginsberg. (1990). Microbiology (4th edition). J.B. Lippincott Company, New York.

20. Prescott L.M., Harley J.P. and Klein D.A. (2008). Microbiology (7th edition). McGraw Hill, New York.
21. Larry McKane and Judy Kandel (1996). Microbiology essentials and applications. (2nd edition). McGraw Hill, New York.
22. Madigan M.T., Martinko, J. IVI and parker J. Brock T.D. (1997). Biology of microorganisms. (8th edition. Prentice hall international Inc, London.
23. Nester, E.W., Roberts, C.V., and Nester, M.Y. (1995). Microbiology. A Human perspective. IWOA, USA.
24. P.Saravanan. (2006). Virology, MJP Publishers, Chennai.
25. Luria, S.E. and Darnel, J.E. Jr., Baltimore, D. amdCampbelll, A. (1978). General Virology, (3rd edition). John Wiley and Sons, New York.
26. Dimmock- Virology
27. Rhodes and Van Royen – Text book of Virology
28. Biswas and Biswas – An Introduction to Viruses
29. AnanthRai – Animal viruses.
30. Green wood – Textbook of Virology.

WEB RESOURCES

1. https://www.sciencedirect.com/topics/immunology-and-microbiology/history-of-virology
1. https://courses.lumenlearning.com/boundless-biology/chapter/viral-evolution-morphology-and-classification/#:~:text=Viruses%20are%20classified%20into%20four,their%20replication%20inside%20the%20cell.
2. https://www.nature.com/scitable/definition/bacteriophage-phage-293/#:~:text=A%20bacteriophage%20is%20a%20type,surrounded%20by%20a%20protein%20structure.
3. https://en.wikipedia.org/wiki/Plant_virus
4. https://en.wikipedia.org/wiki/Animal_virus#:~:text=Examples%20include%2C%20rabies%2C%20yellow%20fever,and%2Dmouth%20disease%20and%20bluetongue.
5. https://en.wikipedia.org/wiki/Cyanophage#:~:text=Cyanophages%20are%20first%20reported%20by,are%20called%20Mycoviruses%20or%20Mycophages.
6. https://en.wikipedia.org/wiki/Mycobacteriophage
7. https://en.wikipedia.org/wiki/Antiviral_drug#:~:text=Antiviral%20drugs%20are%20a%20clas
8. s,instead%20they%20inhibit%20its%20development.

Cognitive level	Content
K-1	Remember
K-2	Understand

K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	3	2	1	2	2	3	2	2	2	2
CO2	1	2	1	2	1	2	1	1	1	1
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	1	2	1	2	2	2	3	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **2 Elective - Theory** **Credits 3**

BIODEGRADATION AND BIOREMEDIATION	**SUB CODE:**

COGNITIVE LEVELS:

K- 1 Knowledge, comprehension K-2 Application K -3 Analysis, synthesis, evaluation

COURSE OBJECTIVES

1. *To infuse the role of microbes in creating sustainable environment*
2. *To strengthen the knowledge of students over the biodegradativeroles of microbes in ecology*
3. *To give a better picture regarding the friendliness of microbial process in the ecosystem*

4. *To make the students aware of the microbes associated with degradation of complex materials*
5. *To make the students to improve their thinking process to use microbial resources effectively for the problems into prosperity*
6. *To Enrich the studied concepts by undertaking a Elective Course Project / Elective Course Field Work*

COURSE OUTCOMES (COs), ON COMPLETION OF THE COURSE,

COURSE OUTCOMES	COGNITIVE LEVELS
Students will be taught about the roles of microbes in creating sustainable environment	*K-1, K-2, K-3 & K-4*
CO2: Students will have strong knowledge over the negative roles of microbes in ecology	*K-1, K-2, K-3 & K-5*
CO3: Students will be more focused on the friendliness of microbial process in the ecosystem	*K-1, K-2, K-4 & K-6*
C04: Students will be aware of the microbes associated with degradation of complex materials	*K-1, K-2 & K-5*
CO5: Students will be in a position to use microbial resources effectively for the conversion of problems into prosperity	*K-1, K-2, K-3 & K-4*
CO6: To Enrich the studied concepts by undertaking a Elective Course Project / Elective Course Field Work	*K1-K6*

L T P C

3 0 0 3

Unit: I

Biodegradation and heterotrophic microbial population in aquatic, terrestrial and arid ecosystems – Degradation of natural polymers (Cellulose, lignin and hemicellulose).

(10 L)

Unit: II

Microbial degradation of paper, paints, metals, textiles and leather goods – Biodegradation enhancement – Stimulation of Oil spills for degradation – Surface and sub-surface degradation.

(10L)

Unit: III

Bioleaching – Recovery of metals from ores – oxidation of minerals – testing for biodegradability – Biomagnifications – Removal of heavy metals and

radionucleoidefrom effluents – Precipitation of metal sulfides.

(12L)

Unit: IV

Bioremediation – Case histories – Constraints and priorities – Types of bioremediation – *insitu* bioremediation, *exsitu* bioremediation – Bioaugumentation – Bioreactors for bioremediation process.

(14L)

Unit: V

Biodegradation of xenobiotic compounds: organic contaminants: Hydrocarbons, halogenated organic solvents, herbicides, pesticides – Treatment of solid and liquid wastes – Vermicompoosting – Aiming for eco-friendly biodegaradable products – Bioplastics.

(14L)

TEXTBOOKS RECOMMENDED:

1. Baker, W.C. and Herson, D. S. (1994). Bioremediation. McGraw Hill Inc., New York.
2. Rajendran, P. and Gunasekharan, P. (2000). Microbial bioremediation. MJP Publishers, Chennai.
3. Alexander, M. (1999). Biodegradation and Bioremediation. Academic Press.
4. Foster, C.F. and John Ware, D.A. (1987). Environmental biotechnology. Ellis Horwood Ltd.
5. Karrely, D., Chakrabarty, K. and Omen, G.S. (1989). Biotechnology and Biodegradation – Advances in Applied Biotechnology Series. Vol. IV, Gulf Publications Co. London.
6. Cookson, J.T. (1995). Bioremediation Engineering – Design and Application, McGraw Hill Inc.
7. Jogdand, S.N. (2007). Environmental Biotechnology. Himalaya Publishing Company Ltd.
8. Rittman, B. McCarty, p. (2000). Environmental Biotechnology; principles and Applications. McGraw Hill College.

9. Eweis, J.B. (Editor). Schroeder, E.D., Ergc; 1s-S.J., Chang, D.P.Y. (1998). Bioremediation principles. McGraw Hill College.
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11. Glick, B.R. and Pasternak, J.J. (2003). Molecular Biotechnology. Pamima Publishers.
12. Prescott, L.M., Harley, J.P. and Klein, D.A. (2008). Microbiology (7th edition) McGraw Hill, New York
13. Larry Mc Kane and Judy Kandel (1996). Microbiology – Essentials and Applications. (2nd edition). McGraw Hill Inc., New York.
14. Madigan, M.T. Martinko, J.M. and Parker, J., Brock TO. (1997). Biology of Microorganisms. (8th edition). Prentice Hall InternationslInc, London.
15. Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology – A Human perspective. IWOA, USA.
16. Salle, A.J. (1996). Fundamental Principles of Bacteriology. (7th edition). Tata McGraw-Hill Publishing Company Ltd., New Delhi.
17. PelczarJr.,M.J., Chan E.C.S. and Kreig, N.R. (1993). Microbiology. McGraw Hill Inc., New York.
18. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. amd Painter, P.R. (1986). General Microbiology. MacMillan Education Ltd., London.
19. Subramanian, M.A. (2004). Toxicology (Principles and Methods). MJP Publishers, Chennai.

WEB RESOURCES

1. https://en.wikipedia.org/wiki/Biodegradation
2. https://www.sciencedirect.com/topics/chemistry/biodegradation
3. https://www.onlinebiologynotes.com/bioremediation-concept-types-advantages-and-limitations/
4. https://www.angloamerican.com/futuresmart/stories/our-industry/mining-explained/mining-terms-explained-a-to-z/bioleaching-definition-and-process#:~:text=Bioleaching%20(or%20biomining)%20is%20a,such%20as%20bacteria%20or%20archaea.
5. https://www.researchgate.net/publication/279568331_Biodegradation_of_paints_A_current_status#:~:text=Paint%20and%20painting%20has%20been%20practiced%20since%20ancient%20times.&text=Various%20types%20of%20organisms%20are,overall%20rate%20of%20paint%20biodegradation.
6. https://www.intechopen.com/books/trace-metals-in-the-environment-new-approaches-and-recent-advances/bioremediation-techniques-for-polluted-environment-concept-advantages-limitations-and-prospects
7. https://link.springer.com/chapter/10.1007/978-3-319-47744-2_21
8. https://www.youtube.com/watch?v=eO4O5freA2U
9. https://www.ercofusa.com/blog/7-common-liquid-waste-disposal-methods/
10. https://www.sciencedirect.com/topics/engineering/bioplastics

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	2	3	1	2	2	3	2	2	2	2
CO2	2	2	1	2	1	2	1	1	1	1
CO3	1	2	1	2	1	2	2	2	2	2
CO4	2	3	1	2	1	2	2	3	2	3
CO5	2	2	1	2	2	2	3	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **I Semester** **1 Internship** **Credits 2**

INTERNSHIP	**SUB CODE:**

COURSE OBJECTIVES

1. *To explore career path and gain valuable experience*

2. *To develop and refine skills in students*
3. *To help students to gain confidence and acquire real time job experience*
4. *To provide space for developing the art of networking with professionals in the field.*
5. *To make them to realize their self edge in the market / self employment sectors*

COURSE OUTCOMES (COs), ON COMPLETION OF THE INTERNSHIP,

COURSE OUTCOMES	COGNITIVE LEVELS
1. **Students will get explored about career path and gain valuable experience**	*K-1 –K6*
2. **Students will develop and refined skills.**	*K-1 –K6*
3. **Students will gain confidence and acquire real time job experience**	*K-1 –K6*
4. **Students will learn the art of networking with professionals in the field.**	*K-1 –K6*
5. **It will be an opportunity to have self analysis about their potential required to be employed and to emerge as an entrepreneur.**	*K-1 –K6*

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For students, field work studies create opportunities for first-hand experiences that encourage critical thinking, long-term retention, transfer potential, positive attitudes towards science, appreciation for nature, and increased scientific curiosity. Cognitive development and motivation are also enhanced when students are active participants in the planning of the field study and in the activity itself. To enjoy the above benefits by students, Field work has been introduced in the First semester with 2 credits (3 Hours / Cycle) to address microbes based problems and solution in the local area.

