Annamalai University

(Accredited with 'A' Grade by NAAC)

Faculty of Science

Department of Microbiology

M.Sc. MICROBIOLOGY (Two - Year)

Programme Code: SMIC21

Regulations, Curricula and Syllabi

2019-20 onwards

Annamalai University
Faculty of Science
DEPARTMENT OF MICROBIOLOGY
M.Sc. MICROBIOLOGY
Programme Code: SMIC21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Microbiology** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science M.Sc. Microbiology (Two-year) Regulations 2019**".They shall come into force with effect from the academic year 2019 – 2020.

1. **Definitions and Nomenclature**

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/ Laboratory /Seminar/Project work/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

1.12 **Elective Course** is a course that a student can choose from a range of alternatives.

1.13 **Value-added Courses** are optional courses that complement the

students' knowledge and skills and enhance their employability.

1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 **Learning Objectives** are statements that define the expected goal of a course in **Course Objectives** in terms of demonstrable skills or knowledge that will be acquired by a student.

1.19 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters is given in section11.4.

1.22 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programme Offered and Eligibility Criteria:

The Department of Microbiology offers a M.Sc. Microbiology (Two - Year) programme. A pass in B.Sc. Microbiology / Biotechnology /Zoology and B.Sc. Botany / Chemistry / Biochemistry /Physics with any one ancillary subjects of Microbiology / Zoology / Botany or any other science subjects with biology accepted by the Syndicate of Annamalai University as equivalent thereto are eligible for admission.

3. **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 Departmental Electives (DEs) are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 Interdepartmental Electives (IDEs) are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations, either within the classroom, within the community, or within the work place-based learning outcome that are specifically focused on employability skills.

5.4.2 In – plant training/ field trips/internships/ industrial visits (as applicable) fall under this category.

5.4.3 **Experiential Learning** is categorized as **Non-Credit Compulsory Course.**

5.5 Project

5.5.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognized institutions/ industry shall obtain prior permission from the Department. The Research Supervisor will be from the host institute.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction. Classes for a VAC are conducted beyond the regular class hours and preferably in the III Semester.

5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of

students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 **Credit Distribution:** The credit distribution is organized as follows:

	Credits
Core Courses	72
Elective Courses	15
Constitution of India	02*
Project	06
Total	**93**

5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester.

1 Tutorial period of one hour duration per week over a semester.

1 Practical/Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their

progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students will be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be set by the respective faculty using Blooms Taxonomy.

8.4.4 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.

8.4.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.4.6 For the CIA Tests, the assessment will be done by the Course teacher.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.5.2 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses and project, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.2. Assessment of CIA Tests

9.2.1. For the CIA Tests, the assessment will be done by the Course Teacher.

9.2.2. For the Theory Courses, the break-up of marks shall be as follows:

CIA for Theory Courses	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3. For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

CIA for practical	Marks
Test-I	15
Test-II	15
Viva-voce and Record	10
Total	40

9.3. Assessment of End-Semester Examinations

9.3.1. Evaluation for the ESE is done by Internal examiner.

9.4. Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/ field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6. The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
		Project / Dissertation Evaluation	Viva-voce
Review-I - 10	Review-II -15	50	25

9.5. Assessment of Value-added Courses

9.5.1. Assessment of VACs shall be internal. Two CIA Tests shall be conducted by the Department(s) offering VAC.

9.5.2. The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6. Passing Minimum

9.6.1. A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2. A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **The GPA** is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i

n is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i

n is the number of Courses passed in that semester.

m is the number of semesters.

11.5. Evaluation:

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2. A ten point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	**First Class with Distinction**
6.5 and above but below 8.25	**First Class**
5.0 and above but below 6.5	**Second Class**
0.0 and above but below 5.0	**Re-appear**

11.6 **Classification of Results**. The successful candidates are classified as follows:

11.6.1 **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **First Class:** Candidates who have passed all the courses with a CGPA of 6.5and above.

11.6.3 **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the first appearance itself are eligible for **University Rank**.

11.7 **Course-Wise Letter Grades**

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade sheet of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once

during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct: Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. Transitory Regulations: Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF MICROBIOLOGY

TWO YEAR M. Sc. MICROBIOLOGY Programme

PROGRAMME CODE: SMIC21

Curricula and Scheme of Examination
(For students admitted from the academic year 2019 - 2020)

Course Code	Course Title	L	P	C	CIA	ESE	Total
		Hours/ Week					
SEMESTER – I							
19MICC101	Core 1: General Microbiology	4		4	25	75	100
19MICC102	Core 2: Pharmaceutical Chemistry & Pharmaceutical Microbiology	4		4	25	75	100
19MICC103	Core 3: Immunology & Immuno Technology	4		4	25	75	100
19MICP104	Core 4: Practical I (Core course- 1,2 & 3)		12	6	40	60	100
19XXXXXXX	**Elective 1: Interdepartmental Elective**	3		3	25	75	100
	Total credits			21			
SEMESTER – II							
19MICC201	Core 5 : Bioprocess Technology	4		4	25	75	100
19MICC202	Core 6: Bacteriology & Virology	4		4	25	75	100
19MICC203	Core 7: Mycology & Parasitology	4		4	25	75	100
19MICP204	Core 8: Practical – II (Core course - 5, 6 & 7)		12	6	40	60	100
19MICE20X	**Elective 3: Department Elective**	3		3	25	75	100
19XXXXXXX	**Elective 2: Interdepartmental Elective**	3		3	25	75	100
	Total credits			**24**			
SEMESTER – III							
19MICC301	Core 9: Molecular biology & Recombinant DNA Technology	4		4	25	75	100
19MICC302	Core 10: Biofuel & Bioenergy	4		4	25	75	100
19MICC303	Core 11: Microbial Inoculants & Mushroom Technology	4		4	25	75	100
19MICC304	Core 12: Bioinstrumentation & Research Methodology	4		4	25	75	100
19MICP305	Core 13: Practical – III (Core course -9, 10, 11 & 12)		12	6	40	60	100
19MICE30X	**Elective 5: Department Elective**	3		3	25	75	100
19XXXXXXX	**Elective 4: Interdepartmental Elective**	3		3	25	75	100
19PSCI300*	Constitution of India	2		2*	25	75	100
	Total credits			**28**			

SEMESTER – IV							
19MICC401	Core 14: Medical Diagnostic Technology	4		4	25	75	100
19MICC402	Core 15: Applied Microbiology	4		4	25	75	100
19MICP403	Core 16: Practical – IV (Core course14 &15)		12	6	40	60	100
19MICD404	Project work (Dissertation & Viva-voce)		12	6	25	75	100
	Total Credits			**20**			
	TOTAL CREDITS			**93**			
	Value Added Courses						
	Online Courses (SWAYAM, MOOC, NPTEL)						

NOTE: * ⟹ Non-Credit Compulsory Course

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available. The details of interdepartmental electives are given in the "**Handbook of Interdepartmental Electives-Two Year Programme**" and listed in the University website.

2. Students may opt for any Value-added Courses listed in the University website. The details of Value Added Courses are given in the "**Handbook of Value Added Courses**" and listed in the University website.

3. Guidance/Discussion on course specific **experiential learning** to Students will be provided wherever feasible to apply the knowledge, skills and attitude taught in the course, either within the classroom, within the community, or within the workplace, to learn by experience which would improve their employability skills.

ELECTIVE COURSES

I. DEPARTMENT ELECTIVE COURSES (DE)

Course Code	Course Title	L	P	C	CIA	ESE	Total
		Hours/ Week					
19MICE205	Entrepreneurship And Management For Microbiology	3		3	25	75	100
19MICE206	Bioremediation	3		3	25	75	100
19MICE207	Microbial Nanotechnology	3		3	25	75	100
19MICE208	Food & Dairy Microbiology	3		3	25	75	100
19MICE306	Microbial Diversity & Extremophiles	3		3	25	75	100
19MICE307	Environmental Microbial Technology	3		3	25	75	100
19MICE308	Vermitechnology	3		3	25	75	100
19MICE309	IPR, Biosafety & Bioethics	3		3	25	75	100

ANNAMALAI UNIVERSITY
Department of Microbiology
[Question Paper Pattern - INTERNAL TESTS I & II (CIA)]
(Based on Revised Bloom's Taxonomy)

Programme: M.Sc. : Two Year PG
Semester: All

Time: 2 Hrs

Max.Marks:50

Part-A (Level-K1) **Marks: (6x2=12)**
(Answer ALL of the questions)

1. Define /Choose/ Relate……
2. What / Why / How?
3. Multiple Choices a. b. c. d.
4. Multiple Choices a. b. c. d.
5. Match the following i - a ii - b iii - c iv - d v - …..
6. Match the following i - a ii - b iii - c iv - d v - …..

Part-B (Level-K2) **Marks: (3x5=15)**
(Answer any THREE of the questions)

7. Explain…..
8. Describe…..
9. Select……
10. Compare

Part-C (Level-K3/ Level-K4) **Marks: (2x7=14)**
(Answer any TWO of the questions)

11. Apply….
12. Calculate….
13. Categorize…

Part-D (Level-K5/ Level-K6) **Marks: (1x9=9)**
(Answer any ONE of the questions)

14. Discuss….
15. Summarize….

ANNAMALAI UNIVERSITY
Department of Microbiology
Pattern of question paper for END semester examinations
(Based on Revised Bloom's Taxonomy)

Year : I

Programme: M.Sc. Two Year PG Programme

Semester: I / II

Course Code: **Course Name:**

Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) Marks: (10x2=20)
(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe……
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4)Marks: (8x5=40)
(Answer any EIGHT of the questions)

11. Prepare…..
12. Solve…..
13. Apply……
14. Show…..
15. Categorize…
16. Analyze…
17. Distinguish….
18. Infer….
19. Compare….
20. Compute

Part-C (Level-K5)Marks: (3x10=30)
(Answer any THREE of the questions)

21. Discuss…
22. Summarize….
23. Evaluate…..
24. Disprove….

Part-D (Level-K6)*Marks: (1x10=10)
(Answer any ONE of the questions)

25. Design….
26. Develop…

ANNAMALAI UNIVERSITY
Department of Microbiology
Year: II

Programme: M.Sc. Two Year PG Programme **Semester: III / IV**

Course Code: **Course Name:**
Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) Marks: (10x2=20)
(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe…..
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4) Marks: (6x5=30)
(Answer any SIX of the questions)

11. Apply……
12. Show…..
13. Prepare
14. Make use of….
15. Categorize…
16. Analyze…
17. Distinguish….
18. Simplify…..

Part-C (Level-K5) Marks: (3x10=30)
(Answer any THREE of the questions)

19. Discuss…
20. Recommend with
21. Evaluate…..
22. Justify….
23. Optimize…

Part-D (Level-K6)*Marks: (2x10=20)
(Answer any TWO of the questions)

24. Design….
25. Formulate …
26. Modify …..

M.Sc. Microbiology (TWO YEAR) PROGRAMME									
[End Semester Examinations] Bloom's Taxonomy - Questions Conforming to Levels K1 to K6									
	I Year (Two year PG)					II Year (Two Year PG)			
	Level	Part	Questions & Marks	Total Marks		Level	Part	Questions & Marks	Total Marks
	K1	A	5 x 2	10		K1	A	5 x 2	10
	K2		5 x 2	10		K2		5 x 2	10
	K3	B	4 x5	20		K3	B	2 x 5	10
	K4		4 x5	20		K4		4 x 5	20
	K5	C	3 x 10	30		K5	C	3 x10	30
	K6	D	1 x 10	10		K6	D	2x 10	20
				100					100

Programme Outcomes (POs):

On completion of Two Year M.Sc. Microbiology, students will be able to

PO1:	**Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.**
PO2:	**Resource Utilisation.** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
PO3:	**Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4:	**Critical thinking and Problem solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
PO5:	**Project Management**: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.
PO6:	**Individual and team work**: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7:	**Effective Communication**: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO8:	**Environment and Society**: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9:	**Ethics**: Commitment to professional ethics and responsibilities.
PO10:	**Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

Programme Specific Outcomes (PSOs):

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

PSO1:	**Acquire basic Microbiology laboratory skills and expertise in the use of instruments applicable to research, clinical methods and analysis of the observations.**

PSO2:	Understand prokaryotic and eukaryotic genetic systems & physiology of microorganisms.
PSO3:	Gain familiarity with applications of microbes for synthesis of valuable products through fermentation.
PSO4:	Explore the application of genetic engineering to create GMO, transgenic plants, animals, Gene therapy, etc.,
PSO5:	Understand the role of microorganisms in human health, immune response to infection and antibiotic resistance.

