Annamalai University

(Accredited with 'A' Grade by NAAC)

M.Sc. Microbiology (Two-Year) Programme

Regulations & Curriculum - 2019

Department of Microbiology
Faculty of science

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE TWO-YEAR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculties of Arts, Science, Indian Languages, Education, Marine Sciences, and Fine Arts from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centres 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/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/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 also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

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.

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 Two Year M.Sc. Microbiology 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 are eligible for admission.

2.1 In the case of SC/ST and Differently - abled candidates, a pass is the minimum qualification for all the above Programmes.

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 Programmes 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.

5.3.3 Students shall take a combination of both DEs and IDEs.

5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

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

5.4.3 Experiential learning is categorised as Core.

5.5 Project

5.5.1 Each student shall undertake a Project 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 recognised institutions/industry shall obtain prior permission from the University. The

Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

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. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

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 organised as follows:

	Credits
Core Courses	65-75
Elective Courses	15
Project	6-8
Total (Minimum requirement for award of Degree)	**90-95***

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 90-95 credits.*

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 per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) 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 organisation of lesson plan of the Course Instructor.

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

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor 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, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

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

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6 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.

8.5 End Semester Examinations (ESE)

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

8.5.2 A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

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. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

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

9.1.3 For the Practical courses, the CIA Tests will constitute 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 Instructor

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

	Marks
Test-I & Test-II	15

Seminar	05
Assignment	05
Total	25

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

	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 both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation 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)	
Review-I 10	Review-II: 15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 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 from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GGG = \frac{\sum_{GG\,G}^{G} G_G G_G}{\sum_{GG\,G}^{G} G_G}$$

where, G_G is the Credit earned for the Course G in any semester;

G_G is the Grade Point obtained by the student for the Course G and

G 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.

$$GGGG = \frac{\sum_{GG\,G}^{G} \sum_{GG\,G}^{G} G_G G_G}{\sum_{GG\,G}^{G} \sum_{GG\,G}^{G} G_G}$$

where, G_G is the Credit earned for the Course G in any semester;

G_G is the Grade Point obtained by the student for the Course G and

G is the number of Courses passed in that semester.

G is the number of semesters

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

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

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

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or 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 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **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 highest marks in all examinations at the first appearance alone will be considered 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 card 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.

12.3 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.

12.4 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.

12.5 Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

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

12.7 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 sensitised 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

Programme Structure
(For students admitted from the academic year 2019-2020)

Course Code	Course Title	L	P	C	CIA	ESE	Total
		Hours/ Week					
SEMESTER - I							
19MIBC101	Core 1: General Microbiology	4		4	25	75	100
19MIBC102	Core 2: Pharmaceutical Chemistry & Pharmaceutical Microbiology	4		4	25	75	100
19MIBC103	Core 3: Immunology &Immuno Technology	4		4	25	75	100
19MIBP104	Core 4: Practical I (Core course- 1,2 & 3)		12	6	40	60	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
	Total credits			21			
SEMESTER - II							
19MIBC201	Core 5 : Bioprocess Technology	4		4	25	75	100
19MIBC202	Core 6: Bacteriology & Virology	4		4	25	75	100
19MIBC203	Core 7: Mycology & Parasitology	4		4	25	75	100
19MIBP204	Core 8: Practical – II (Core course - 5, 6 & 7)		12	6	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
	Elective 3: Department Elective	3		3	25	75	100
	Total credits			**24**			
SEMESTER - III							
19MIBC301	Core 9: Molecular biology & Recombinant DNA Technology	3		4	25	75	100
19MIBC302	Core 10: Biofuel & Bioenergy	4		4	25	75	100
19MIBC303	Core 11: Microbial Inoculants And Mushroom Technology	4		4	25	75	100
19MIBC304	Core 12: Bioinstrumentation & Research Methodology	4		4	25	75	100
19MIBP305	Core 13: Practical – III (Core course -9, 10, 11 & 12)		12	6	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Elective 5: Department Elective	3		3	25	75	100
	Total credits			**28**			

SEMESTER - IV							
19MIBC401	Core 14: Medical Diagnostic Technology	4		4	25	75	100
19MIBC402	Core 15: Applied Microbiology	4		4	25	75	100
19MIBP403	Core 16: Practical – IV (Core course14 &15)		6	6	40	60	100
19MIBPJ404	Project work / In-plant Training		10	6		75 25	100
	Total Credits			**20**			
	TOTAL CREDITS			**93**			
	Value Added Courses						
	Online Courses (SWAYAM, MOOC, NPTEL)						

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.**
2. **Students may opt for any Value-added Courses listed in the University website.**

ELECTIVE COURSES

DEPARTMENTAL ELECTIVES (DE)