Evaluation

Student shall submit their report (Minimum of 5 pages focusing field work, excluding front page, declaration, certificate etc.,).

The evaluation will be done at the end of the first semester by both external and internal examiners for a maximum marks of 25.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	3	2	2	2	3	3	3	1	3	3
CO2	2	3	2	2	3	3	3	2	3	3
CO3	2	3	2	2	3	3	3	2	3	3
CO4	3	2	2	2	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	2	3	2

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **Practical - III** **Credits 4**

PRACTICAL – III Lab in Molecular biology and Immunology	**SUB CODE:**

COGNITIVE LEVELS:

K- 1 Knowledge, comprehension K-2 Application K -3 Analysis, synthesis, evaluation

COURSE OBJECTIVES

1. *To isolate genetic materials from different microbial sources*
2. *To understand the effect of mutagens*
3. *To expose students about techniques in microbial genetics*
4. *To make the students aware of immunological techniques*
5. *To teach qualitative and quantitative analysis of proteins.*
6. *To Enrich the studied concepts by undertaking a Practical Project / Practical Field Work*

COURSE OUTCOMES (COs), On completion of the Practicals, Students will be able to

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. To isolate genetic materials from different microbial sources	K-2,K-3,K-4,K-5,K-6
CO2. To understand the effect of mutagens	K-1,K-2,K-4,K-5,K-6
CO3. To expose students about techniques in microbial genetics	K-2,K-3,K-4 & K-5
CO4. To make the students aware of immunological techniques	K-2,K-3,K-4,K-5,K-6
CO5. To teach qualitative and quantitative analysis of proteins.	K-2,K-3,K-4 & K-5
CO6. To enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work	K-1 -K-6

L T P C

0 06 3

1. Isolation of chromosomal DNA
2. Isolation of bacterial plasmids
3. Induced mutagenesis – UV and NTG
4. Spontaneous mutation
5. Agarose gel electrophoresis – plasmid and DNA samples
6. SDS-PAGE – Demonstration
7. Transformation in *E.coli.*
8. Conjugation in *E.coli* – Uninterrupted and interrupted
9. Isolation of auxotrophic mutants.
10. Checking for antibiotic markers.

11. Collection of venous blood from human and separation and preservation of serum / plasma
12. Blood grouping
13. Latex agglutination tests: CRP, RA, ASO and VDRL
14. Widal (Qualitative and Quantitative)
15. Precipitation reactions – SRID, DID, Rocket electrophoresis and immunoelectrophoresis and staining of precipitin lines (DEMO).
16. ELISA technique – (DEMO)
17. Skin test – Mantoux test - (DEMO)
18. Western Blot - (DEMO)
19. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (196). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palan Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sundararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4tyh edition). Butterwoths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology. Elseiver, Amsterdam

WEB RESOURCES

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BI501%20Advanced%20Biochemistry%20and%20Immunology.pdf
2. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/GeneticEngineeringLaboratorymanual.pdf
3. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf
4. https://vlab.amrita.edu
5. https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf
6. https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf
7. https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	2	2	2	3	3	3	1	3	3
CO3	3	2	2	2	3	3	3	1	3	3
CO4	3	3	2	2	3	3	3	1	3	3
CO5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **Practical - IV** **Credits 3**

PRACTICAL – IV: LAB IN VIROLOGY AND BIODEGRADATION	**SUB CODE:**

COGNITIVE LEVELS:
K- 1 Knowledge, comprehension K-2 ApplicationK -3 Analysis, synthesis, evaluation

COURSE OBJECTIVES

1. *To develop skills for carrying out techniques in virology*
2. *To train students in microbe based bio-remedial techniques*
3. *To develop entrepreneurial skill in in ecofriendly techniques like vermitechnology and mushroom production for effective solid waste management*
4. *To enhance the knowledge on practical applications of solid state fermentation technique*
5. *To get associated with immobilization technique*
6. *To Enrich the studied concepts by undertaking a Practical Course Project / Practical Coure Field Work*

COURSE OUTCOMES (COs), On completion of the Practicals, Students will be able to

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. To develop skills for carrying out techniques in virology	K-1,K-2,K-4,K-5,K-6
CO2. To train students in microbe based bio-remedial techniques	K-2,K-3,K-4 & K-5
CO3. To develop entrepreneurial skill in in ecofriendly techniques like vermitechnology and mushroom production for effective solid waste management	K-2,K-3,K-4 & K-5
CO4. To enhance the knowledge on practical applications of solid state fermentation technique	K-2,K-3,K-4,K-5,K-6
*CO5. To get associated with immobilization technique*CO6.	K-2,K-3,K-4 & K-5
CO6. To enrich the studied concepts by undertaking a Practical Course Project / Practical Course Field Work	K-1 -K-6

L T P C

0 06 3

1. Cultivation of virus – Embryonated egg method (DEMO)

2. Isolation of bacteriophage from sewage.
3. Phage titration
4. Preparation of virus stocks (DEMO)
5. Study of virus infected plant specimens -(DEMO).
6. Isolation and purification of degradative plasmid of microbes growing in pollutedenvironments.(DEMO)
7. Recovery of toxic metal ions from an industrial effluent by immobilized cells.
8. Utilization of biomass by Solid State Fermenation (SSF) for the production of valuable products. (Enzyme Production - DEMO).
9. Mushroom production
10. Vermicomposting
11. Bioremediation – Treatment of dye by immobilization

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (196). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palan Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sundararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
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11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology. Elseiver, Amsterdam

WEB RESOURCES

1. http://www.ndvsu.org/images/StudyMaterials/Micro/Exercise-4-Micro.pdf
2. https://www.asmscience.org/docserver/fulltext/10.1128/9781555815974/9781555814625_FM.pdf?expires=1624436187&id=id&accname=guest&checksum=7B63E33525150AC808AFD5B2102A757B
3. https://microbiologyinfo.com
4. https://user.eng.umd.edu/~nsw/ench485/lab11.htm

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	2	2	2	3	3	3	1	3	3
CO3	3	2	2	2	3	3	3	1	3	3
CO4	3	3	2	2	3	3	3	1	3	3
CO5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

First Year **II Semester** **1 Iternship** **Credits 2**

INTERNSHIP	**SUB CODE:**

COURSE OBJECTIVES

1. To enrich the concepts and facts learnt in class by comparing information and dataobtained from the real world.
2. To make the students to analyze, compare the problems learnt in class rooms and to find out practical solutions for the same from beneficiaries or / in natural environment
3. To improved critical thinking, strong reasoning, analytical skills .
4. To make the students aware of rights and responsibilities.
5. To achieve btter communication skill and high adaptability towards various career transitions.

COURSE OUTCOMES (COs)

On completion of the Field work,

COURSE OUTCOMES	COGNITIVE LEVELS
CO1. Students Will find enrichment in the concepts and facts learnt in class by comparing information and dataobtained from the real world.	*K1, K-2,-K3 K5 &K6*
CO2. Students will be able to analyze, compare the problems learnt in class rooms and to find out practical solutions for the same from beneficiaries or / in natural environment	*K3, K4, K5 &K6*
CO3. Students will have improved critical thinking, strong reasoning, analytical skills .	*K2, K4, K5 &K6*
CO4. Students will be made aware of rights and responsibilities.	*K1, K4, K5 &K6*
CO5.Students and staff will enjoy better communication skill and high adaptability towards various career transitions.	*K2, K3, K5 &K6*

L T P C

0 0 3 2

For students, field work studies create opportunities for first-hand experiences that encourage critical thinking, long-term retention, transfer potential, positive attitudes towards science, appreciation for nature, and increased scientific curiosity. Cognitive development and motivation are also enhanced when students are active participants in the planning of the field study and in the activity itself. To enjoy the above benefits by students, Field work has been introduced in the First semester with 2 credits (3 Hours / Cycle) to address microbes based problems and solution in the local area.

Evaluation

Student shall submit their report (Minimum of 5 pages focusing field work, excluding front page, declaration, certificate etc.,).