Overall, the Programme is reasoning and applications oriented, equipping the students eligible for higher studies, jobs in various sectors and entrepreneurship abilities.

Semester	19MICC101: GENERAL MICROBIOLOGY	L	P	C
I		4	0	4

Learning Objective (LO):

LO	To learn about the general characteristics of different types of bacteria, bacterial respiration and to understand microbial diversity in extreme environments.

Course Outcomes (CO)

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

CO1:	Gain knowledge about the Classification of microorganisms.
CO2:	Appreciate the principles and applications of microscopes.
CO3:	Understand the structural features of bacteria, Protozoa, Algae, Fungi and Viruses.
CO4:	Understand the metabolism of microorganisms.
CO5:	Understand the microbial diversity in extreme environments

Unit – 1: History of Microbiology & Classification of Microorganisms

Introduction, History and scope of Microbiology. Recent developments Spontaneous generation – Biogenesis. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchinkoff, Edward Jenner and Fleming. Classification - Haeckel's three kingdom concept, Whittaker's Five-kingdom concept. Classification of Bacteria (Bergey's Manual), Fungi, Algae and Virus.

Unit – 2: Microscopy And Staining Methods

Microscopy**:** Simple, Compound, Dark Field, Phase contrast, Fluorescence and Electron microscopes. (SEM & TEM), Confocal microscopy – Principles and their applications. Staining techniques: Nature of dyes, Simple, Differential and negative and spore staining. Culture methods: Culture media and Nutritional types, Growth curve.

Unit – 3: General Characteristics And Structure Of Bacterial Cell

General characteristics and nature of Archaebacteria, Eubacteria, Cyanobacteria, Mycoplasmas, Rickettsiae, Chlamydias, Spirochaetes, Actinomycetes, Protozoa, Algae, Fungi and Viruses. Cell walls of Gram negative and Gram positive bacteria, Cell wall synthesis, Capsule types, S- layers. Composition and Function. Structure and function of flagella and Pili, Endospore types, structure

and functions. Reserve food materials – Polyhydroxy butyrate- Polyphosphate granules- Oil droplets – Cyanophycin granules and Sulphur inclusions. Fungi: Cell wall – Chemical composition and functions.

Unit – 4: Microbial Metabolism

Aerobic respiration- nutritional requirements of Bacteria. Nutritional Types. Glycolysis, ED, TCA, Oxidative and substrate level Phosphorylation, glyoxylate pathway, Gluconeogenesis. Fermentation of carbohydrates - homo and heterolactic fermentations. Photosynthesis - Phototrophy, oxygenic and anoxygenic Photosynthesis.

Unit – 5: Extremophiles

Introduction to microbial biodiversity - distribution, abundance, ecological niche. Survival at extreme environments - Thermophiles, Alkalophiles, Acidophiles and Halophiles. Bioluminescence – Mechanism - Advantages. Space Microbiology aims and objectives of space research.

Text Books:

1. Dubey, R.C. and Maheswari, D.K. (2011). *A Textbook of Microbiology*. S. Chand and Company Ltd., New Delhi.
2. Ananthanarayan. R. and Paniker C.K. (2009).*Text Book of Microbiology.* Orient Longman.
3. Pelczar, C & Kreig J (2009). Microbiology 5th edition. Tata McGraw Hill, New Delhi.

Supplementary Books:

1. Willey, Joanne M. (2014). *Prescott's Microbiology*. 9th Edition: McGraw - Hill Education - London.
2. Jawetz, Melnick, &Adelberg's (2013). *Medical Microbiology*. 26th Edition. McGraw - Hill**.**

Web References:

1. https://www.microscopy.co.za/what-is-microscopy
2. https://biologydictionary.net/aerobic-respiration/
3. https://www.livescience.com/51720-photosynthesis.html
4. https://en.wikipedia.org/wiki/Bioluminescence
5. https://biologywise.com/characteristics-of-archaebacteria

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	3	3	2	1	1	3	3	3	2	2	2
CO2	2	3	3	3	1	1	3	1	1	3	3	1	2	3	2
CO3	3	3	3	3	3	3	3	1	1	3	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	1	3	3	1	2	3	2
CO5	3	3	3	3	3	3	3	3	1	3	3	1	2	3	2

Semester	19MICC102: PHARMACEUTICAL CHEMISTRY & PHARMACEUTICAL MICROBIOLOGY	L	P	C
I		4	0	4

Learning Objective (LO):

LO	To learn about the basic principles of pharmaceutical chemistry and pharmaceutical microbiology

Course Outcomes (CO)

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

CO1:	Gain a strong knowledge on Volumetric Analysis.
CO2:	Acquire knowledge about photometric methods and Microbial transformations.
CO3:	Apply the Concepts of pharmaceuticals and biopharmaceuticals.
CO4:	Understand about the bacterial mechanism and action of antibiotics.
CO5:	Apply the Quality Assurance, good laboratory practices in microbiology laboratory.

Unit – 1: Basic Chemistry

Volumetric Analysis – Definition of Mole, Equivalent, Molarity, Normality, Equivalent of Acids, Bases, Oxidising & Reducing agents – Primary and Secondary Standards. Calculations involved in the preparations, Dilutions, Assay and standardization of volumetric solutions. Conversion of Molarity to Normality and vice versa.

Unit – 2: Photometric Methods & Microbial Transformations

Photometric methods – Ultraviolet and Visible Spectrometry: Principle, Electronic transitions, Beer – Lambert's Law, Instrumentation and Pharmaceutical Applications. Spectro fluorimetry - Principle, Mechanism of fluorescence &Phosphorescence. Factors affecting fluorescence intensity. Quenching instrumentation & applications of fluorescence in pharmacy.

Microbial Transformations – Introduction, Methods of transformation, Types of transformation, Oxidation, Reduction, Hydrolysis, Isomerization, hydroxylation. Production of steroids by microbial transformation.

Unit – 3: Biopharmaceuticals

Sources- biopharmaceuticals in production and research, Cytokines, Hormones, Blood products, Therapeutic enzymes (Asparaginase, Streptokinase, β-

Lactamase), Antibiotics (Aminoglycosides, Tetracyclines) Synthetic antimicrobial agents - Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents, Antifungal antibiotics, Antitumor substances, Chemical disinfectants, Antiseptics and Preservatives. Vaccines - New vaccine technology, DNA vaccines, Synthetic peptide vaccines, Multivalent subunit vaccines, vaccine clinical trials. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.

Unit – 4: Mechanism And Action Of Antimicrobial Agents

Mechanism and action of antibiotics (Inhibitors of cell wall synthesis, Nucleic acid and protein synthesis). Molecular principles of drug targeting. Bacterial resistance to antibiotics. Mode of action of bacterial killing by Quinolinones. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses (Cellular permeability barrier, Cellular transport system and Drug diffusion). Microbial contamination and spoilage of pharmaceutical products (Parenteral and Non parenteral, Ophthalmic preparations and Implants).

Unit – 5: Quality Assurance And Validation

Quality Assurance and Validation - Regulatory aspects of Quality Control (QC), Quality Assurance (QA), Quality Management (QM), Current Good Manufacturing Practices (CGMP), Good Laboratory Practices (GLP) and CMP in Pharma Industry. ISO9000, WHO, USFDA certification. Microbial Limit test of pharma products. Sterility testing, Pyrogen testing and LAL test of Sterile pharma products. Sterilization - heat, D - value, Z - value and Survival curve, Radioactive, Gaseous and Filtration. Chemical and biological indicators. Designing layout for microbiology laboratory and Safety in microbiology laboratory. Market planning.

Current Streams of Thought

(Not for final Examination only for discussion)

Current developments related to drug delivery systems in gene therapy - Discussion on addressing antimicrobial resistance - Antimicrobial drug - Methodologies for testing (in-vivo, in - vitro infectivity models) - Good bacterium is bad news for atherosclerosis (updated quiz) - New drug target for emerging viral diseases.

Text Books:

1. Cassida, J.E. (2007).*Industrial Microbiology*. New Age International.
2. Agarwal, A.K.& Pradeep Parihar.(2006). *Industrial Microbiology*. Published by Student Edition, Behind Nasrani Cinema, Chopasani Road, Jodhpur.

3. Patel, A. H. (2005). *Industrial Microbiology*. Laxmi Publications, New Delhi; Second edition.
4. Douglas A,Skoog, Donald M. James. F. Hall Stanley R. Crouch. (2013).*Fundamentalsof AnalyticalChemistry*. 9th edition, Brooks/Cole Cengage learning; ISBN; 9780495558286.

Supplementary Books:

1. Jain,N.K.*Pharmaceutical Microbiology*. Second edition. (2005). publication: VALLABH Prakasahan, Delhi- ISBN: 81-85731-25-X VPBN-50.
2. DOUGLAS.J.Pisan, David.S.Mantus.(2008).*FDA regulatory affairs.* 2nd Ed Informa health care, New York. ISBN: 9781420073546.

Web references:

1. Pharmacology; action and Uses of Drugs by Maurice VejuxTyrode.
2. Pharmaceuticals Management for Underserved Populations by Johns Hopkins University.
3. http://202.74.245.22:8080/xmlui/bitstream/handle/123456789/1014/Chapter%2012-Sterilization-and-sterility-assurance.pdf?sequence=14
4. https://cdsco.gov.in
5. https://www.fda.gov/cder

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3	3	3	2	2	3	2	3	3	3	3
CO2	3	3	3	3	2	1	3	2	3	3	2	3	3	2	3
CO3	3	3	3	3	3	3	3	2	2	3	2	3	3	2	3
CO4	3	3	3	3	3	2	3	3	2	3	3	3	3	2	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3

Semester	19MICC103: IMMUNOLOGY & IMMUNO TECHNOLOGY	L	P	C
I		4	0	4

Learning Objective (LO):

LO	To gain an understanding of basic concepts of cells and components of the immune system and immune diagnostic techniques

Course Outcomes (CO)

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

CO1:	Understand the functional organization of the immune system.
CO2:	Evaluate the interactions between Antigen and Antibodies.
CO3:	Analyze the basis of Immunological disorders.
CO4:	Appreciate the guidelines and methods for sample collection and processing.
CO5:	Understand serological methods for diagnosis of infections.

Unit – 1: Immunity And Immune System

Basic concepts and terminologies in immunology. Haematopoiesis. Types of immunity. Central and Peripheral Lymphoid Organs: structure and functions. Cells of the immune system. Phagocytosis, Maturation and differentiation of T - cell and B - cell T cell and B cell receptor and function.