The evaluation will be done at the end of the first semester by both external and internal examiners for a maximum marks of 25.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

Cos	Pos					PSOs				
	1	2	3	4	5	1	2	3	4	5
CO1	1	2	3	4	5	1	2	3	4	5
CO2	3	3	2	2	3	3	3	1	3	3
CO3	3	2	2	2	3	3	3	2	3	3
CO4	3	2	2	2	3	3	3	1	3	3
CO5	3	3	2	2	3	3	3	2	3	3

	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year III Semester 7 Core –Theory Credits 4

BIOINFORMATICS AND BIOSTATISTICS	**SUB CODE:**

COURSE OBJECTIVES:

1. *To comprehend the basics of computers, operation systems, search engines and data bases*
2. *To reinforce the knowledge over gene sequencing, analysis of data bases and phylogeny*
3. *To impart information on proteomics*
4. *To introduce the basic concepts of Biostatistics*
5. *To enrich the knowledge on different statistical tests commonly used*
6. *To Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work*

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		**Cognitive level**
CO1	*Recall the basics of computer plan with computational approach in biology. Demonstrate the biological databases and carry out to search the scientific articles*	*K-1 & K-2*
CO2	*Compile the genomic sequence and develop quires against the databases and construct the alignment of phylogenetic tree.*	*K-3 & K-6*
CO3	*Illustrate the structure of protein and the important biochemical databases. Describe the secondary and 3D structure predication and correlate its function.*	*K-2, K-3 & K-4*
CO4	*Carryout and cconstructthe methods of collecting data, sampling, Tabulating and graphical representations of data. and illustrate its significance in biological research*	*K-1, K-3 & K-4*
CO5	*Record and formulate inferential statistics. Design and assess thehypothesis test. Distinguish the errors in the experiments and calculate it precisely.*	*K-1, K-3& K 5*

L T P C

4 0 0 4

Unit: I

Biology in the computer age: Computational Approaches in Biology. Basics of computers – servers, workstations, operating systems, Unix, Linux. World Wide Web. Search engines, finding scientific articles – Pubmed – public biological databases.

(12 L)

Unit: II

Genomics Sequence analysis – Sequencing genomes – sequence assembly – pairwise sequence comparison – geneome on the web – annotating and analysing genome sequences. Genbank – sequence queries against biological databases – BLAST and FASTA – multifunctional tools for sequence analysis. Multiple sequence alignments, Phylogenetic alignment – profiles and motifs.

(14 L)

Unit: III

Proteomics Protein Data Bank, Swiss-prot – biochemical pathway databases – Predicting Protein structure and function from sequence – Determination of structure – feature detection – secondary structure prediction – predicting 3 D structure – protein modeling.

(12 L)

Unit: IV

Biostatistics Introduction – Population and sample – Variables – Collection and presentation of data – Descriptive statistics – Measures of Central tendency – mean (arithmetic, harmonic & geometric) median and mode – Measures of dispersion – range, mean deviation, variance & standard deviation, Skewness and Kurtosis.

(12 L)

Unit: V

Biostatistics Inferential statistics – Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test – Student's t-test – Correlation and Regression – ANOVA.

(10 L)

REFERENCES:

1. W.J. Ewens, Gregory Grant,(2005). Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology & Health), Springer
2. Bryan Bergeron,(2003).Bioinformatics Computing First Indian Edition, Prentice Hall,
3. Cynthia Gibas& Per Jambeck (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors (O'Reilly), Mumbai

4. HH Rashidi& LK Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London
5. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press
6. Baxevanis AD & Ouellette BEF (2001) Bioinformatics: A practical guide to the analysis of genes and proteins, Wiley Interscience – New York
7. Arora PN &Malhon PK (1996). Biostatistics Himalaya Publishing House, Mumbai.
8. Sokal&Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
9. Stanton A &Clantz, Primer of Biostatistics — The McGraw Hill Inc., New York.
10. Gurumani.N. (2006). Research Methodology for Biological Sciences. MJP Publishers, Chennai.

WEB RESOURCES

11. 1.nu.libguides.com/biostatistics
12. 2.https://newonline courses.sciences.psu.edu/

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	2	3	3	2	3	3
CO 2	3	2	2	2	2	3	3	2	3	3
CO 3	3	2	2	2	2	3	3	2	3	3
CO 4	3	3	2	2	2	3	3	2	3	3
CO 5	3	3	3	3	2	3	3	2	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year III Semester 8 Core –Theory Credits 4

MEDICAL AND PHARMACEUTICAL MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To impart basic knowledge on themost common infectious diseases and summarize the diagnostic methods from the clinical presentation.*
2. *To recognize and relate the microbes affecting nervous system and categorize the infectious agents into vector borne, protozoan and fungal infections.*
3. *.To impart information on the emerging viral threats including how infectious diseases are transmitted.*
4. *To critically analyze the rationaleof tests in pharma based products.*
5. *To provide outline on different pharma standards on diverse products used in the field of clinical sector.*
6. To enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work

Course Outcomes: By the completion of this course, students will be able to:

	Course Outcomes	**Cognitive level**
CO1	Represent the most common infectious diseases and summarize the diagnostic methods from the clinical presentation	*K-2*
CO2	Expertise the microbes affecting nervous systemand categorize the infectious agents into vector borne, protozoan and fungal infections. Created awareness on prevention of infectious diseases including infection control measure and vaccines	*K-4*
CO3	Familiarise the emerging viral infectious agents including how infectious diseases are transmitted. Compare and correlate different techniques used to diagnose and interpretation	*K-3& K-5*
CO4	Understood theproperties and use of antimicrobial agents and represent the mechanisms of antimicrobial action and resistance.	*K-1& K-2*
CO5	Demonstrated the basic concepts of different standards used in the field of clinical sectors and measure the sterility test.	*K-5*
CO6	Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K-1-K-6*

L T P C

4 0 0 4

Unit: I

Etiology, transmission, pathogenesis, clinical manifestation, lab diagnosis, chemotherapy and prophylaxis of respiratory tract infections :**upper respiratory tract infections** (*Streptococcal pharynghgitis*, Diphtheria) and **lower respiratory tract infections.** (Tuberculosis and bacterial pneumonia) – **Urinary tract infections** – **Sexually transmitted infections.** (Syphillis, Gonorrhea) – **Gastro intestinal infections** – (Bacteria-*Escherchia coli*, *Salmonella sp*, *Shigellasp*, *Vibrio sp*, Protozoan – *Enatamoebahistolytica*– Viral-Rotaviruses).

(15 L)

Unit: II

Studies on **central nervous system infections** (Bacterial: meningitis and tetanus ; **Viral infections** (Rabies, Poliomyelitis). **Skin infections** (Bacterial: PyogenicStaphylococcal and Streptococcal) – Mycobacterial disease (leprosy) – **Vector borne infections** (Ricketsial infections) – –**Fungal infections** (Dermatophytosis, Candidiasis) – **Protozoa infections** (Malaria)

(14 L)

Unit: III

Emerging infectious diseases: SARS – Avian – H1N1 influenza – Chikungunya, Dengue, Ebola – Zika –COVID-19 and its mutant strains – other recent diseases

(10 L)

Unit: IV

Pyrogentesting - Sterility and toxicity test – Antimicrobial testing (Kirby-Bauer method) – MIC and MBC – Types of disinfectants, antiseptics and sanitizers – Factors influencing the selection of drugs. (Dose, route, toxicity and combined therapy) – Drug resistance in microbes.

(11 L)

Unit: V

Standards of drugs: BP, EP, IP and USP – sterility testing of parental products (solid and liquid products) – Sterility testing of pharmaceutical products – Sterility testing of sterile surgical device, dressings absorbable, hemostats, surgical ligatures, suture and surgical catgut.

(10 L)

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4. Prescott L.M. Harley J.P., and Klein D.A (2008). Microbiology (7th Edition). McGraw Hill, New York.
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9. Salle, A.J. (1996). Fundamental Principles of Bacteriology. (7th Edition). Tata MoGraw Hill, Publishing Company Ltd, New Delhi.
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12. Starr, M.P., Stolp, H., Truper H.C., Ballows, A., and Schegel, H.C. (1991). The Prokaryotes. A Hand Book of Habits, Isolation and Identification of Bacteria, Springer Verlag.
13. Larry Mckane and Judy Kandel (1996). Microbiology – Essentials and Applications. (2nd Edition). McGraw – Hill Inc, New York.
14. Madigan M.T., Martinako, J.M. and Parker J Brock T.D. (1997). Biology of Microorganisms. (8th Edition). Prentice Hall International Inc, London.
15. Nester, E.W., Roberts, C.V., and Nester, M.T. (1995). Microbiology, A Human Perspective. IWOA; U.S.A.
16. P. Saravanan (2006). Virology, MJP Publishers, Chennai.
17. Luria S.E, and Darnel, J.E Jr., Baltimore, D., and Campbell, A. (1978). General Virology, (3rd Edition) John Wiley and Sons, New York.
18. Dimmock – Virology.
19. Rhodes and Van Royen –Text Book of Virology.
20. Biswas and Biswas – An Introduction to Viruses.
21. AnanthRai – Animal Viruses.
22. Green Wood – Text Book of Virology.
23. Purohit, S.S., Saluja. A.K., and Kakrani. H.N., (2003) Pharmaceutical Microbiology. Student Edition (Publ), Jodhpur.
24. Purohit. S.S., Salujia. A.K., and Kakrani. H.N. (2003). Pharmaceutical Biotechnology. Student Edition (Publ), Jodhpur.
25. Jai, N.K., Pharmaceutical Microbiology.
26. Hugo. W.B. Pharmaceutical Microbiology.

WEB RESOURCES:

1. https://www.microbe.net/resources/microbiology/web-resources/
2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	2	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **III Semester** **9 Core –Theory** **Credits 4**

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To gain knowledgeon the concepts of soil microbiology and its importance.*
2. *To impart informationon the significance of air microbiology.*
3. *To give an insight on waterborne diseases ans assessment of water .*
4. *To understand the role of bio fertilizers required for sustainable agriculture.*
5. *To Recognize commonly affecting microbial diseases of crops and its control measure.*
6. *To e*nrich the studied concepts by undertaking a Core Course Project / Core Course Field Work

Course Outcomes: By the completion of this course, students will be able to:

	Course Outcomes	**Cognitive level**
CO1	*Remember the soil structure and profile. Understand the soil microorganisms and connect the factors affecting the microbial flora in soil. Bestow the biogeochemical cycle.*	*K-1, K-2 & K-4*
CO2	*Determine the quality of Air and the airborne diseasesand control measures*	*K-3*
CO3	*Understand the Aquatic Environment and differentiate the fresh and marine habitats. Evaluate the assessment of water quality. Analyze the waterborne diseases and its control measures*	*K-2,K-4& K-5*

CO4	*Demonstrate the rhizosphere effect and summarize the role of biofertilizer in agriculture.*	*K-4 & K-5*
CO5	*Recognize the plant pathogens in horticultural crops. Discuss the important of bacterial plant diseases. Employ the role of bio control agent tomanage the sustainable agricultural crops.*	*K-1& K-2*
CO6	Enrich the studied concepts by undertaking a Core Course Project / Core Course Field Work	*K-1-K-6*

L T P C

4 0 0 4

Unit I:

Soil microbiology: soil structure and profile – Classification of soil – Physical and Chemical characteristics – Micro flora of various soil types – Quantification of soil micro flora – Factors affecting microbial community in soil – Biogeochemical cycles – Carbon, nitrogen, phosphorus and sulphur cycles.
(12 L)

Unit II:

Aero microbiology: Droplet nuclei – aerosol – Assessment of air quality – Solid and liquid impingement method – Airborne transmission of microbes – Diseases and preventive measures (Bacteria, fungi and viruses).
(12 L)

Unit III:

Aquatic environment – Freshwater habitats (ponds – lakes) marine habitats (mangroves, deep sea, hydrothermal vent) –Potability of water, microbial assessment of water quality – waterborne diseases and control measures – water pollution: Eutrophication.
(12 L)

Unit IV:

Rhizosphere effects – R/S ratio – Rhizoplane – Biofertilizers and role in agriculture – Bacteria (Rhizobium, Azotobacter, Azospirillum and Phosphobacteria) -Algae (Blue green Algae) and Fungi (VAM).

(12 L)

Unit V:

Important diseases of horticultural crops – Symptoms – Etiology, lifecycle and management – Bacterial leaf blight of Paddy, Late blight of Potato – Apple scab – stem rust of wheat – Transgenic plants for crop improvement – Bio-control agents of bacteria, fungi and virus.

(12 L)

TEXTBOOKS RECOMMENDED:

1. Rangasamy. G., and Bagyaraj. D.J. (1996). Agricultural Microbiology. Prentice – Hall of India , New Delhi.
2. Atlas, R.M., and Bartha.M. (2003). Microbial Ecology – Fundamentals and applications. Benjamin – Cummings, Menlo Park,California.
3. Talaro, K.P. and Talaro. A (1999). Foundations in Microbiology. WCB McGraw Hill New York.
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WEB RESOURCES

1. https://www.microbe.net/resources/microbiology-web-resources
2. https;//www.microbes.info/resources/3/environmental-microbiology
3. https://blogs.ntu.edu.sg/library-resources/resource-guide-formicrobiology
4. https://www.asm.org/division/w/web-sites.htm

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	1	2	3	4	5	1	2	3	4	5

CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	1	3	3	3	2	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	2	2	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **III Semester** **10 Core –Theory** **Credits 4**

RESEARCH METHDOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. *To understand the basic concepts of different aspects of research.*
2. *To demonstrate the importance of research ethics in addition to hypothesis and testing procedures.*
3. *To create the research design after understanding the principle.*
4. *To aware of report preparation and illustrate different mode of presentation.*
5. *To enhance the basic knowledge of scientific writing and the role of computers in report preparation.*
6. *To e*nrich the studied concepts by undertaking a Elective Course Project / Elective Course Field Work

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		**Cognitive level**
CO1	*Apply research methods in biological science and categorize the different methods.*	*K-3 & K-4*
CO2	*Express the importance of research ethics and identify the research hypothesis*	*K-1& K-2*

CO3	*Recognize and relate the research design. Classify different research design. Observe the principles of experimental design.*	*K-1&K-2*
CO4	*Expertise the research design and interprets report writing. Illustrate various steps involved in report writing.*	*K-2 & K-3*
CO5	*Expertise the information Collect ion tor scientific writing. Assemble research tools in thesis format. Estimate data's used in research.*	*K-2&K-6*
CO6	*E*nrich the studied concepts by undertaking a Elective Course Project / Elective Course Field Work	*K1-1-K-6*

L T P C

4 0 0 4

Unit: 1

Objectives – principles – types of research approaches – Research process – Criteria of good research – Research and Scientific method – Defining the Research problem – Selecting the problem – Techniques in defining the problem.

(12 L)

Unit: II

Importance and need for research ethics and scientific research - Formulation of hypothesis – Types and characteristics – Hypothesis testing – Procedures.

(12 L)

Unit: III

Designing a research work – Need of research design – Features of a good design – Concepts and different research design – Basic principles of experimental design. (12 L)

Unit: IV

Interpretation and report writing. Meaning – Techniques and significance of report writing – Steps - Types of report – Oral presentation.

(10 L)

Unit: V

Scientific writing – Characteristics – Logical format for writing thesis and papers – Essential features of abstract, introduction, review of literature, materials and methods, results and discussion. Effective illustration – Tables and figures – Plates – Conclusion and Bibliography – Application of computer in research – Publication ethics – Plagiarism.

(14 L)

TEXTBOOKS RECOMMENDED:

1. Vijayalekshmi, G. and C. Sivapragasam (2008). Research Methods (Tips and techniques). MJP Publishers, Chennai.
2. Gurumani, N. (2006). Research methodology for Biological Sciences. MJP Publishers, Chennai.

WEB RESOUCES

3. 1. http://nptel.ac.in/syllabus.php?subject Id= 102107028.
4. 2. http://b-ok.xyz/book/674611/288bc3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate

K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **III Semester** **1 Industrial & Institutional Visit** **Credits 1**

INDUSTRIAL AND INSTITUTIONAL VISIT	**SUB CODE:**

COURSE OBJECTIVES

1. *To recognize the operations, practices and regulations in industries and leading institutes by students.*
2. *To differentiate the gap between theoretical training and practical learning in a real-life environment.*
3. *To focus an opportunity for active/interactive learning experiences in-class as well outside the classroom environment.*
4. *To recommend the students to identify their prospective areas of work in the overall organizational function.*
5. *To plan the outlook of students with exposure to different workforces from different industries with improved communication and networking skills.*

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		Cognitive level
CO1	Comprehend the operations, practices and regulations in industries and benefits of leading institutes.	*K-1, K-2 & K-3, K-4*
CO2	Understand the gap between theoretical training and practical learning in a real-life environment.	*K-1, K-2 & K-4*
CO3	Expertise active/interactive learning experiences in-class as well outside the classroom environment.	*K-1, K-2 &K5*
CO4	Identify their prospective areas of work in the overall organizational function.	*K-1, K-4& K-6*
CO5	Develop broadened outlook with exposure to different workforces from different industries with improved communication and networking skills.	*K-3, K-6, K-2*

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To give exposure about scope and developments in the field of Microbiology for students, Industrial / Institutional visits is included in the third semester with 1 credit (2 Hours / Cycle). It helps the students to make themselves aware of the demands in the fields, expectations of the concerned and the qualifications to be developed in them. Understanding the societal needs, current status and market potential will explore the possibilities of becoming an entrepreneur. Staff accompanying the students should be given non-remunerative OD for such visits.

Evaluation

Student shall submit their report (10 pages focusing Industrial and Institutional, excluding front page, declaration, certificate etc.,) individually.

The evaluation will be done at the end of third semester by both external and internal examiners for a maximum marks of 50.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	3	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	2	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year

III Semester **Practical – V** **Credits 3**

PRACTICAL-V LAB IN BIOINFORMATICS, BIOSTATISTICS, MEDICAL AND PHARMACEUTICAL MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. *To analyzethe sequence alignment and similarities using bioinformatics tools and formulate and express to improve their presentation skills*
2. *To examine average , standard deviation and standard error and chi-square test*
3. *To practice and record the processing of different clinically important specimens for the isolation and identification of microbial pathogens*
4. *To interpret the endotoxin test and evaluate MIC, MBC and LD_{50} tests*
5. *To select the efficacy of antibiotics against test pathogens by KB method.*

6. *Enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work*

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		Cognitive level
CO1	Understand the sequence alignment and similarities using bioinformatics tools and will have improved presentation skills	K-2,K-3,K-4
CO2	Calculate mean, median, mode, standard deviation and standard error and chisquare test	K-2,K-3,K-4,K-5
CO3	Examine the different clinically important specimens for the isolation and identification of microbial pathogens	K-2,K-3,K-4,K-5
CO4	Perform the endotoxin identification test, MIC, MBC and LD50 tests	K-2,K-3,K-4,K-5
CO5	Demonstrate the efficacy of antibiotics	K-2,K-3,K-4,K-5
CO6	*Enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work*	K1-K6

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1. Perform pairwise sequence alignment for a set of two analogous protein **(DEMO)**.
2. Sequence similarity search using NCBI – BLAST tool **(DEMO).**
3. Construction of graph and bar diagram.
4. Calculation of mean, median and mode,
5. Calculation of standard deviation and standard error
6. Basics of Chi-Square test.
7. Collection and transport of clinical specimens-methodology and media.
8. Determination of MIC **(DEMO)** *
9. Determination of MBC **(DEMO)** *
10. Determination of LD_{50} **(DEMO)** *

11. Testing the efficacy of antiseptics by Phenol Coefficient test **(DEMO)**
12. Bacteriological analysis of throat *
13. Bacteriological analysis of sputum *
14. Bacteriological analysis of ear *
15. Bacteriological analysis of wound*
16. Bacteriological analysis of pus *
17. Bacteriological analysis of urine sample *
18. Bacteriological analysis of faeces*
19. WIDAL test: Qualitative and quantitative *
20. Detection of endotoxin – LAL Test **(DEMO)** *
21. Antibiotic sensitivity test – Kirby – Bauer disc diffusion method. *
22. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

* Effective learning could be made possible by arranging Field / Industrial visits and Training programmes.