Unit – 2: Antigen and Antibody Reactions

Antigens: Types, Properties, Haptens, Epitopes, Adjuvants, Auto antigens, Blood group antigens. Immunoglobulin structure, Types, Properties and Function. Theories of antibody production - Clonal selection theory, Antibody diversity. Factors governing Antigen – Antibody interactions - Affinity, Avidity, Valency, Cross reactivity. Hybridoma Technology and Monoclonal Antibodies. Interferons (IFN), Interleukins and its types.

Unit – 3: Immune Disorders

Complement system, Major Histocompatibility Complex- Class I and Class II, MHC structure and function. Transplantation immunity – Organ transplantation and HLA tissue typing. Autoimmune Disorders and immunology of Infectious Disease- Immunity to infection, Hypersensitivity reactions, Immunological tolerance, Immunosuppression, Immunodeficiency disorders. Tumors: Type of tumor antigens, Immune response to tumors,.

Unit – 4: Sample Collection, Processing, Vaccines and Immunotechnology

Guidelines for the collection, Transport, Processing and analysis of clinical specimens Vaccines-Killed and Attenuated, Recombinant, DNA and peptide vaccines, Edible vaccines. Application of immunotechniques- Flow cytometry, Immunoelectron microscopy, Immunohistochemistry and Bioplex array

Unit – 5: Serology

Serology - Serological methods for diagnosis purpose – Agglutination, Immuno diffusion, Widal, VDRL, RPR, ASO, CRP test, Precipitation, Latex Agglutination Test, CFT, ELISA and its types, RIA, CLIA.

Current Streams of Thought

(Not for final Examination only for discussion)

Foreign body reaction to biometerials - Immunological biosensors-Review on prospects and future of immunosensors - Quiz: Abzymes, properdin, complement, aggressions - Review and debate on chemotherapy v/s immunotherapy.

Text Books:

1. John P. Harley. (2007). *Microbiology Lab Manual*. 7th edition McGraw Hill Medical publication division.
2. Ramnik sood. (2009). *Laboratary Technology [Methods and interpretation]*. 6thEd. J.P.Bros, New Delhi.
3. Owen, J., Punt, J and Strandford, S. “Kuby. (2012). *Immunology.* 7th Ed., W. H. Freeman Publication, New York, USA.

Supplementary Books:

1. P.J.Delves, SJ.Martin, DR.IM.Roitt. (2011). *Roitt’s Essential Immunology*. Blackwell Scientific Publications, Oxford.
2. Rao, C.V.(2008).*Immunology*, Narosa Publishing House, India.
3. T.J.Kindt, RA.Goldsby, BA.Osborne, Janis Kuby. (2008). *Cuby Immunology* III Edn. Panimabook company limited. New Delhi.

Web references:

1. http://www-immuno.path.cam.ac.uk/-immuno/part1.html
2. http://www.Iclark.edu/-reiness/immuno/lectures.html
3. http://www.hhmi.org/biointeractive/immunology/lectures.html
4. http://www.immuneweb.xxmc.edu.cn/immunology/immunology.html

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3

Semester	19MICP104: PRACTICAL I (GENERAL MICROBIOLOGY, PHARMACEUTICAL CHEMISTRY & PHARMACEUTICAL MICROBIOLOGY, IMMUNOLOGY & IMMUNO TECHNOLOGY	L	P	C
I		-	12	06

Learning Objective (LO):

LO	To acquire practical skills in basic microbiological techniques, sterility testing and microbial contamination of pharmaceutical products and to examine Antigen – Antibody reactions by immunological tests.

Course Outcomes (CO)

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

CO1:	Understand the sterilization methods and media preparation.
CO2:	Enumerate bacterial and yeast cells
CO3:	Detect microbial contaminations in pharmaceutical products.
CO4:	Determine antimicrobial activity of chemical compounds.
CO5:	Perform various immunological experiments.

Practicals:

1. Different methods of sterilization.
2. Preparation of Media.
3. Bacterial growth curve – Turbidity measurement.
4. Pure culture techniques.
5. Measurement of microbial cell size – Micrometry.
6. Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count).
7. Motility determination - Hanging drop method, soft agar method.
8. Staining methods: Simple, Negative, Acid fast, Gram staining, Spore, Capsule, Metachromatic granular staining, Lactophenol Cotton Blue staining,
9. Fungal slide culture.
10. Sterility testing by *Bacillus sterothermophillus*
11. Sampling of pharmaceuticals for microbial contamination and load
12. Determination of phenol coefficient of chemical compounds
13. Blood group typing - slide method and tube method

14. Identification of leukocytes from blood smear.
15. Precipitation method- Immunodiffusion and Immuno-electrophoresis
16. Latex Agglutination test
17. ELISA
18. Urine Pregnancy test.

References:

1. Kannan, N. (2002). *Laboratory manual in General Microbiology*.
2. Cappuccino and Natalie Sherman. (2014). *Microbiology A laboratory Manual*.10th edition.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3

Semester	19MICC201: BIOPROCESS TECHNOLOGY	L	P	C
II		4	0	4

Learning Objective (LO):

LO	To gain knowledge on the principles of fermentation, microbial production of therapeutic compounds and nanoparticles.

Course Outcomes (CO)

On completion of the course students will be able to:

CO1:	Develop an understanding of various aspects of bioprocess technology.
CO2:	Understand the principles of fermentor design and types.
CO3:	Gain knowledge about mass transfer in bioreactors.
CO4:	Evaluate nanotechnology and microbial production of therapeutic compounds.
CO5:	Understand various downstream processing techniques.

Unit – 1: Fermentation Process

An introduction to fermentation process - The range of fermentation process, Chronological development - Component parts of fermentation process - Types of fermentation. Immobilization – Types.

Unit – 2: Fermentors

Fermentor design - Body construction, Individual parts, Fermentors - Stirred tank, Bubble column, Air lift, Tower Fermentors, CSTR. Computers in bioprocess control. Bioprocess control - Control of pH, Foam, pressure, Temperature - Computer application in fermentation technology.

Unit – 3: Mass Transfer and Types

Sterilization of Bioreactors, air and nutrients, Mass transfer in bioreactor. Gas liquid exchange - Mass transfer - Heat transfer - O_2 transfer - Stirring and mixing - Newtonian, Non Newtonian fluids – Effect of viscosity Scale up, Scale down.

Unit – 4: Production ff Therapeutic Compounds

Microbial production of therapeutic compounds (Antibiotics) - Bioplastics (PHB & PHA) - Biopolymer (Xanthan) – Nanotechnology - Biological synthesis of nanoparticles - Types of nanoparticles - Characterization studies (UV - Visible

spectroscopy, FTIR, SEM, TEM, XRD analysis) - Advantages and disadvantages of microbial synthesis of nanoparticles.

Unit – 5: Downstream Processing

Downstream processing - Recovery of intracellular and extracellular products - Biomass separation by centrifugation, Filtration, Flocculation and other recent developments, Cell disintegration - Physical, Chemical and Enzymatic methods. Extraction - Solvent, Two phase, Liquid extraction, Whole broth, Aqueous multiphase extraction - Purification by different methods. Concentration by precipitation, Ultra filtration, Reverse osmosis. Drying and Crystallization.

Current Streams of Thought

(Not for final Examination only for discussion)

Field trip to beverage and pharmacutical industries - Review and debate on Nanoparticles v/s antibiotics - Synergestic action of Nanoparticles and antibiotics - Quiz program related to the fermentor types - Seminar on downstream processing.

Text Books:

1. Michael.J, Wailes, Neil, L.Morgan, John S, Rockey, Gary Higton,A. (2015).*Industrial Microbiology*. *An Introduction* 2nd edition, Sinavous Association, Inosundeland.
2. Patel A H.(2015).*Industrial Microbiology* 2/e. Laxmi Publications-New Delhi.
3. W. Clarke. (2016). *Biotechnology: Industrial Microbiology A Textbook*. 1/ed.
4. Cassida,J.E. (2007).*Industrial Microbiology*. New Age International.
5. Peppler, H.J, and Pearlman, D. (2014). *Microbial technology*.vol.11 and 2/e, Elsevier press.

Supplementary Books:

1. Stanbury I.F., Whittakar, A and Hall S.J.(2016). *Principles of fermentation technology*. 3rdEditon, Pergamon press.
2. Prescott and Gunn, S.(2009). *Industrial Microbiology*. agrobios publications.
3. Anuj Kumar Rana. (2015).*Downstream* processing *for biotechnology*. Global Vision Publishing House.

Web references:

1. https://en.wikipedia.org/wiki/Fermentation
2. https://nptel.ac.in/courses/102106022/

3. http://www.understandingnano.com/nanoparticle-synthesis.html
4. http://cdn.intechweb.org/pdfs/13555.pdf

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	3
CO4	3	3	3	3	3	3	2	2	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester	19MICC202: BACTERIOLOGY & VIROLOGY	L	P	C
II		4	-	4

Learning Objective (LO):

LO	To learn about host - parasite relationship, bacterial and viral diseases, drugs, vaccines and antiviral agents.

Course Outcomes (CO)

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

CO1:	Understand host parasite relationships.
CO2:	Evaluate the causes, prevention and management of diseases caused by Gram positive bacteria.
CO3:	Analyze the causes, prevention and management of diseases caused by Gram negative bacteria.
CO4:	Understand properties and classification of Viruses.
CO5:	Gain an insight into viruses and the life cycle and pathogenicity, prevention and treatment of viral diseases.

Unit – 1: Bacteriology

Bacteriology: Indigenous normal microbial flora of human body. Infection – Types, Sources, Mode of transmission etiology, epidemiology. Host parasite relationships - Nonspecific host immune mechanisms. Rules for collection and transportation of clinical specimens for microbiological diagnosis. Nosocomial infection – prevention and treatments. Hospital waste disposal.

Unit – 2: Medically Important Gram Positive Bacteria

Morphology, Classification, Cultural characteristics, Pathogenicity, Laboratory diagnosis, Prevention, Control and treatment of diseases caused by *Staphylococcus aureus, Streptococcus pyogenes, pneumococci, Corynebacterium diphtheriae, Mycobacterium tuberculosis, leprae, Clostridium tetani, perfringens and Bacillus anthracis,*

Unit – 3: Medically Important Gram Negative Bacteria

Gram negative Bacteria causing human infection – *Vibrio cholerae, Escherichia coli, Proteus vulgaris, Klebsiella pneumoniae, Salmonella typhi & para typhi, Shigella dysentriae, Brucella abortus, Pseudomonas aeruginosa, Yersinia pestis. Neisseriae*

[Gonococci & Meningococci], Gram negative Anaerobes, Spirochetes, Rickettsia, Chlamydia, Mycoplasma and *Ureoplasma.* Zoonotic diseases and their control.

Unit – 4: Properties And Classification Of Viruses

Introduction to virology - Properties, Nomenclature, Classification, Morphology and Cultivation. General methods in diagnosis and serology, viroids, prions, satellite RNAs and virusoids. Newly emerging viruses - Corona virus, SARS virus, Swine flu and Dengue virus.

Unit – 5: Viral Diseases

Life cycle, Pathogenicity, diagnosis, prevention and treatment of DNA & RNA viruses - Pox viruses, Herpes viruses, Adeno viruses, Papova virus, Polio virus, Hepatitis viruses (A – E), Picorna, Orthomyxo, Paramyxo, Toga and other arthropod borne viruses, Rhabdo, Rota and HIV, Ebola virus, Zikavirus, Rabies virus, Oncogenic viruses. Viroids, Prions, Satellite RNAs, Virusoids. Viral vaccines and Antiviral agents.