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino. J.G., and Sherman. N. (1996). Microbiology – Laboratory Manual. Benjamin Cummins. New York.
2. Kannan. N (1996), Laboratory Manual in General Microbiology. Palani Paramount Publication, Palani.
3. Gunasekaran. P. (1996). Laboratory Manual in Microbiology. New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005), Microbiology – Laboratory Manual. (1st Edition), PubinSundararaj. A, Chennai.
5. Jayaraman, J. (1985) Laboratory Manual in Biochemistry. Willey Eastern Ltd., New Delhi.
6. Plummer D.T. (1998). An introduction to Practical Biochemistry Tata McGraw Hill, NewDelhi.
7. Palanivelu.P. Analytical. Biochemistry and Separation Techniques.
8. Benson (2002). Microbiological Applications – Laboratory Manual in General Microbiology. International Edition, McGraw Hill Higher Education.
9. Collins, C.R. and Lyne. P.M. (1976). Microbiological Methods (4th edition), Butterworths, London.
10. Dubey. R.C. and Maheswari O.K. (2002). Practical Microbiology. S.Chand and Co Ltd., New Delhi.
11. Baron E.L and Finegold S.M. (1995). Diagnostic Microbiology, Stack well Scientific Press.

12. Davis. L, M.D. and Battey J.F. (1986) Basic methods in Molecular Biology. Elsevier, Amsterdam.

WEB RESOURCES

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BI0505%20LAB%20MANUAL.pdf
2. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO500.pdf
3. https://www.researchgate.net/publication/309619313_MEDICAL_MICROBIOLOGY_LABORATORY_MANUAL_Second_Edition_2009
4. http://www.qfbytlchospitalcivilgdl.com/wp-content/uploads/2014/08/Practical-Manual-of-Medical-Microbiology.pdf
5. https://mountainscholar.org/bitstream/handle/20.500.11919/4774/OERW_MOLB_2021_20190101_Spring%202019%20Micro%20Lab%20Manual.pdf?sequence=1
6. https://www.researchgate.net/publication/257028879_Lab_Manual_in_Pharmaceutical_Microbiology_Biotechnology-I
7. https://www.fda.gov/media/88801/download

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate

K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	3	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	2	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year

III Semester **Practical - VI** **Credits 3**

PRACTICAL – VI LAB IN ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. *To focus the basic physico, chemical and microbiological qualities of packaged water / river water samples*
2. *To examine the distribution of microbes in air*
3. *To enumerate microbes used as biofertilizers*
4. *To observe the production of Azolla and vermicompost*
5. *To record the identification of microbial disease infected plants*

6. To enrich the studies concepts by undertaking a Practical Course Project / Practical Field Work

Course Outcomes
By the completion of this practicals, students will be able to:

Course Outcomes		Cognitive level
CO1	*Outline the methods checking basic physico, chemical and microbiological qualities of packaged water / river water samples*	K-1,K-2,K-3
CO2	*Ability to check the distribution of microbes in air*	K-1,K-2,K-3
CO3	*Applications of biofertilisers for plant growth*	K-2,K-3,K-4,K-5
CO4	*Expertise to produce Azolla and vermicompost*	K-3,K-4,K-5
CO5	*Demonstrate the nature of microbial diseases infected plants.* .	K-2,K-3,K-4
CO6	*Enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work*	K1-K6

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1. Determination of PH in packaged water / River water*.
2. Determination of TDS packaged water / River water*.
3. Determination of conductivity packaged water / River water*.
4. Determination of Salinity packaged water / River water*.
5. Determination of alkalinity packaged water / River water*.
6. Estimation of dissolved oxygen*.
7. Determination of BOD*.
8. Determination of COD*.
9. Screening Aerobic Bacterial Count in packaged water / River water*.
10. Screening of *Pseudomonas sp*in packaged water / River water*.
11. Collection and observation of plankton in freshwater*.
12. Microbiological examination of water portability by (i) MPN method (ii) Membrane filter method – **(DEMO)** *.
13. Microbial sampling of air– **(DEMO)** *.
14. Population assay of extra cellular enzyme activities (amylase, cellulose

and lipase).

15. Microbial flora from different soil types – population study*.
16. Isolation of *Rhizobium* from root nodules*.
17. Study of Mycorrhizae in roots of crop plants*.
18. Isolation of *Azotobacter* and *Azospirilium*from soil samples*.
19. AzollaProduction –**(DEMO).***
20. VermicompostProduciton **-(DEMO).***
21. Isolation and testing of antagonistic microorganisms from soil.
22. Plant diseases: Tobacco mosaic, bacterial blight, powdery mildew and citrus canker*.
23. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

* Effective learning could be made possible by arranging Field / Industrial visits and Training programmes.

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino. J.G., and Sherman. N. (1996). Microbiology – Laboratory Manual. Benjamin Cummins. New York.
2. Kannan. N (1996), Laboratory Manual in General Microbiology. Palani Paramount Publication, Palani.
3. Gunasekaran. P. (1996). Laboratory Manual in Microbiology. New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005), Microbiology – Laboratory Manual. (1st Edition), PubinSundararaj. A, Chennai.
5. Jayaraman, J. (1985) Laboratory Manual in Biochemistry. Willey Eastern Ltd., New Delhi.
6. Plummer D.T. (1998). An introduction to Practical Biochemistry Tata McGraw Hill, NewDelhi.
7. Palanivelu.P. Analytical. Biochemistry and Separation Techniques.
8. Benson (2002). Microbiological Applications – Laboratory Manual in General Microbiology. International Edition, McGraw Hill Higher Education.
9. Collins, C.R. and Lyne. P.M. (1976). Microbiological Methods (4th edition), Butterworths, London.
10. Dubey. R.C. and Maheswari O.K. (2002). Practical Microbiology. S.Chand and Co Ltd., New Delhi.
11. Baron E.L and Finegold S.M. (1995). Diagnostic Microbiology, Stack well Scientific Press.
12. Davis. L, M.D. and Battey J.F. (1986) Basic methods in Molecular Biology. Elsevier, Amsterdam.

WEB RESOURCES

1. https://www.researchgate.net/publication/43451458_Environmental_microbiology_A_laboratory_manual
2. https://catalog.pfw.edu/preview_course_nopop.php?catoid=57&coid=152877
3. ***https://www.researchgate.net/publication/43451458_Environmental_microbiology_A_laboratory_manual***
4. ***http://www.kau.in/document/microbiology-laboratory-manual***

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **IV Semester** **11 Core –Theory** **Credits 4**

FOOD MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. *To instructthe concepts and scope of food microbiology*
2. *To understand the contamination and preservation methods in microbe based food industries*
3. *To aware on food borne infections , its control and prevention methods*

4. *To demonstrate the production, preservation and spoilage of different fermented foods*
5. *To evaluate and assess the foods produced by microbes*
6. *To e*nrich the studied concepts by undertaking a Core Course Project /Core Course Field Work

Course Outcomes
By the completion of this course, students will be able to:

Course Outcomes		Cognitive level
CO1	*Recall the scope of food microbiology and classify types of microorganisms in food material. Interpret the microbial growth factors.*	*K-1, K-2 & K-3*
CO2	*Distinguish contamination and spoilage. Infer the principles of food preservation. Explain the methods to control deterioration and spoilage. Record the importance of food additives*	*K-1&K-2*
CO3	*Tabulate food born infection and intoxication. Analysis of fungal toxin.*	*K-1& K-4*
CO4	*Develop the principles that make a fermented food product and justify for safe consumption.*	*K6*
CO5	*Practices of food processing techniques and assess the parameters influencing the product quality. Evaluate laboratory techniques and emphasize the development of microbial food industry in human welfare.*	*K-3,K-4& K-5*
CO6	Enrich the studied concepts by undertaking a Core Course Project /Core Course Field Work	*K-1-K-6*

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Unit: I

Concept and scope of food microbiology – Food composition – Types and microorganisms in food materials. (Bacteria, Mold, and Yeasts) – Factors influencing microbial growth in food. Extrinsic and intrinsic factors. (Nutrient content, p^H, buffering capacity, redox potential, relative humidity).

(14 L)

Unit: II

Contamination and its sources. Spoilage of foods and its classification Principles of food preservation. (Temperature – Dehydration – Osmotic pressure – Chemicals – Radiation). Contamination, spoilage and preservation of Cereals – Vegetables – Fruits – Seafood's – Meat – Milk and poultry products. Canning and food additives.

(14 L)

Unit: III

Food borne infections and intoxications of *Brucella*, *Bacillus*, *Clostridium*, *E. coli*, *Listeria*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia* – Fungal toxins.

(10 L)

Unit: IV

Fermented foods – bread – Cheese – Vinegar – Dairy products – Oriental fermented foods – fermented beverages (Beer and Wine) –Genetically engineered foods.

(10 L)

Unit: V

Food produced by microbes – Microbial cells as food – SCP (*Spirulina*and *Chlorella*) – Mushroom cultivation – Laboratory testing procedures – Food controlling agencies and its regulations (AGMARK, BIS, FDA, HACCP, ISO). Plant sanitations – Employees health and preventive measures.