Current Streams of Thought

(Not for final Examination only for discussion)

Role of cell signaling and quorum sensing in microbial diseases - Keeping track of recent outbreaks of bacterial and viral diseases through daily news and research paper - Awareness program on personal hygiene, vaccination, contagious and emerging microbial diseases - Application of CRISPR / Cas 9 (deciphering mechanisms of HIV1 persistence) - Potential of engineered Antibody for HIV 1 therapy and cure. Small RNAs - to treat HIV - 1 infection by gene therapy.

Text Books:

1. Ananthanarayan.R. and Paniker C.K.J Text book of Microbiology, orient Longman,2013
2. Ram Reddy, Essentials of Virology, 2017.
3. Baijayanthi Mala Mishra, Text book of Medical Virology, CBS Publisher and Distributor Pvt. Limited, 2018.
4. Paul Hyman & Srephen T. Abedon, Viruses of microorganisms, Caister academic Press, 2018.

Supplementary Books:

1. Paul G Western, MV Michael Valentine. (2016).*Essentials of Bacteriology*. Wentworth press.
2. Paul Hyman & Stephen T. Adedon, Coasster. (2018).*Viruses of Microorganisms.* Academic Press.

Web references:

1. http:// www.virology.net/garryfavwebaids.html
2. http:// www. virology.net/garryfavwebaids.html≠genaids
3. http:// www.bact.wisc.edu/bact330
4. http:// www.bact.wise.edu/microtextbook/
5. http:// www.textbook of bacteriology.net/

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3

Semester	19MICC203: MYCOLOGY & PARASITOLOGY	L	P	C
II		4	0	4

Learning Objective (LO):

LO	To acquire knowledge of fungal and parasitic diseases, etiology, diagnosis and treatment.

Course Outcomes (CO)

After the course the student will be able to:

CO1:	**Gain knowledge about mycology and classification of fungi.**
CO2:	Understand the etiology diagnosis and management of the different fungal infections.
CO3:	Evaluate the Life cycle and pathogenicity of the most important parasitic protozoa.
CO4:	Analyze life cycle and pathogenicity of helminthes**.**
CO5:	Understand common lab techniques used in the identification of parasites.

Unit – 1: Mycology

Historical introduction to mycology - Morphology – Taxonomy - Classification of fungi - Isolation and Identification of fungi from clinical specimens. Mycotoxins and Mycetism. Antifungal agents - Testing methods and quality control.

Unit – 2: Fungal Diseases

Superficial mycosis - Tinea, Piedra- Dimorphic fungi causing systemic mycosis - Blastomycosis and Histoplasmosis - Cutaneous mycosis – Dermatophytosis. Subcutaneous mycosis - Sporotrichosis, Mycetoma, Rhinosporidiosis. Opportunistic mycosis- Candidiasis, Cryptococcosis and Aspergillosis.

Unit – 3: Parasites – Protozoan Diseases

Introduction and classification of parasites, Transmission life cycle, Lab diagnosis and treatment for the following Protozoa - Intestinal amoebae - *Entamoeba histolytica, E.coli.* Free living *Amoebae – Naegleria fowleri, Acanthamoeba spp.* Intestinal and Genital flagellates – *Giardia lamblia, Trichomonas vaginalis.* Blood and tissue flagellates - *Leishmania donovani, Trypanosoma brucei, Haemosporina* - Malarial parasite. Coccidian – *Toxoplasma gondii, Cryptosporidium parvum.*

Unit – 4: Parasites – Helminths

Infection of helminthes -*Taenia solium, T.saginata, Fasciola hepatica, Paragonimus westermani* and *Schistosoma haematobium, Ascaris lumbricoides, Ancyclostoma duodenale, Trichuris trichiura, Enterobius vermicularis,* and *Wuchereria bancrofti.*

Unit – 5: Laboratory Techniques In Parasitology

Laboratory techniques in Parasitology - Examination of faeces - Direct and concentration methods - Blood smear examination - Cultivation of protozoan parasites, serology and PCR techniques. Antiparasitic drugs.

Current Streams of Thought

(Not for final Examination only for discussion)

Mold infections; Determination of identity of medically important fungi; and diseases (eg - modern techniques like PCH and MALDI - TOF for fungal diagnosis and differentiation); fungal biofilms; fungal toxins - Health and economic significance - Organoids - new models for host - helminth interactions - Awareness program on contagious fungal and parasitic diseases - antiworm medication and personal hygine.

Text Books:

1. Jagdish chander. (2017). *Text book of Medical Mycology*, 4th edition, Taypee Publisher.
2. Gopinath hait. (2017).*A Text book of Mycology*, New central book agency (NCBA).
3. Jayaram Paniker, .C. K. (2013). *Paniker's Textbook of Medical Parasitology*, 7th edition, Jaypee Brothers Medical Publishers (P) Ltd.

Supplementary Books:

1. Errolraiss H. Jeanshadorry, G. Mashallyon. (2014).*Fundamental Medical Mycology*, Weiley Blackwell.
2. Russel F. Cheadle and Ruth Leventhal. (2011).*Medical Parasitology*.

Web References:

1. http://dmoz.org/Science/Biology/Microbiolg y//
2. http://cal.vet.upenn.edu/parasite/links.html
3. http://www.biosci.ohio-state.edu/-zoology/parasite/home.html
4. http:// www.cellsalive.com/ecoli.html
5. http:// www. Pitt.edu/-super1/lecture/lec4771/

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Semester	19MICP204: PRACTICAL II (BIOPROCESS TECHNOLOGY, BACTERIOLOGY & VIROLOGY, MYCOLOGY & PARASITOLOGY)	L	P	C
II		-	12	06

Learning Objective (LO):

LO	To acquire skills for the production and recovery of products from microorganisms and steps to identify pathogens from clinical samples.

Course Outcomes (CO)

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

CO1:	Produce microbial metabolites by fermentation.
CO2:	Identify pathogens from clinical samples.
CO3:	Identify the fungi from clinical samples.
CO4:	Identify the Parasites, eggs & Larvae from Processed samples

Practicals:

1. Screening of antibiotic producing microorganisms from soil.
2. Screening of enzyme producing microorganisms.
3. Solid state fermentation and Submerged fermentation.
4. Production of alcoholic beverages.
5. Production of Citric acid.
6. Production of enzymes – Protease / Amylase / Lipase
7. Purification of enzymes.
8. Immobilization techniques.
9. Identification of pathogenic microorganisms from a given samples
    a. Pus
    b. Blood
    c. Urine
    d. Stool
    e. Sputum
10. Egg inoculation techniques
11. Spotters of Viral inclusions and CPE – stained smears.
12. Skin/nail scrapings for fungi isolation.

13. Lactophenol Cotton Blue mount for identification of fungi.
14. Cultivation fungi from clinical specimens.
15. Germ tube test for yeast.
16. Sugar assimilation test for yeast.
17. Isolation of ova / cyst from faeces
18. Spotters of Anopheles, Glossina, Ticks, Mites, Sand fly.
19. Blood smear examination of malarial parasites.

References:

1. Kannan, N. Laboratory manual in General Microbiology (2002).
2. Sundararajan, T. Microbiology laboratory manual. 2nd edition (2007).
3. Rajan, S., & Selvi Christy. R., Experimental procedures in life sciences.1st edition (2010).

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	2	3	1	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3

Semester	19MICC301: MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY	L	P	C
III		04	-	04

Learning Objective (LO):

LO	To gain knowledge about the basic principles of molecular biology and advanced gene manipulation techniques.

Course Outcomes (CO)

On completion of the course the students will be able to:

CO1:	Understand DNA structure and Protein interactions.
CO2:	Appreciate the hierarchical organization of DNA and DNA replication.
CO3:	Gain an insight into the mechanism of transcription and translation and regulation of gene expression.
CO4:	Evaluate the strategies in gene cloning.
CO5:	Appreciate the applications of rDNA technology.

Unit – 1: Structure and Properties of DNA/ RNA

Concept of molecular biology - DNA Structure: Chemistry of DNA, Forms of DNA, Physical properties of Double stranded DNA and DNA topology. DNA – Protein interactions. RNA – types and structure.

Unit – 2: Organization of DNA and Replication

Organization of DNA into chromosomes: Packaging of DNA and organization of chromosome in bacterial cells, Packaging of DNA in Eukaryotic nucleosome and Chromatin condensation. DNA Replication in Prokaryotes and Eukaryotes. Types of DNA polymerase, replication of nucleic acid in viruses. Inhibitors of DNA replication. DNA damage and repair.

Unit – 3: Transcription and Translation

Transcription, Translation, Regulation of gene expression in prokaryotes: Operon concept - Positive regulation (*E. coli ara* operon) and Negative regulation (*E. coli* - *lac* operon). Regulation by attenuation – *his* and *trp* operons. Anti terminators. RNAi, Regulation of gene expression in Eukaryotes- Transcriptional, Translational and Processing level, control mechanism.

Unit – 4: Gene Cloning Process

Concept and Importance of genetic engineering, General strategies and steps involved in gene cloning. Extraction and Purification of DNA from bacteria, plant and

animal cells. mRNA and cDNA preparation, Cloning vectors: – types – Bacteriophage vectors- Host systems.

Unit – 5: Transgenesis and rDNA Applications

Transgenic plants, Transgenic animals. Knock out mice. Gene therapy. Recombinant products - Recombinant hormones, Recombinant vaccines. Genetic engineering guidelines, Containment levels. Indian guidelines. Applications of Genomics and Proteomics.

Current Streams of Thought

(Not for final Examination only for discussion)

Review on prospects and future on GMOs - Controversy about production of genetically modified food discussion/ debate - Genome editing techniques (in embryo) - seminar on Biomedical tattoo - Review and debate on impact of genetically engineered microbes and crops on biodiversity.

Text Books:

1. An introduction to genetic engineering. 2010. Desmond S.T Nicholl, Cambridge University Press.
2. Molecular biology of Genetics.2008.ManoramaSingh,Discovery Publishing House.
3. Introduction to genetics: A molecular approach, T.A. Brown, Garland Science, 2011.

Supplementary Books:

4. James. D. Watson, Tania A. Baker, Stephen P. Bell and Alexander Gann 2013, Molecular biology of the gene,7th edition, Pearson publication.
5. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. 2013. Molecular Biology of the gene, 7th edition, Benjamin/Cummings publishing company.
6. Molecular Biology of the Gene (7th Edition, J.D.Watson, Tania A. Baker, Stephen P. Bell , Michael Levine, Richard Losick) Benjamin/Cummings Publ. Co., Inc., California, 2013.
7. Genes XI (9th Edition) Benjamin Lewin, Jones & Bartlett Learning, 2008.

Web References:

1. https://link.springer.com
2. https://opentextbc.ca>biology>
3. https://www.scienceabc.com
4. https://www2.le.ac.UK>vgec>topics>
5. https://study.com>academy

6. https://www.sciencedaily.com

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Semester	19MICC302: BIOFUEL & BIOENERGY	L	P	C
III		04	-	04

Learning Objective (LO):

LO	To understand the basic principles of Biofuels, Bioenergy and their applications.

Course Outcomes (CO)

On the completion of course the students will able to:

CO1:	Acquire knowledge about classification of biofuels.
CO2:	Evaluate the utilization of alternative feed stock for biogas and biofuel production.
CO3:	Analyze renewable and non – renewable energy sources and energy management.
CO4:	Develop an understanding of utilization of biomass for energy production.
CO5:	Understand bioelectricity generation from microbes.

Unit – 1: Classification and types of biofuels

Introduction, Classification of biofuels - liquid and gaseous. Gaseous biofuel, biogas and biohydrogen. Liquid biofuels - Bio ethanol, Bio diesel. Bio gas plants - Types – Construction details - Loading of biogas plants - Biogas requirement for various use - Biogas applications - Dual fuel engine.

Unit – 2: Applications of biofuels

Alternative feedstock for biofuels. Effective use of Agricultural, Horticultural, Forest and fishery wastes and byproducts as an alternative feed stock for biogas plants – Bio digested slurry - Manurial value - Enrichment - Pelletization.

Unit – 3: Biomass briquetting and alcohol production

Biomass briquetting - Coir pith groundnut shell etc., Alcohol from Sweet sorghum, Tapioca, Sweet potato -Producer gas - Aqua gas, Pyrolytic gas from biomass such as Maize cob, Groundnut husk, Cotton stalk, Briquettes.

Unit – 4: Bioenergy and utilization

Energy - Renewable and non - Renewable energy - Energy plantations - Latex producing plants - Nuclear energy - Energy management and use.

Unit – 5: Bioenergy production

Utilization of biomass for energy production. Fast growing biomass species as energy source - Solid, Liquid, Gaseous energy production from biomass and its

use. Hydrogen Production, Utilization - Biofuel cells, Bioelectricity generation from microbes.

Current Streams of Thought

(Not for final Examination only for discussion)

Assignment related to Biofuels and biogas from different raw materials - Mini project in various research topics - Group discussion about the wide applications of biofuels - Field visit to bioenergy/ biogas/ biofuel industry.

Text Books:

1. Ozcan Konur Bioenergy and Biofuels1st Edition 2018. CRC Press.
2. Anju Dahiya Bioenergy: Biomass to Biofuels. 2014 Academic press.
3. FW Bai, CG Liu, H Huang, G T Tsao, Biotechnology in China III: Biofuels and Bioenergy: 3 (Advances in Biochemical Engineering/Biotechnology) 2014, Springer press.
4. Vaughn C. Nelson, Kenneth L. Starcher. Introduction to Bioenergy 2016 CRC Press.

Supplementary Books:

5. V. K. Gupta, M. Tuohy, C. P Kubicek, J Saddler, Feng Xu, Bioenergy Research: Advances and Applications, 2014, Elsevier press.

Web References:

1. https://study.com>academy
2. www.bioconstruct.com
3. https://onlinelibrary.willey.com
4. www.ieabioenergy.com , https;//energypedia.info

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO2:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3:	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO4:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5:	2	3	3	3	3	3	3	2	3	3	3	3	3	3	3

Semester	19MICC303 - CORE 11: MICROBIAL INOCULANTS & MUSHROOM TECHNOLOGY	L	P	C
III		04	-	04

Learning Objective (LO):

LO	To learn about the production and distribution of biofertilizers and to understand about mushroom cultivation techniques.

Course Outcomes (CO)

After the completion of the course the students will be able to:

CO1:	Appreciate the importance of microbial inoculants and biofertilizers in agriculture.
CO2:	Understand the cultivation and production methods for biofertilizers.
CO3:	Differentiate types of mushrooms cultivated around the world.
CO4:	Understand the cultivation of different types of mushroom.

Unit – 1: Introduction and Fungal Biofertilizers

Introduction to biofertilizers, types, advantages and application. Fungal Biofertilizers - Ectomycorrhizal association with pines: Vescicular Arbuscular Mycorrizal Association (VAM) – *Glomus* sp:

Unit – 2: Bacterial Biofertilizers

Bacterial Biofertilizers - Free living forms: *Azotobacter, Azospirillum*: Symbiotic forms: *Rhizobium* - Legume Association: *Pseudomanas*, Nonlegume association.

Unit – 3: BGA and Actinomycetes biofertilizers

Cyanobacterial Biofertilizers - *Nostoc, Anabaena, Gloeocaps* and *Scytonema*. Symbiotic association with *Azolla*; Actimomycetes as Biofertilizers - Actinomycetes associations - *Frankia* sp.

Unit – 4: Mushroom and types

Edible and non-edible mushroom (Historical account, most commonly cultivated mushrooms in the world, Distribution and production in various countries). Poisonous mushroom, identification and effect on human health.

Unit – 5: Mushroom Cultivation

Cultivation of button mushroom - Morphology raising a pure culture & Spawn preparation. Preparation of compost & Cultivation *of Agaricus bisporus, Pleurotus*

flabelltus harvest. Cultivation of oyster and paddy straw mushroom - Preparation of pure culture & Spawn cultivation methods, Harvest.

Current Streams of Thought

(Not for final Examination only for discussion)

Mushroom research and development in improving yield and reducing contamination wastage; present status of mushroom industry in India - Novel technologies for high priced mushroom cultivation, preservation - global medicinal values of various mushrooms – importance of various biofertilizers; ill effects of chemical fertilizers (All aspects). Steps to promote biofertilizer usage among farmers. Meeting of local entrepreneurs involved in mushroom and biofertilizer production.

Text Books:

1. S Biswas, M. Datta and S.V. Ngachan Mushrooms: A Manual for Cultivation, 2012, PHI Learning Private Limited.
2. Dhar and Kaul, Biology and Cultivation or Edible Mushrooms, 2007, Westville Publishing House.
3. Mahendra Rai, Handbook of Microbial Biofertilizers, 2008, CRC Press.

Supplementary Books:

4. Rao, N.S., 2007. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., Pvt., Ltd., Bombay.
5. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R., 2008. Biofertilizers Technology. Agrotech Publishing Academy. Udaipur, Rajasthan.

Web References:

1. http://www.csir.res.in/ruralsectors/button-mushroom-cultivation
2. https://www.crcpress.com/Handbook-of-Microbial-Biofertilizers/Rai/p/book/9781560222705
3. http://www.fungaldiversity.org/fdp/sfdp/FD38-2.pdf
4. https://www.jstor.org/stable/4354403

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	1	3	3	3	3	3	2	3

CO3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester	19MICC304: BIOINSTRUMENTATION & RESEARCH METHODOLOGY	L	P	C
III		04	-	04

Learning Objective (LO):

LO	To learn the fundamentals of research methodology, working principles and applications of instruments used in biology.

Course Outcomes (CO)

At the end of this course, students will be able to:

CO1:	Appreciate the working principles and applications of Microscopy.
CO2:	Understand principles and applications of spectroscopy, centrifugation.
CO3:	Evaluate the various types & applications of chromatography and electrophoresis.
CO4:	Understand the methodology of doing research.
CO5:	Understand the mechanics of thesis writing.

Unit – 1: Microscopy

Light Microscopy - Microscopic optics, Components of microscopes. Basic principles and types of Bright field, Dark field, Phase contrast. Fluorescence, Polarization and Confocal microscopes and their applications. Immunofluorescence – Flow Cytometer – Immuno Electron Microscope - In situ hybridization. Electron Microscopy - Principle, Techniques and applications of Transmission Electron Microscope (TEM) and Scanning Electron Microscope (SEM).

Unit – 2: Spectroscopy, Centrifugation & Radioactivity

Spectroscopic methods - UV-Visible, Atomic Absorption and Atomic Emission Spectroscopy. Centrifugation - Principles and types centrifugation Radioactive Analysis: Principles of radioactivity, GM counter & LS counter.

Unit – 3: Chromatography &Electrophoresis

Theory, principles and applications of Paper, Thin layer, Gel filtration, Ion exchange, Affinity, GC and HPLC methods. Electrophoresis - Principle, types and methods. Horizontal, Vertical, PAGE, Agarose electrophoresis, Blotting techniques and its Applications. Pulse Field Gel Electrophoresis (PFGE) - Principle and applications. Gel Documentation and molecular weight analysis.

Unit – 4: Research Methodology

Research Methodology - Meaning and importance. Statement, Constraints, Review of literature - Review and synopsis presentation. Types of research, Research tools, Qualities of a good researcher. Research process, Research designs - Experimental and non-experimental. Preparation of research report. Guidelines for preparing an article. Impact factor, Citation index, h-index, i-10 index, Scopus, Web of science. Computers in biological research.

Unit – 5: Guidelines For Thesis Writing

Thesis writing - Defining research problem, Research design, General format, Literature survey, Primary source - Articles, Reviews, Abstract, Current contents (both text and CCOD), Reference card, Data analysis, Data interpretation, Report writing, Proof correction.

Current Streams of Thought

(Not for final Examination only for discussion)

Seminar/ assignment on thesis writing- Keeping track of advances in instrumentation techniques - Statistical methods used in biology - Current developments in instrumentation techniques through internet, webinars and discussions - Quiz about the principle and application of instruments used in biology.

Text Books:

1. Baltz Demain, R.H., A.L., and Davies, J.E. (2010). *Manual of Industrial Microbiology & Biotechnology.* ASM Press.
2. Murphy, D.B., and Davidson, M.W. (2012) *Fundamentals of Light Microscopy and Electronic Imaging,* Wiley-Blackwell.
3. Kothari, C.R, (2013). *Research methodology Methods and Techniques,* New Age International Pvt. Ltd Publishers., New Delhi.

Supplementary Books:

1. John, G., Webster. (2008). *Bioinstrumentation.* University of Wisconsin, John Wiley & Sons, Inc.
2. Anderson, J., Durosn, B.H., and Poole, M. (2011). *Thesis and assignment writing*, Wiley Eastern Ltd., New Delhi.

Web References:

1. https://libguides.wits.ac.za/c.php?g=693518&p=4914913
2. https://explorable.com/defining-a-research-problem
3. https://www.sciencedirect.com/book/9780127843094/spectroscopic-methods-of-analysis
4. https://en.wikipedia.org/wiki/Bioinstrumentation
5. http://www.asmscience.org/content/book/10.1128/9781555816827

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3

Semester	19MICP305: PRACTICAL III (MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY, BIOFUEL & BIOENERGY, MICROBIAL INOCULANTS & MUSHROOM TECHNOLOGY, BIOINSTRUMENTATION & RESEARCH METHODOLOGY)	L	P	C
III		-	12	06

Learning Objective (LO):

LO	To acquire skills to perform techniques in recombinant DNA technology, biomass briquetting, biogas production, biofertilizers, mushroom cultivation and chromatography techniques.

Course Outcomes (CO)

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

CO1:	Isolate genomic and plasmid DNA and undertake Molecular biology experiments.
CO2:	Quantify biogas and analyze biogas slurry.
CO3:	Cultivate Mushrooms.
CO4:	Undertake biomass briquetting uses coir pith, groundnut cake and bagasse.

Practicals:

1. Genomic DNA Isolation.
2. Plasmid DNA Isolation.
3. Restriction digestion.
4. Transformation.
5. Conjugation.
6. PCR
7. RAPD Fingerprinting.
8. Southern and Northern Blotting.
9. Quantification of biogas from different feedstock.
10. Analysis of nutritive value of biogas slurry.
11. Biomass briquetting – Coir pith, Groundnut cake, Bagasse.

12. Cultivation of button mushroom.
13. Cultivation of Oyster mushroom.
14. Production of microbial inoculants.
15. Cultivation of *Azolla.*
16. Separation of microbial cells using centrifugation
17. Production of buffer solutions and pH Measurements.
18. Protein estimation by spectrophotometric method.
19. Paper Chromatography.
20. Thin Layer Chromatography.
21. Preparation of molar solutions.

References:

1. Merck. (2000). *Microbiology Manual.*12th edition.
2. Cappuccino. and Natalie Sherman. (2014).*Microbiology A laboratory Manual.*10th edition.
3. Oelkers, P. (2016)10th*Molecular biology lab manual laboratory manual.*10thedition.
4. Sundararajan, T. (2007) *Microbiology laboratory manual*.2nd edition.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2

Semester	19PSCI300: CONSTITUTION OF INDIA	L	P	C
III		02	-	02

Learning Objective (LO):

LO	To understand the basic features of Indian Constitution. To grasp about the basic Rights & duties of Indian Citizenry To ponder over the form of Indian Political System. To have broad understanding about the pivotal provisions related with liberty, Equality and fraternity.