(12 L)

TEXT BOOKS RECOMMENDED:

1. Adams, M.R. and Moses, M.O. (1995). Food Microbiology. The Royal Society of Chemistry, Cambridge.
2. Frazier, W.C. and Westhoff, D.C. (2008). Food Microbiology. (4th edition). Tata McGraw Hill Publishing Co Ltd., New Delhi.
3. Jay, J.M. (1987), Modern Food Microbiology. CBS Publishers and Distributors, New Delhi.
4. Atlas, R.M (1989). Microbiology. Fundamentals and Applications Macmillian Publishing Company.
5. Banwart, G.J. (1989). Basic Food Microbiology. Chapman & Hall New York.
6. Board, RC. (1983). A Modern Introduction to Food Microbiology. Blackwell Scientific Publications, Oxford.

7. Robinson, RK (1990). Dairy Microbiology. Elsevier Applied Science, London.
8. Hobbs. B.C. and Roberts, D. (1993). Food Poising and Food Hygiene. Edward Arnold (A Division of Hodder and Stoughton), London.
9. Robinson, R.K. (1990). Dairy Microbiology. Elsevier Applied Sciences London.
10. Vijaya Ramesh, K., (2007). Food Microbiology. MJP Publishers, Chennai.
11. Kharatyan, S.G. (1978). Microbes as Food for Humans. Annual forMicrobial, 32: 301-30).
12. Sudhir Andrews (2008). Food and Beverage Management. McGraw Hill Companies, NewDelhi.
13. NeelamKhetarpaul (2006). Food Microbiology. Daya Publishing House, New Delhi.
14. S.N.Tripathy (2006). Food Biotechnology. Dominant Publishers and Distributors, New Delhi.

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1. Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold, S. Ginsberg. (1990). Microbiology. (4th Edition). J.B. Lippincott Company, New York.
2. Prescott LM., Harley J.P., and Klein D.A., (2008). Microbiology. (7th Edition). McGraw Hill, New York.
3. Larry Mc Kane and Judy Kandel (1996). Microbiology Essentials and Applications. (2nd Edition). McGraw – Hill Inc, New York.
4. Madigan M., T., (Martinko. J.M., and Parker J., Brock TO. (1997) Biology of Microorganisms. (8th Edition). Prentice Hall International Inc, London.
5. Nester, E.W., Roberts, C.V., and Nester, M.T. (1995). Microbiology – A Human Perspective. IWOA, U.S.A.
6. Salle, A.J., (1996). Fundamental Principles of Bacteriology, (7thEdition). Tata McGraw-Hili Publishing Company Ltd, New Delhi.
7. Pelezar Jr., M.J.Chan E.C.S., and Kreig N.R (1993). Microbiology, McGraw Hill, Inc., New York.
8. Stainer RY., Ingraham J.L., Wheelis M.L., and Painter: P.R.(1986). General Microbiology, MacMillan Education Ltd., London.
9. Tortora, Funke,Case Addison (2001), Microbiology – AnIntroduction. (7th Edition). Wesley Longman Inc.
10. Dubey R.C., and Maheswari, S. (2003) A Text Book of Microbiology.S. Chand, & Co, New Delhi.
11. John L. Ingraham and Catherine A Ingrahani. (2000) Introduction to Microbiology. Books/Cole Thomas Learning, New York.
12. Talaro. P., and Talaro. A (1999). Foundations in Microbiology. WCP McGraw – Hill, New York.

WEB RESOURCES:

1. http://www.microbes.info
2. http://www.fsis.usda.gov/
3. http://www.cdc.gov.
4. http://www.microbes.info/ resource/food microbiology
5. http://www.binewsonline.com/1/what is food microbiology.html

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **IV Semester** **12 Core –Theory** **Credits 4**

FERMENTATION AND INDUSTRIAL MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To create a comprehensive knowledge on historical aspects, phases of microbes based industries, microbes and their products, strain improvement , screening, media and their components, sterilization methods used*
2. *Tounderstand the the different microbial culture techniques and fermentors design*
3. *To know the factors affecting fermentation and the role of computers.*
4. *To understand the principle and methods in down stream processing*
5. *To inculcate the knowledge on production and application of commonly used microbial products used in different sectors.*
6. *To e*nrich the studied concepts by undertaking a Core Course Project /Core Course Field Work

Course Outcomes
By the completion of this course, students will be able to:

Course Outcomes		Cognitive Level
CO1	*Recall the utility of microorganism in the field of industrial process. Discuss the raw material and their role in fermentation.*	*K-1& K-2*
CO2	*Illustrate the basic design and components of fermenter summarize the microbial growth parameters*	*K-2,K-3& K-5*
CO3	*Explain the fermenter types and apply the process control in fermentation. Recommend the role of computer in process control.*	*K-2 ,K-3 & K-5*
CO4	*Employ the stages of downstream processing and its application in product design .Recall the principle of instruments involved in DSP*	*K-1& K3*
CO5	*Analyze the knowledge of various industrial products and its impacts on the society. Recognize the importance of immobilization.Justify the role of production strain in Industrial product development for the human welfare* Enrich the studied concepts by undertaking a Core Course Project /Core Course Field Work	*K-1,K4 & K-6* *K-1- K-6*

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Unit: I

Concepts and historical development of Industrial microbiology. Industrial microbes & products. Growth and product formation in industrial process. Types of processing: upstream and down stream. Screening: primary and secondary. Preservation of microbes and its types. Strain improvement. Culture collection. Media: significance, types & components. Raw materials in industrial fermentation and their role: molasses, cellulose, corn steep liquor, soybean meal and malt extract. Industrial sterilization of equipment, production media and air.

(14 L)

Unit: II

Microbial growth kinetics. Stages of fermentation. Scale up of fermentation. Inoculum development for large scale. Inoculum development and production media. Fermenter and bioreactor: Principle and factors involved in fermentor design. Basic components and functions of fermenter.

(10 L)

Unit: III

Fermenter types: **size**: Lab, pilot scale & industrial fermentor, **process:** submerged and solid state. **Nature:** Continuous reactor, plug flow reactor, air-driven column reactors, bubble column , air lift bioreactor, fluidized bed reactor, tower fermentor and shake flask fermentor. Process control in fermentation: aeration, oxygen delivery system, foam control, temperature, pH, agitation and operation. Role of computer in process control.

(12 L)

Unit: IV

Down stream processing: **Stages:** Removal of insoluble, product isolation, purification and polishing technologies involved. **An overview on the process, types limitations and applications :** filtration, flocculation, sedimentation, gravity settling, cell disruption, centrifugation, solvent extraction, precipitation, membrane processing, whole broth processing, chromatography, drying, crystallization and lyophilization.

(12 L)

Unit: V

Industrial products produced by microorganisms. Enzymes (Amylase, protease), Organic acids (Lactic acid, Vinegar). Solvent (Ethyl alcohol, butane diol). Amino acids (L- Lysine, L – Glutamic acid). Production of antibiotics (Penicillin, streptomycin). Vitamins (B_{12}). Beverages (Beer, wine). Yeast (Baker's, brewer and food and feed yeast production). Immobilization: principle, types, significance and applications.

(12 L)

TEXTBOOKS RECOMMENDED:

1. Reed.G. (Editor), Industrial Microbiology, CBS Publishers, AVI Publishing Company.
2. Demain. A.L., and Soloman N.A. (1986). Manual of IndustrialMicrobiology and Biotechnology.
3. Hershnergy. CL.Queener. S.W. and Hegeman. Q Genetics and Biotechnology of Industrial Micoorganisms. ASM Press. USA.
4. Stanbury, P.F.A., Whitaker and .Hal. S.J. (1995). Principles of Fermentation Technology. (2nd Edition). Pergamon, U.K.
5. Casida. L.E (1989). Industrial Microbiology. Willey Eastern Limited, New Delhi.
6. Waif Crueger and AnnelieseCrueger. (2002). Biotechnology – A Text Book of Industrial Microbiology. Sinauer Associates Inc. Laderiand, USA.
7. Ward, O.P.(1998). Fermentation Biotechnology – Principles, Processand Products.
8. Jackson. A.T. Process Engineering in Biotechnology.
9. Nielson &Villadson. Bioreaction Engineering Principles.
10. Prescott & Dunn. (1992). Industrial Microbiology. (4th Edition).
11. Glazer &Nikaido (1998). Microbial Biotechnology.
12. Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold, S.
13. Ginsberg. (1990). Microbiology. (4th Edition). J.B.Lippincottcompany, NewYork.
14. Kalaiselvan, P.T., ArulpandLI. (2007). Bioprocess Technology. MJPPublishers, Chennai.
15. Hershnergy C.L., Queenersw and Hegemanq (1998), Genetics and Biotechnology of Industrial Microorganism. ASM Press. USA.
16. Peppler, H.J., and Perlman, D. (1979). Microbial Technology. Vol and Academic Press.