Course Outcomes (CO)

After completion of course students will be able to:

CO1:	Imbibed about the basic features of Indian Political System.
CO2:	Enlighten with the rights & duties of Indian Citizens.
CO3:	Understand the significance of rule of law.
CO4:	Inculcated with basic liberties.

Unit – 1: Introduction

Meaning of the Constructional law and Constitutionalism – Historical Perspective of the Constitution of India – Salient features Characteristics of the Constitution of India

.**Unit – 2: Rights and Duties**

Scheme of the Fundamental Rights – The scheme of the Fundamental Duties and its legal status – The Directive Principles of State Policy-Its importance and implementation

Unit – 3: Centre State Relationship

Federal Structure and distribution of legislative and financial powers between the union and the states- Parliamentary form of Government in India – The Constitution powers and status of the president of India.

Unit – 4: Amendments and Provisions

The Historical perspectives of the constitutional amendments in India – Emergency Provision: National Emergency, President Rule. Financial Emergency

Unit – 5: Institutions

Judiciary –Judiciary Activism – Amending Procedures- Recent Trends –Rights to Information- Lokpal and Lok Ayukta.

Text Books:

1. Bipan Chandra, Mridula Mukherjee, Adility Makherjee 2016., India after Independence 1947-2000, Penguin Publishers, New Delhi.
2. Durga Das Basu, 2018., Introduction to the Constitution of India Prentice Hall, New Delhi.
3. Jogendra Yadav 2000, Transforming India: Dynamics of Democracy, Oxford University Press, New Delhi

Supplementary Readings:

1. The Constitution of India 1950 (Bare Act), Government Publications.
2. Busi S.N Ambedkar B.R 2015 Framing of Indian Constitution
3. Jain M.P 2014 Indian Constitution Law Lexis Nexis
4. Paul R.Brass 1999.The politics of India Since Independence Cambridge University Press
5. Granvila Austin 2006.The Indian Constitution: Cornerstone of a Nation, Oxford University Press, New Delhi

OUTCOME MAPPING

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	2	-	-	-	-	-	-	-	2	-	-	-	-
CO2	1	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO3	2	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO4	-	2	2	-	-	-	-	-	-	-	2	-	-	-	-

Semester	19MICC401: MEDICAL DIAGNOSTIC TECHNOLOGY	L	P	C
IV		04	-	04

Learning Objective (LO):

LO	To learn the diagnostic methods and sample collection to diagnose the disease.

Course Outcomes (CO)

After completion of course students will be able to:

CO1:	Understand laboratory safety precautions, quality assurance and disposal of waste.
CO2:	Understand pathological analysis of clinical specimens.
CO3:	Know about blood grouping and analysis.
CO4:	Perform tissue fixation and staining.

Unit – 1: Laboratory Safety

Organization of laboratory and safety precautions in laboratory and personal cleanliness and care with regards to infected materials and chemical burns. Quality assurance and disposal of wastes. Maintenance of clinical laboratory instruments. Regulatory agencies NABL.

Unit – 2: Analysis of clinical specimens

Sample collection, preservation and transportation of various clinical pathology samples. Pathological analysis of clinical specimens

Unit – 3: Analysis of Blood

Collection and analysis of Blood, Blood cells, Separation of serum, plasma, complete, differential blood counts, platelet count, Determination of ESR, PCV. Blood grouping systems, Rh typing, Blood bank operation.

Unit – 4: Tissue Fixation and Staining

Tissue reception, labeling, fixation for different tissue and section cutting. Preparation of paraffin blocks. Handling and care of microtome sharpening of razors, and section cutting. Preparation of common stains. H & E, Congo red, methyl violet, Leishman stain, Giemsa, VG, PAS, PASM etc. and staining techniques.

Unit – 5: Biochemical Analysis & Serology

Liver, Renal functions and their assessment blood urea estimation, serum uric acid, total protein, albumin, globulin, glucose, cholesterol, bilirubin, estimation. Serological tests - agglutination and precipitation reactions

Current Streams of Thought

(Not for final Examination only for discussion)

APPT, FDP estimation; conventional and rapid methods of isolation and identification of microbes - Record keeping, indexing of slides and mounting museum specimens - Lab visit - Blood bank visit - Keeping track of advances in diagonostic techniques through internet, webinar and discussions.

Text Books:

1. Bros, J.P. (2012). Satish Gupte, - Short Text book of medical laboratory for technicians, New Delhi.

Supplementary Books:

1. Todd. and Sanford. (2011). Clinical Diagnosis by laboratory method. Nabu Press.

2. Orchard, G. (2011) Histopathology (Fundamentals of Biomedical Science). OUP Oxford.

3. Culling - Histopathology techniques.

4. Bain, Dacie and Lewis. (2011) Practical Haematology. Elsevier.

5. Ramani Sood. (2009). Laboratory Technology (Methods and interpretations) J.P.Bros, New Delhi, 6th edition.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	2	3	3	2	3	2	3	3	2
CO4	3	3	3	2	3	3	3	2	3	3	3	3	3	3	3

Semester	19MICC402: APPLIED MICROBIOLOGY	L	P	C
IV		04	-	04

Learning Objective (LO):

LO	To learn the applications of microbiology in diverse fields.

Course Outcomes (CO)

After completion of course students will be able to:

CO1:	**Understand the nature of soil microbial interactions.**
CO2:	Gain knowledge about Interactions between plant and microbes.
CO3:	Analyze the cause of various plant diseases and the principles of organic farming.
CO4:	Understand the impact of air and water contamination and evaluate air and water quality.
CO5:	Understand waste types and Bioremediation

Unit – 1: Microbial Diversity in Soil

Nature of soil - Soil as micro environment. Soil organic matters and humus, Soil and surface environment, Soil pores and movement of gases for microbial activity, Microbes in soil surface and different zones of soil. Decomposition of plant and animal residues by microorganisms in soil.

Unit – 2: Microbial Interactions in Soil

Interactions between plants and microbes – Phyllosphere, Mycorrhizae (Ecto, ,Endo, Ectendo & VAM), Rhizosphere – Symbiotic association in root nodules. Biofertilizers – *Rhizobium*, *Azotobacter, Azospirillum* and *Azolla*. Phosphate solubilising Bacteria. Soil anaerobes - Methanogens in rice field.

Unit – 3: Plant Diseases and Organic Farming

Plant diseases – Bacterial – Brown spot of rice and wilt of potato. Fungal – Leaf Blight of Potato and Red Rot of sugarcane. Viral diseases in cotton, Tomato, Potato, Tungro disease of Rice, Sugarcane Mosaic Virus. Organic farming - Management of nutrient weed, Insect pest and Diseases. Advantages, Limitations and Implications of Organic Farming.

Unit – 4: Air and Water Microbiology

Aero microbiology - A brief account on droplets, droplet nuclei, Aerosols - Air borne microbes and disease. Assessment of air quality. Water microbiology - Water microbial communities - Hydrosphere - Ecology of fresh water, Composition and Activity of fresh water, Microbial communities.

Unit – 5: Waste and Waste Management

Types of waste – Solid and liquid wastes. Treatment of solid waste – Composting, Vermicomposting, Saccharification and Gasification. Production of biogas from waste. Bioremediation – Principles and metabolic pathway for the biodegradation of Xenobiotics - and Hydrocarbons.

Current Streams of Thought

(Not for final Examination only for discussion)

Discussions on biodegradable plastics and super bug - Role of Microalgae and aquatic plants - to decrease radioactive pollution - Emerging plant disease/ pathogens - Applications of GIS and RS in environmental monitoring.

Text Books:

1. Mishra R.R., (2014). Soil Microbiology. CBS Publishers and Distributors, New Delhi.
2. Soil Microbiology 2018 by Prof. N.S. Subba Rao, Fourth Edition, Oxford and Ibh publishing CO.PVT, LTD., New Delhi.
3. Vijaya Ramesh K.E. 2013 Environmental Microbiology MJP publishers Chennai.

Supplementary Books:

4. Modern soil Microbiology, Drik J, Elas V, Trevors JT, Wellington, EMH (2017) Marcel Dekker INC, New York.
5. Microbial Ecology: (2005) Fundamentals and applications, Ronals M, Atlas, fourth edition, Animprint of Addison Wesley Longongman. Inc, California.
6. Shirish H. Sonawane, Y. PydiSetty, T. Bala Narsaiah, S. Srinu Naik 2017. Innovative Te
7. Technologies for the Treatment of Industrial Wastewater: A Sustainable Approach. Apple Academic Press.

Web References:

1. geography.name>the-nature-of the soil
2. https://www.mocroscopemaster.com

3. www.biologydiscussion.com
4. Vikaspedia.in>crop-production>organic
5. www.yourarticlelibrary.com

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2:	3	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO3:	3	3	3	3	3	2	3	3	2	3	3	2	3	3	3
CO4:	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CO5:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Semester	19MICP403: PRACTICAL IV (MEDICAL DIAGNOSTIC TECHNOLOGY & APPLIED MICROBIOLOGY)	L	P	C
IV		-	12	06

Learning Objective (LO):

LO	To learn the medical diagnostic techniques, methods to enumerate soil microorganisms, Aeromicrobiology and Water microbiology.

Course Outcomes (CO)

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

CO1:	**Enumerate soil microorganisms.**
CO2:	Identify free – living nitrogen fixing bacteria and symbiotic N_2 fixing bacteria from soil.
CO3:	Screen phosphate solubilizers from soil.
CO4:	Enumerate airborne microorganisms.
CO5:	Perform diagnostic techniques in microbiology.

Practicals:

1. Different methods of blood collection and preparation of anticoagulant bottles.
2. Cross matching major, minor.
3. Antibiotic Sensitivity Test – MIC, MBC.
4. Anti - Streptolysin “O” test.
5. CRP
6. HB, TC, DC and ESR
7. Analyses of clinical samples urine/sputum
8. Fixing and staining of tissues for pathological examination.
9. Enumeration of microorganism from air- Settle plate technique.
10. Isolation and enumeration of bacteria from soil by serial dilution methods.
11. Isolation and enumeration of Fungi from soil by serial dilution methods.
12. Isolation of free - Living Nitrogen Fixing Bacteria from soil - *Azotobacter.*
13. Cultivation of *Azolla.*
14. Isolation of entomopathogenic fungi
15. Microscopic demonstration of VAM fungi
16. Vermicomposting

17. Isolation of dye degrading organisms

References:

1. Kannan, N. Laboratory manual in General Microbiology (2002).
2. Sundararajan, T. Microbiology laboratory manual. 2nd edition (2007).
3. Rajan, S., & Selvi Christy. R., Experimental procedures in life sciences.1st edition (2010).

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2:	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3
CO3:	3	3	3	3	3	2	3	2	3	3	2	3	3	3	3
CO4:	3	3	3	3	3	3	3	3	2	3	3	3	3	2	3
CO5:	3	3	3	3	3	3	2	3	3	3	2	3	2	3	3

DEPARTMENTAL ELECTIVES

Semester	19MICE 205: ENTREPRENEURSHIP AND MANAGEMENT FOR MICROBIOLOGY	L	P	C
II		03	-	03

Learning Objective (LO):

LO	**To learn the basic concepts related to entrepreneurship within the life science sectors and to acquire knowledge about the production of biofertilizers and compost**

Course Outcomes (CO)

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

CO1:	**Explain bio entrepreneurship and describe its components and forms.**
CO2:	Gain knowledge about institutions and schemes of government of India.
CO3:	Understand the required skills for entrepreneurs.
CO4:	Gain knowledge about composting methods.
CO5:	Explain methods of production of Teaching kits and Diagnostic kits.

Unit – 1: Entrepreneurship

Evolution of the concept of entrepreneur - Entrepreneurship: Definitions- concept of Entrepreneurship, development - need - role of resource, talent and spirit - process of Entrepreneurship to socio-economic gains.

Unit – 2: Institutions And Schemes Of India

Institutions and schemes of government of India- Schemes and programmes. Department of science and technology schemes, Nationalized banks - other financial institutions, etc - SIDBI - NSIC - NABARD - 1DBI - IFCI - 1CICI etc.

Unit – 3: Development Of Skills

Skills for entrepreneurs - communication skills, problem solving skills; Business plan development; Market need - market research, SWOT analysis, identify your competition. Financial plan - obtain financing for your business, insure your business, Marketing - mix- product, distribution, price, promotion, set marketing goals.

Unit – 4: Composting & SCP

Composting - domestic waste, agricultural and industrial waste, vermi - composting. SCP production - Mushroom cultivation.

Unit – 5: Production Of Teaching And Diagnostic Kits

Biofertilizers and Biopesticides. Production of teaching kits (Plasmid DNA isolation, Serum electrophoresis) and Diagnostic kits (WIDAL test kits, ABO blood grouping kits).

Text Books:

1. Patzelt, H. and Brenner,T.(2008)*Handbook of Bio entrepreneurship*. Springer press. New york
2. Rao, N.S., (1995). *Biofertilizer in agriculture and forestry*. Oxford and IBH, New york.

Supplementary Books:

1. Teng, P.S.(2007). *Bioscience Entrepreneurship in Asia: Creating Value with Biology*, , World Scientific Publishing Co Pte Ltd. Singapore
2. Adams,D. and Sparrow,J. (2008) *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Scion Publishing Ltd. Banbury.
3. Rao, N.S., (2007). Biofertilizers in Agriculture. Oxford & IBH Publishing Co., Pvt., Ltd., Bombay.
4. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R., 2008. *Biofertilizer Technology*. Agrotech Publishing Academy. Udaipur, Rajasthan.

Web References:

1.http://www.rishibiotech.com/bioentrepreneurship

2.https://careerdevelopment.aaas.urg

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
CO2:	3	3	2	3	3	3	3	2	3	3	1	3	2	3	2
CO3:	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3
CO4:	3	3	3	2	3	3	3	3	3	3	3	2	3	1	3

Semester	19MICE 206: BIOREMEDIATION	L	P	C
II		03	-	03

Learning Objective (LO):

LO	To acquire knowledge about principles of bioremediation, process design for biotreatment studies and types of bioremediation

Course Outcomes (CO)

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

CO1:	Understand the principles of bioremediation.
CO2:	Understand the biodegradation process.
CO3:	Evaluate various types of bioreactors.
CO4:	Understand Bioremediation in fresh and marine water system.
CO5:	Understand the degradation of xenobiotics.

Unit – 1: Biology Of Bioremediation

Principles of Bioremediation – Rapid growth and Metabolism- Genetic plasticity – Metabolic pathways for the degradation of xenobiotics, hydrocarbons – Microbial site characterization – Biodegradation potential.

Unit – 2: Biodegradation Process

Bioprocess design, optimization – Microbial removal rates – inherent problems associated with biotreatment studies. Microbiological methodologies – Standard biotreatability protocols – Quantification of biodegradation; Biocleaning - Chernobyl radioactive contaminated area - Phytoremediation.

Unit – 3: Bioremediation And Its Types

Aerobic Bioremediation: Bioremediation of Surface Soils: Fate and transport of contaminants in the Vadose zone – Biodegradation in soil ecosystems – Types of soil treatment systems – Bioreactors. Subsurface Aerobic Bioremediation: in situ Bioremediation – in situ Bioventing – in situ treatments of Harbor Sediments and Lagoons.

Unit – 4: Applications Of Bioremediation

Bioremediation in fresh water and marine systems: Bench and Pilot Scale studies – in situ Bioreactor treatment of sediments – in situ treatment in marine ecosystem.

Unit – 5: Xenobiotics

Anoxic/Anaerobic Bioremediation: Anoxic/Anaerobic Processes – Fermentation, Degradation of Xenobiotic – Anoxic/Anaerobic bioremediation of hydrocarbons, Phenols, Chlorophenolic compounds, Polycyclic Aromatic Hydrocarbons (PAH), Heterocyclic Compounds, Cyanide, dyes, Radioactive wastes.

Text Books:

1. Pichtel,J. (2014) *Waste Management Practices: Municipal, Hazardous, and Industrial* 2nd ed. CRC Press. Florida
2. Hazardous Wastes and Solid Wastes, Liu, D.H.F and Liptak, B.G (2005), Lewis Publishers, New York.

Supplementary Books:

3. Atlas, R.M and Bartha, R., (2000) *Microbial Ecology*, 4th ed., Addison Wesley Longman Inc. Boston.
4. Madigan, M.T.Martinko, J.M.Stahl, D.A. Clark, D.A. (2010) *Brock Biology of Microorganisms*, - 12th ed. Pearson Benjamin Cummings. San Francisco.
5. Crawford, R.L.Crawford, D.L. (2009) *Bioremediation: Principles and Applications.* Cambridge University Press. Cambridge.

Web References:

1. www.environmentalpollution.in.
2. https://archive.epa.gov

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	2	3	3	3	1	3	3
CO2:	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2
CO3:	3	3	3	3	3	3	2	3	2	3	1	3	2	3	3
CO4:	3	3	3	3	3	3	3	3	3	3	3	1	3	1	3
CO5:	3	3	3	3	3	3	2	3	3	3	3	3	2	3	2

Semester	19MICE 207: MICROBIAL NANOTECHNOLOGY	L	P	C
II		03	-	03

Learning Objective (LO):

LO	To acquire knowledge about biological research with various fields of nanotechnology

Course Outcomes (CO)

To acquire knowledge about biological research with various fields of nanotechnology.

CO1:	Understand the nanotechnology concepts.
CO2:	Gain knowledge about Microbial nanotechnology & its applications.
CO3:	Acquire knowledge about preparation of nano biomaterials.
CO4:	Understand the nanoscale applications in biology and medicine.
CO5:	Gain knowledge about implications of Nanotechnology.

Unit – 1: Introduction To Nanotechnology

Characteristic scale for quantum phenomena, nanoparticles, nano - clusters, nanocomposite, nanotubes, nanowires and emergence of bionanotechnology. Characterization of nanoparticles - UV – Vis Spectroscopy, Electron Microscopic – HRTEM & SEM.

Unit – 2: Microbial Nanotechnology

Microbial synthesis of Nanoparticles - Synthesis of nanodrugs – metal nanoparticles and drug delivery vechicles - Nanoshells - Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

Unit – 3: Preparation Of Nanomaterials

Physical and chemical properties of nanoparticles – types, functions – Silver, Gold and Titanium. Electrochemical properties of Nanoscale Materials, Intra-molecular bonding, Inter - molecular bonding, Nanocatalysis. Interaction between biomolecules and nanoparticle surfaces.

Unit – 4: Applications Of Nanoscale In Biology And Medicine

Polymeric , Lipid nanoparticels for drug delivery , Micelles in drug delivery . Biosensors – protein in Nanotechnology enabled sensors – Nano - sensors based on

Nucleotides and DNA Microarrays – cell Biochips – *in vitro* characterization – *in vivo* Investigations.

Unit – 5: Implications Of Nanotechnology

Health and safety implications from nanoparticles: Health issues – Environmental issues - Need for regulation – societal implications: Possible military applications - potential benefits and risks for developing countries.

Text Books:

1. Parthasarathy, B.K. (2007). *Introduction to Nanotechnology*, IshaPublication.New Delhi

2. Papazoglou, E.S and Parthasarathy,A. (2007). *Bionanotechnology*. Morgan & Claypool Publishers. Williston

Supplementary Books:

1. Rehm, B. (2006). *Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures*. Horizon Scientific Press. London

2. Reisner, D.E.Bronzino, J.D. (2008). *Bionanotechnology: Global Prospects*. CRC Press. Florida

3. Gazit,E. (2006). *Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology.* Imperial College Press. London.

Web References:

1. https://www.ntnu.edu/physics/research/bionano
2. https://nanohub.org/resources/180

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	1	3	3	3	2	3	1
CO2:	3	3	3	3	3	3	2	3	3	2	2	3	3	3	3
CO3:	3	3	3	3	3	3	3	3	2	3	3	1	3	3	2
CO4:	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3
CO5:	3	3	3	3	3	2	3	3	2	3	2	3	1	3	2

Semester	19MICE 208: FOOD & DAIRY MICROBIOLOGY	L	P	C
II		03	-	03

Learning Objective (LO):

LO	To emphasize the beneficial role of microorganisms in fermented food, contamination, spoilage, preservation of foods and to gain knowledge about food safety and foodborne diseases.

Course Outcomes (CO)

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

CO1:	**Understand the types of microorganisms in food.**
CO2:	Gain knowledge about fermented food.
CO3:	Acquire knowledge about contaminations and spoilage of various food products.
CO4:	Explain food borne diseases.
CO5:	Demonstrate food preservation methods.

Unit – 1: Types Of Microorganisms In Food

Importance of food microbiology - Types of microorganisms in food - Source of contamination (Primary Sources) - Factors influencing microbial growth of food (extrinsic and intrinsic) Regulations in food industry-The Food Safety and Standards Authority of India, INFOSAN.

Unit – 2: Fermented Foods And Enzymes

Food fermentations: Cheese, Bread, Wine, Beer. Fermented vegetables - Methods and organisms used. Food and enzymes from microorganisms - Single Cell Protein. Production of Amylase, Protease and other enzymes from food.

Unit – 3: Food Spoilage And Preservation

Contamination, Spoilage and preservation of Cereals and Cereals products - Sugar and sugar products - Vegetables and fruits - Meat and meat products - Fish and the Sea foods - Egg and poultry - Dairy and fermentative products (Butter milk, Yoghurt, kefir, Kumis, acidophilus milk, Cheese production, Ice cream and other products).

Unit – 4: Food Borne Diseases

Food borne diseases, intoxication and food poisoning - *Staphylococcus, Clostridium, Vibrio cholerae, Escherichia coli* and *Salmonella* infections, Hepatitis, Polio myelitis, Amoebiosis, Giardiasis and Mycotoxins. Encounter of *Aeromonas* in food. EHEC and Enteropathogens. Sea food Toxicants.

Unit – 5: Food Preservation

Food preservation: Principles - Methods of preservation - Physical and chemical methods, Food hygiene, Food sanitation & control. Good manufacturing process and in the retail trade - Hazard analysis, Food control agencies & its regulations. Critical control Points and Personnel hygiene.

Current Streams of Thought

(Not for final Examination only for discussion)

Quiz on Prebiotics, Probiotics and synbiotics; advantage of probiotics, Field trip to food, dairy and beverage industries. Analysis of microbiological quality of milk and other food products - Algal and mycotoxin detection in food samples.- Government regulatory practices and policies FDA,EPA,ISI. Daily news and research papers on food borne outbreaks and food preservation

Text Books:

1. Adams, M.R. and M.O Moss. (2008).*Food Microbiology.* The Royal Society of Chemistry, Cambridge.
2. Doyle, M.P. (2005). *Handbook of Hygiene Control in the Food Industry*. 1nd Edn. Woodhead Publishing.
3. Frazier, W.C and Westhoff, D.C. (2013). *Food Microbiology*. TATA McGraw Hill Publishing Company Ltd. New Delhi.