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1. Prescott L.M., Harley J.P., and Klein D.A (2008). Microbiology. (7th Edition). McGraw Hill, New York.
2. Larry Mc Kane and Judy Kandel (1996). Microbiology – Essentials and Applications. (2nd Edition). McGraw-Hill Inc, New York.
3. Madigan M., T martinko. J.M., and Parker J., Brock T.D. (1997). Biology of Microorganisms. (8th Edition). Prentice Hall International Inc, London.
4. Nester, E.W., Roberts, C.V., and Nester, M.T.(1995). Microbiology -A Human Perspective. IWOA, U.S.A.
5. Salle, A.J. (1996). Fundamental Principles of Bacteriology. (7th Edition). Tata McGraw Hill Publishing Company Ltd, New Delhi.
6. PelezarJr; M.J.Chan E.C.S., and Kreig N.R. (1993). Microbiology McGraw Hill, Inc, New York.
7. Stainer R.Y., Ingraham J.L., Wheelis M.L, And Painter P.R(1986). General Microbiology, MacMillan Education Ltd., London.
8. Starr, M.P., Stolp, H., Truper, H.C., Balows, A., and Schegel, H.C. (1991). The Prokaryotes. A Hand Book of Habitats, Isolation and Identification of Bacteria, Springer Verlag.
9. Tortora, Funke, Case Addison (2001), Microbiology – An Introduction (7th Edition). Wesiey Longman Inc.
10. Dubey R.C., and Miaheswari, S. (2003) A Tex Book of Microbiology. S.Chand& Co, NewDelhi.
11. John L. Ingraham and Catherine A Ingrahani (2000) Introduction to Microbiology. Books/ Cole. Thomas Learning, New York.
12. Talaro K.P., and Talaro. A. (1999).Foundations in Microbiology. WCP McGraw – Hill New York.

WEB RESOURCES :

1. www.rmit.edu.au/courses/034150
2. microbiologyonline.org
3. https://www.omicsonlineorg/.../industrial-microbiology-journals-articles- ppt-list.php
4. www.nature.com/nrmicro/series/applied and industrial

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate

K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year IV Semester 13 Core –Theory Credits 4

BIOTECHNOLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To make the students to understand the historical aspects, he significance of DNA, its related techniques and restriction enzymes.*
2. *To teach about types and roles of vectors and differences among them.*
3. *To strengthen the knowledge of students about the screening of recombinants*
4. *To enlighten knowledge of students over the characters, method of production, applications and ethical issues of Genetically Engineered plants.*
5. *To educate students about the characters and applications and ethical issues of Genetically Engineered animals.*
6. *To e*nrich the studied concepts by undertaking a Core Course Project /Core Course Field Work

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		**Cognitive level**
CO1	*Recognize the historical development of biotechnology and employ the basic tools in recombinant DNA.-design the important techniques in gene cloning.*	*K-1&K-3*
CO2	*Explain the different types of vectors and facilitate screening methods in identification of recombinant.*	*K-2 & K-6*
CO3	*Construct the biosensor design and speculate the product development.*	*K-6*
CO4	*Discuss the biomass energy and construct the biological process. Examine the bioenergy product.*	*K-2,K-3& K-6*
CO5	*Develop the techniques and methods of transgenic plant and animals. Express its importance and uses. Emphasizes the regulatory authorities governing safety biotechnology products. Recognize the role of IPR and IIP.*	*K-1 & K-2*
CO6	Enrich the studied concepts by undertaking a Core Course Project /Core Course Field Work	*K-1-K-6*

L T P C

4 0 0 4

Unit: I

Definition, Concepts – History of biotechnology – Basic tools and techniques of rDNA Technology – Restriction enzymes Types I, II, and III – Modifying enzymes – Ligases – Isoshizomers – Isolation of fragments with cohesive end and blunt end – Homopolymer tailing – Isolation of nucleic acids, DNA sequencing – Maxmam Gilbert – Dideoxy and automation methods – Gene editing- CRISPR cas9 technology and application PCR-Key factors for optimizing PCR, Application of PCR . DNA finger printing – RFLP – RAPD – AFLPandQTLS.

(14 L)

Unit: II

Cloning vectors – Derived bacterial plasmid vectors – Properties – Isolation – Special Vectors – Phage vectors – Cosmids, phasmids, M_{13} and Mu phage – Yeast cloning vectors.Screening procedures – Cloning strategies – DNA hybridization, immunological assay, protein activity –Isolation of cloned genes – Gene libraries – Identification of recombinants, structural and functional analysis of recombinants in bacteria and yeast.

(10 L)

Unit: III

Biotransformation and production of useful compounds –Poly hydroxy butyrate and valerate(PHBV), Xanthangum - Biosensors – definition and outline design- types of electrode systems – Oxygen electrode system, Fuel cell type electrode, Potentiostatic, Piezoelectric membrane and Dye-coupled electrode membrane filter systems –Biosensors for nutrients (glucose sensors). Sensor for cell population (Lactate sensor) - Biosensor for products (alcohol sensor, formic acid sensor and methane sensor) - Biosensor for environmental control (BOD sensor, Ammonia sensor, Nitrite sensor and Sulfite Ion sensor).

(12 L)

Unit: IV

Biomass energy – Composition of biomass-wastes as sources of renewable source of energy – Composition wastes – sources of wastes (Industrial, agricultural, forestry, municipal sources). Biomass conversion: biological process (enzymatic digestion, anaerotic digestion, aerobic digestion). Bioenergy products – ethanol, biogas and Hydrogen

(12 L)

Unit: V

Genetic engineering of plants – Plant transformation, Ti plasmids, derived vectors. Physical methods of gene transfer in plants – Reporter genes in transformed cells. Developing plant strains by genetic engineering – insecticide – herbicide – viral resistant plants – Stress and senescence tolerance – flower pigmentation – plant products.

Transgenic animals – Transgenic mice, methodology – Direct gene transfer – Retroviral vector transfer – EEE method and application – Development and use of transgenic cattle sheep, goat, pigs, birds and fish - Rules and regulation in biotechnology – biosafety, bioethics, hazards of environmental engineering and intellectual property rights (IPR) and protection (IIP).

(12 L)

TEXTBOOKS RECOMMENDED:

1. Brown. T.A (1999). Gene Cloning. (3rd Edition). Chapman and Hall publications, USA.
2. Burrel, M.M. (1993). Enzymes of Molecular Biology. Humana Press.
3. Chirikiian, J.G. (1995), Biotechnology – Theory and Techniques. Vol. II, Jone and Burtlett Publishers.
4. Gerhardt, P., Murray, R.G., Wood W.A., and Kreig, N.R. (1994)Methods for General and Molecular Bacteriology. ASM Press, Washington D.C.
5. Glick, B.R. and Pasternak, J.J. (1998) – Molecular BiotechnologyPrinciples and applications of Recombinant DNA. ASM Press, Washington D.C.
6. Cafferty, M.C., J., Hoogenboom, H.R. and Chiswell, D.J. (1996) Antibody Engineering – A Practical Approach, Oxford University Press.
7. Lewin, B.(2000). Genes VII. Oxford University Press, Oxford.
8. Murray Moo Young (1992). Plant Biotechnology. Pergamon Press.

9. Radleadge, C., and Kristiansen, B. (2001). Basic Biotechnology. (2nd Edition) Cambridge University Press.
10. BIOTOC-Biotechnology (1993). Techniques for Engineering Genes, Published on behalf of Open Universitat and University of Greewnwhich, Butter Heinman Ltd, Oxford.
11. Water G. and Headon D. (1994). Frotein Biotechnology. John Wileyand Sons, New York.
12. Mariappan C.A., text book of molecular biotechnology. Pooja Publishers India.
13. Winnacker, E.L. (1987). From Genes to Clones: Introduction to GeneTechnology. VCH Publication Federal Republic of Germany.
14. Antony, J.F., Griffiths, Gilbert, W.M., Lewontin, RC. and Miller, J.H. (2002). Modern Genetic Analysis., Integrating Genes andGenomes. (2nd Edition). WH Freeman and Company, New York.
15. Blackburn, G.M. and Gait, M.J. (1996). Nucleic Acids in Chemistry and Biology. Oxford University Press.
16. Alberts, B.Brag, D., Lewis, J., Raff, M., Roberts, K., and Watson. J.D(1994). Molecular Biology of Cell. Garland Publ Inc.
17. Malacinskl G.M., and Freifelder. D. (1998). Essentials of Molecular Biology. Jones and Bartlett Publ.
18. Maloy, SR., Cronan, JR. Freifelder, D. (1994). Microbial Genetics. Jones and Bartlett Publ.
19. Macinski, G.M. and' Freifelder, D. (1998). Essentials of Molecular Biology. (3rd Edition). John Bartlett Publishers.
20. Sir John Kendrew (1994). The Encyclopedia of Molecular Biology. Blackwell Science Ltd.
21. Swaminathan. M.S.andJana.S. (1992). Bio-diversity. Implications for Global Food Security. Mac Millan, Madras.
22. Rigby. P.W.J. (Editor). 1987.Genetic Engineering. 6th Academic Press, London.
23. Wiseman. A. (1983). Principles of Biotechnology. Chapman and Hall, New York.
24. Gupta. P.K. (1996). Elements Biotechnology. Chapman and Hall, New York.
25. Michael Boylan and Kevin. E. Brown (2003). Genetic EngineeringPearsonEducation (Singapore) , New Delhi.
26. MukbeshPasupuleti (2006). Molecular Biotechnology. S. Chand and Co Ltd., New Delhi.
27. Dubey. R.C. (1996). A Text Book of Biotechnology. S. Chand and Co Ltd., New Delhi.
28. Das.H.K. (2005). Text Book of Biotechnology. Wiley Dreamtech India (P) Ltd., New Delhi.
29. Cheremisinoff. P.N. (1985). Biotechnology – Applications and Research TechnomicPub.Co.Inc. Lancaster, USA.
30. Sathyanarayana.(2005). Biotechnology. Books and Allied (P)., Kolkatta.