Supplementary Books:

1. Jay, J.M.(2013). *Modern Food Microbiology*. 7th Edn. CBS Publishers and Distributors, New Delhi.
2. Stanbury, P.F., Whittaker, A. and Hall, S.J., (2009). *Principles of fermentation technology.* 2nd edition, Pergamon press.

Web References:

1. http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.org__Principles_of_Fermentation_Technology.pdf
2. https://www.sciencedirect.com/topics/food-science/food-fermentation

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	2	3	3	3	2	2	2
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3

Semester	19MICE 306: MICROBIAL DIVERSITY & EXTREMOPHILES	L	P	C
III		03	-	03

Learning Objective (LO):

LO	The aim of the course will be on the concept of microbial diversity and characteristics of microorganisms in extreme conditions

Course Outcomes (CO)

After completion of course students will be able to:

CO1:	Know about a Microbial Biodiversity.
CO2:	Gain knowledge about Characteristics, classification and applications of Extremophiles.
CO3:	Understand the Alkalophiles and Acidophiles.
CO4:	Understand about the halophilic and basophilic microorganisms and its importance.
CO5:	Get knowledge about Space Microbiology.

Unit – 1: Biodiversity

Biodiversity Introduction to microbial biodiversity - distribution, abundance, ecological niche. Types - Bacterial, Archael and Eucaryol.

Unit – 2: Extremophiles

Characteristics and classification of Archaebacteria. Thermophiles Classification, hyperthermophilic habitats and ecological aspects. Extremely thermophilic Archaebacteria, thermophile, commercial aspects of thermophiles. Applications of thermozymes. Methanogens: Classification, Habitats, applications.

Unit – 3: Alkalophiles And Acidophiles

Alkalophiles and Acidophiles Classification, alkaline environment, soda lakes and deserts, calcium alkalophily Applications. Acidophiles Classification, life at low pH, acidotolerence, applications.

Unit – 4: Halophiles and Basophiles

Halophiles and Basophiles Classification, Dead Sea, discovery basin, cell walls and membranes - Purple membrane, compatible solutes. Osmoadaptation/ halotolerence. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, basophile, death under pressure.

Unit – 5: Space Microbiology

Space Microbiology aims and objectives of Space research. Life detection methods -Evidence of metabolism (Gulliver) - Evidence of photosynthesis (autotrophic and heterotrophic) - ATP production - Phosphate uptake - Sulphur uptake. Martian environment (atmosphere, climate and other details).

Reference Books:

1 Singh, O.V. (2012) *Extremophiles: Sustainable Resources and Biotechnological Implications*, Wiley - Blackwell. New Jersey.

2 Gerday, C.G lansdorff, N. (2007) *Physiology and Biochemistry of Extremophiles*, ASM Press. Newyork.

3 Anitori, R.P. (2012) *Extremophiles: Microbiology and Biotechnology,* Caister Academic Press. Norfolk.

4 Breidahl, H. (2001) Extremophiles: Life Extr. Envirn. Chelsea House Publications. Philadelphia.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3
CO2:	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2
CO3:	3	3	3	3	3	3	3	3	3	2	2	3	2	3	2
CO4:	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3
CO5:	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2

Semester	19MICE 307: ENVIRONMENTAL MICROBIAL TECHNOLOGY	L	P	C
III		03	-	03

Learning Objective (LO):

LO	To provide a fundamental knowledge about the various scopes in environmental studies

Course Outcomes (CO)

After completion of course students will be able to

CO1:	Demonstrate an understanding of key concepts in ecosystems.
CO2:	know the microorganisms responsible for water pollution.
CO3:	Understand the various assessment techniques of air quality.
CO4:	Describe about different sewage treatment methods employed in waste water treatment.
CO5:	Learn about the global environmental problems.

Unit – 1: Ecosystems

Environment and Ecosystems - Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics structure and function. Food chains, food webs and tropic structures. Ecological pyramids.

Unit – 2: Eutrophication

Eutrophication Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition - causes - microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment - factors influencing eutrophication. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication. Physico - chemical and biological measures to control eutrophication.

Unit – 3: Aerobiology And Airborne Diseases

Aerobiology - Droplet nuclei, aerosol, assessment of air quality, - solid – liquid -impingement methods - Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures.

Unit – 4: Waste Treatment Methods

Waste treatment techniques - Wastes - types - solid and liquid wastes characterization - solid - liquid; treatments - physical, chemical, biological - aerobic - anaerobic - primary - secondary - tertiary; solid waste treatment - saccharification - gasification - composting. Utilization of solid wastes - food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment – trickling filter– activated sludge – oxidation pond - oxidation ditch.

Unit – 5: Bioremediation

Bioremediation & Global environmental problems Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behavior, bio magnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues - Ozone depletion, UV - B, greenhouse effect and acid rain, their impact and biotechnological approaches for management.

Reference Books

1. Crawford, R.L. Crawford, D.L. (2009) *Bioremediation: Principles and Applications.* Cambridge University Press. Cambridge.
2. Eldowney, S. Hardman D.J. and Waite S. (1993)*Pollution: Ecology and Biotreatment* Longman Scientific Technical. Harlow.
3. Glymph,T. (2005) *Wastewater Microbiology: A Handbook for Operators*, Amer Water Works Assn, Mumbai.
4. Bhattacharyya, B.C. Banerjee,R. (2007) *Environmental Biotechnology*. Oxford University Press. Oxford.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2:	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3
CO3:	3	3	3	3	3	3	3	3	2	2	3	3	3	3	2
CO4:	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3
CO5:	3	3	3	3	3	3	3	3	2	3	3	3	3	1	2

Semester	19MICE 308: VERMITECHNOLOGY	L	P	C
III		03	-	03

Learning Objective (LO):

LO	To gain knowledge about the basic principles of vermicompost production and its importance in agriculture

Course Outcomes (CO)

After completion of course students will be able to:

CO1:	Gain knowledge about major types of soil.
CO2:	Understand the characteristics of soil.
CO3:	Describe the role of earthworms in soil.
CO4:	To know the production methods for composting.
CO5:	Develop an understanding of utilization of earthworms for vermicompost production.

Unit – 1: Soil Types

General characteristics of soil - structure of the soil - sand, clay, salt, types of soils – role of microorganisms in soil fertility.

Unit – 2: Soil Properties

Physical properties of soil - soil colour, soil moisture, soil temperature, bulk density of soil, chemical properties of soil PH, Electrical conductivity, organic, Nitrogen, Phosphate and potash.

Unit – 3: Earthworm Biology

Soil biota - Earthworms - Ecological classification of earth worms as Epigeics - Introduction to earthworm biology - physical and chemical effects of earth worms on soils - Role of earthworms in soil - classification of earthworms based on ecological strategies- Burrowing activity of earthworms - Drilospheres - Microorganisms and their relationship with earthworms.

Unit – 4: Composting

Composting - anaerobic composting, aerobic composting, types of composting, vermicompost earthworm species used in vermicompost production - endemic species, exotic species.

Unit – 5: Vermiculture

Vermicopost - setting up vermicompost quality N, P, K, C, N, Microbial quality applications — vermiculture - vermiwash — role of vermicompost in organic farming - its quality and advantages over chemical inputs. Earthworms in Bio - reclamation of soil. Problems in vermiculture units - remedial suggestions. Vermicomposting as a tool for solid waste management - a small scale industry and it's economics.

Text Books:

1. Whitley,N. (2015). *The Application of Geology to Agriculture*, Palala Press. Poland
2. Singh, M.S. and Chaudhuri,P. (2014). *Biology and Ecology of Tropical Earthworms*, Discovery Publishing House Pvt. Ltd. New Delhi
3. Satchell, J.E., (2012). *Earthworm ecology: From Darwin to Agriculture*. Chapman and Hall, London.
4. Dash, M.S. (2012). *Charles Darwin's Plough Earthworm Biology, Ecology and Tool for Vermitechnology*, I K International Publishing House. New Delhi.

Supplementary Books:

1. Barrett, T.J. (2018). *Harnessing the Earthworm*, Forgotten Books. London
2. Yadav, S. and Singh, V.K. (2014). *Vermitechnology: Rebuilding of Sustainable Rural Livelihoods,* Nova Science Publishers. New York.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2
CO2:	3	3	3	3	2	3	2	3	3	3	3	3	2	3	3
CO3:	3	3	3	3	3	3	3	3	2	3	2	3	3	2	3
CO4:	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3
CO5:	3	3	3	3	3	3	2	3	2	3	3	2	3	2	3

Semester	19MICE309: IPR, BIOSAFETY & BIOETHICS	L	P	C
III		03	-	03

Learning Objective (LO):

LO	To learn the basic concepts of Intellectual Property Rights, patents and awareness about Bio safety and ethics.

Course Outcomes (CO)

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

CO1:	Understand the concepts, criteria and importance of IPR and patents.
CO2:	Understand agreements, treaties and recent amendments.
CO3:	Explain logics and concepts of patents.
CO4:	Follow Biosafety practices in a Laboratory.
CO5:	Understand the principles of bioethics.

Unit – 1: IPR - Types And Functions

Introduction to Intellectual Property - IPR - Definition - Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, IP as a factor in R&D; IPs of relevance to Microbiology / Biotechnology and few Case Studies WTO - Definition - Functions - Forms of IPR Protection.

Unit – 2: Agreements And Treaties

Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & Recent Amendments.

Unit – 3: Types And Applications Of Patents

Basics of Patents and Concept of Prior Art IPR & edits. Introduction to Patents; Types of Patent Applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and Complete; Process of Patenting, Indian and International Agencies Involved in IPR & Patenting, Global Scenario of Patents and India's Position, Patenting of biological material, GLP, GMP.

Unit – 4: Biosafety

Biosafety – Introduction. Different levels of biosafety. Guidelines for Recombinant DNA Research Activities in Microorganisms. Good Laboratory Practices (GLP). Containments – Types. Basic Laboratory and Maximum Containment microbiology Laboratory research.

Unit – 5: Bioethics

Bioethics - Definition – Principles of Bio ethics – General Issues Related to Environmental release of Genetically Modified Microorganisms. Ethical Issues Related to the use of Animal as Models for Microbial Diseases - Animal ethics Norms in India - Licensing of Animal House - Ethical Clearance Norms for Conducting Studies on Human Subjects. Ethical Issues Related to Research in Embryonic Stem Cell Cloning.

Current Streams of Thought

(Not for final Examination only for discussion)

Ethical concerns in human gene therapy - Ethical issues at the beginning of life, Ethical issues at the end of life. Daily news and research paper on IPR. Interactive sessions depicting the role of GLP

Text Books:

1. John Bryant (2005). *Bioethics for Scientists*. John Wiley and Sons.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.

Supplementary Books:

1. BAREACT.(2007).*Indian Patent Act 1970 Acts & Rules.* Universal Law Publishing Co. Pvt. Ltd.,
2. Christian Lenk, Nils Hoppe, Roberto Andorno. (2007). *Ethics and Law of Intellectual Property: Current Problems in Politics*, Science and Technology, Ashgate Publisher (p) Ltd.
3. Felix Thiele, Richard E. Ashcroft. (2005). *Bioethics in a Small World*. Springer.
4. Glick, B.R., and Pasternak. (2009). *Molecular Biotechnology.* 4th Edition, J.J., ASM Press, Washington, DC.

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOME										PROGRAMME SPECIFIC OUTCOME				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	2	3	2	2	2	3	3
CO3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	2	2	3	2	2	2	3	3
CO5	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3