31. Peppler, H.J., and Rer/man, D. (1979). Microbial Technology.Vol I and II, Academic Press.

REFERENCES:

1. Desmona.S.T.,Nicholl. (19.94). An Introduction to Genetic Engineering Cambridge Press.
2. Anand Solomon. K.(2008). Molecular Modeling' and Drug. Design. MJP Publishers, Chennai.
3. Susa R. Barnum (2002) Monoclonal Antibodies. MJP Publishers, Chennai.
4. Nisonoff.A(1985). Introduction to Molecular (1) munology. (2nd Edition Sundarland, Mass.)
5. Zaltin. M., Day. P and Hollaender A. (1983). Biotechnology in Plant Sciences Relevant to Agriculture, Academic Press. London.

WEB RESOURCES :

1.https://www.edx.org/learn/biotechnology
2.https://biog.feedspot.com/genetics-blogs/
3.learn.genetics.utah.edu/
4.http://bmc biotechnol.biomedcentral.com

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	2	3	3
CO 2	3	2	2	2	3	3	3	2	2	3
CO 3	3	2	2	2	3	3	3	3	3	3
CO 4	3	3	2	2	3	3	3	1	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **IV Semester** **1 Project** **Credits 3**

PROJECT	**SUB CODE:**

COURSE OBJECTIVES:

1. Recommend and formulate the research thirst among students by making them to refer research articles of International Standards

1. *Evaluate and analyse, the problems affecting the quality of life of local community*
2. *Enhance the liberty to apply basic and advanced techniques to find out the status and solution to the selected problem*
3. *Plan the writing and presentation skills of students*
4. *Adapt an opportunty in the field of research at national and international level*

Course Outcomes
By the completion of this course, students should be able to:

	Course Outcomes	**Cognitive level**
CO1	*Understand the research by reading journal of International Standards.*	K-2,K-3,K-4
CO2	*Analyze, select and pick up problems affecting the quality of life of local community*	K-2,K-3,K-4,K-5
CO3	*Apply the basic and advanced techniques to find out the status and solution to the selected problem*	K-2,K-3,K-4,K-5
CO4	*Aware in research writing ,presentation and publication*	K-2,K-3,K-4,K-5
CO5	*Find the opportunities in the field of research at national and international level*	K-2,K-3,K-4,K-5

L T P C

0 0 6 3

To plan and design an appropriate viable project and statistically apply the data wherever possible and process it accordingly after the correct retrieval of relevant literature and fixation of an organized plan of work. The research project should be supported with figures, tabulations, plates and photographs along with necessitated bibliography.

The project work may be done either in the department itself or in collaboration with any other organization of advanced learning including educational institutions, research centres, Industries, NGO's with research background, etc., without affecting their regular academic affairs.

The final project report should be submitted to the head of the course department 15 days before the university prescribed date. The project report shall contain atleast 35 pages excluding bibliography and appendices. Each student will have to submit THREE copies of his / her project for evaluation in the fourth semester itself.

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3

CO 4	3	2	2	2	3	3	3	1	3	3
CO 5	3	2	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year **IV Semester** **Practical - VII** **Credits 3**

PRACTICAL – VII LAB IN FOOD MICROBIOLOGY AND FERMENTATION AND INDUSTRIAL MICROBIOLOGY	**SUB CODE:**

COURSE OBJECTIVES:

1. *To assess and recognize AGMARK, BIS FSSAI and HACCP and Microbial Culture Collection Centers*
2. *To evaluate routine microbiological tests done in food and diary industries.*
3. *To formulate the production, purification and down stream processing of enzymes and antibiotics*
4. *To visualize cell and microbial immobilization and observe alcohol production*
5. *To facilitate the student society fond of becoming entrepreneur by teaching the science of mushroom cultivation, Spirullina production, and yogurt preparation*
6. To enrich the studies concepts by undertaking a Practical Course Project / Practical Field Work

Course Outcomes: By the completion of this course, students will be able to:

Course Outcomes		**Cognitive level**
CO1	*Aware and utilize Microbial Culture Collection Centers and AGMARK, BIS FSSAI and HACCP*	K-2,K-3,K-4,K-5,K-6
CO2	*Perform the routine microbiological tests in food and diary industries.*	K-2,K-3,K-4
CO3	*Acquire knowledge on production, purification and down stream processing of enzymes and antibiotics*	K-4,K-5,K-6
CO4	*Demonstration of alcohol production and Familiarise immobilization technique*	K-4,&K-6

CO5	*Expertise in the basic concepts of Entrepreneur development*	K-2,K-3,K-4,K-5,
CO6	*Enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work*	K-1 - K-6

L T P C

0 0 6 3

1. Basic aspects of AGMARK, BIS, FSSAI and HACCP.
2. Basics aspects of Microbial Culture Collection Centers.
3. Standard plate count of milk*.
4. Microbiological examination of milk*.
   i) Methylene blue reduction test
   ii) Rezaurin test
   iii) Phosphatase test
5. Microbiology of fermented milk products*.
   i) Curd*
6. Microbiological analysis of foods*.
   i) Soft drinks
   ii) Meat and fish
   iii) Fruits and Vegetables
   iv) Salted and Dried foods
   v) Bread
7. Production of enzymes by batch fermentation (Protease and Amylase).
8. Purification of extracellular enzymes.
   I. Enzyme precipitation – Ammonium sulphate and Acetone. **(DEMO)**
   II. Dialysis of crude enzymes. **(DEMO)**
   III. Ion-exchange chromatography – **(DEMO)**.
9. Enzymes and Whole cell Immobilization*.
10. Fermentative production of ethyl alcohol by yeast*.

11. Wine production – **(DEMO)***.
12. Solid-state fermentation – Mushroom Production – **(DEMO)***.
13. Spirulina Production – **(DEMO)***.
14. Production – extraction and purification of any antibiotic **(DEMO)***.
15. Preparation of fermented product-yogurt from milk*.
16. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

*Effective learning could be made possible by arranging Field / Industrial visits and Training programmes.

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (196). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sundararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4th- edition). Butterwoths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology. Elseiver, Amsterdam

WEB RESOURCES

1. https://www.researchgate.net/publication/306018042_Microbiology_Laboratory_Manual
2. http://www.fao.org/3/T0610E/T0610E.pdf
3. https://www.researchgate.net/publication/344584469_Practical_Manual_on_Fermentation_Technology
4. https://www.researchgate.net/publication/344465390_PRACTICAL_MANUAL_CUM_WORKBOOK_on_INDUSTRIAL_MICROBIOLOGY
5. https://www.researchgate.net/publication/344465390_PRACTICAL_MANUAL_CUM_WORKBOOK_on_INDUSTRIAL_MICROBIOLOGY

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	3	3	1	3	3
CO 2	3	2	2	2	3	3	3	1	3	3
CO 3	3	2	2	2	3	3	3	1	3	3
CO 4	3	3	2	2	3	3	3	1	3	3

CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

Second Year

IV Semester **Practical – VIII** **Credits 3**

PRACTICAL – VIII LAB IN BIOTECHNOLOGY	**SUB CODE:**

COURSE OBJECTIVES

1. To understand and apply the restriction enzymes used in cloning
2. To focus the importance of primer, and its role in PCR and the mechanism of designing
3. To understand and practice on plant tissue culture methods and its applications
4. To adapt the basics and applications of animal cell culture
5. To prepare and observe serum and its storage
6. To enrich the studies concepts by undertaking a Practical Course Project / Practical Field Work

Course Outcomes: By the completion of this course, students will be able to:

	Course Outcomes	**Cognitive level**
CO1	*Demonstrate the restriction enzymes principle and uses in cloning*	K-3&K-4
CO2	*Aware of the importance of primer, and its role in PCR and the mechanism of designing*	K-2,K-3,K-4&K-5
CO3	*Understand the plant tissue culture methods and its applications*	K-2,K-3,K-4&K-

		5
CO4	*Familiarize the basics animal cell culture and its applications*	K-2,K-3,K-4&K-5
CO5	*Understand significance of serum, preparation and its storage*	K-2,K-3,K-4&K-5
CO6	*Enrich the studied concepts by undertaking a Practical Course Project / Practical Field Work*	K1-K6

L T P C

0 0 6 3

1. Restriction enzyme Digestion with Labeled DNA – Lambda phage DNA **(DEMO)**.
2. PCR **(DEMO)**.*.
2. Primer Designing**(DEMO)**.*
3. Blue white selection with IPTG – **(DEMO)***
4. Cloning by desired vector – pBR_{322} – **(DEMO)***
5. Preparation of plant tissue culture media **(DEMO)**
6. Callus induction **(DEMO)***
7. Shoot tip culture **(DEMO)***
8. Isolation of protoplast
9. Isolation of protoplast by enzymatic method
10. Preparation of media for animal cell culture**(DEMO)***
11. Preparation of serum.
12. Submission of Practical Course Project (PCP) / Practical Field Work Report (PCFW)

* Effective learning could be made possible by arranging Field / Industrial visits and Training programmes.

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino.J.C:7 and Sherman. N. (196). Microbiology – Laboratory Manual. Benjamin Cummins, New York
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Paramount Publication, Palani.
3. Gunasekharan. P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sundararaj. T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4th- edition). Butterwoths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology. Elseiver, Amsterdam

WEB RESOURCES

1. https://www.srmist.edu.in/engineering/department-of-biotechnology/infrastructure
2. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BIO217_BASIC_BIOTECHNOLOGY_LAB_MANUAL1.pdf
3. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT0310%20-%20PLANT%20BIOTECHNOLOGY%20PRACTICAL%20MANUAL.pdf
4. https://vlab.amrita.edu/?sub=3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate

K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

	PO					PSO				
COS	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	3	3	3	3	3	3	2
CO 2	3	2	2	3	3	3	3	2	3	2
CO 3	3	2	2	3	3	3	3	2	3	1
CO 4	3	3	2	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1

-END OF SYLLABUS-