Course Code	Course Title	L	P	C	CIA	ESE	Total
		Hours/ Week					
19MIBE 215.1	Entrepreneurship And Management For Microbiology	3		3	25	75	100
19MIBE 215.2	Bioremediation	3		3	25	75	100
19MIBE 215.3	Microbial Nanotechnology	3		3	25	75	100
19MIBE 215.4	Food And Dairy Microbiology	3		3	25	75	100
19MIBE 315.1	Microbial Diversity And Extremophiles	3		3	25	75	100
19MIBE 315.2	Environmental Microbial Technology	3		3	25	75	100
19MIBE 315.3	Vermitechnology	3		3	25	75	100
19MIBE 315.4	IPR, Biosafety & Bioethics	3		3	25	75	100

INTER - DEPARTMENT ELECTIVE COURSE (IDE) (Offered to other departments)

Course Code	Course Title	L	P	C	CIA	ESE	Total
		Hours/ Week					
19MIBX315.1	Microbiology	3		3	25	75	100

INTER-DEPARTMENT ELECTIVE COURSE (IDE) (Offered by other departments)

	Course Code	Course Title	Department	L	P	C	CIA	ESE	Total
				Hours/ Week					
1	19 SOSX115.1	Soft Skills	**English**	3	0	3	25	75	100
2	19 MATX215.1	Discrete Mathematics	**Mathematics**	3	0	3	25	75	100
3	19 MATX215.2	Numerical Methods		3	0	3	25	75	100
4	19 MATX315.1	Differential Equations		3	0	3	25	75	100
5	19 STSX215.1	Statistical Methods	**Statistics**	3	0	3	25	75	100
6	19 STSX215.2	Mathematical Statistics		3	0	3	25	75	100
7	19 STSX315.1	Bio-Statistics		3	0	3	25	75	100
8	19 PHYX215.1	Classical Mechanics and Special Theory of Relativity	**Physics**	3	0	3	25	75	100
9	19 PHYX215.2	Physics of the Earth		3	0	3	25	75	100
10	19 PHYX315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11	19 PHYX315.2	Energy Physics		3	0	3	25	75	100
12	19 CHEX215.1	Applied Chemistry	**Chemistry**	3	0	3	25	75	100
13	19 CHEX315.1	Basic Chemistry		3	0	3	25	75	100
14	19 CHEX315.2	Instrumental Methods of Analysis		3	0	3	25	75	100
15	19 BOTX215.1	Plant Tissue Culture	**Botany**	3	0	3	25	75	100
16	19 BOTX215.2	Plant Science – I		3	0	3	25	75	100
17	19 BOTX315.1	Gardening and Horticulture		3	0	3	25	75	100
18	19 BOTX315.2	Plant Science – II		3	0	3	25	75	100
19	19 ZOOX215.1	Animal Culture Techniques	**Zoology**	3	0	3	25	75	100
20	19 ZOOX315.1	Environmental Science		3	0	3	25	75	100
21	19 GEOX215.1	Environmental Geosciences	**Earth Sciences**	3	0	3	25	75	100
22	19GEOX 315.1	Applied Geophysics		3	0	3	25	75	100
23	19 BIOX 215.1	Basic Biochemistry	**Biochemistry & Biotechnology**	3	0	3	25	75	100
24	19 BIOX 215.2	Basic Biotechnology		3	0	3	25	75	100
25	19 BIOX 315.1	Biochemical Techniques		3	0	3	25	75	100
26	19 BIOX 315.2	Immunology		3	0	3	25	75	100
27	19 CSCX 215.1	R Programming	**Computer & Information Science**	3	0	3	25	75	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 - I **Credits: 04**

Hours: 04

19MIBC101: GENERAL MICROBIOLOGY

Learning Objectives (LO):

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

Unit – 1: History And Classification Of Microorganisms

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

Unit – 2: Microscopy And Staining Methods

Microscopy**:** Simple, Compound, Dark - Field, Phase contrast, Fluorescent 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. Text Book of Microbiology, Orient Longman, 2009.
3. Pelczar, Chan & Kreig (2009). Microbiology5th edition. Tata McGraw Hill, New Delhi.

Supplementary Books:

4. Willey, Joanne M. *Prescott's Microbiology*. 9th Edition: McGraw-Hill Education - London, 2014.
5. 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

Course Outcomes (COs):

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

Outcome Mapping:

COURSE OUTCOME	PROGRAMME OUTCOMES										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 - I **Credits: 04**

Hours: 04

19MIBC102: PHARMACEUTICAL CHEMISTRY & PHARMACEUTICAL MICROBIOLOGY

Learning Objectives (LO):

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

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.

Unit – 6: (Not for final Examination)

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., Industrial Microbiology, New Age International (2007).
2. Agarwal AK & 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, Fundamentals of Analytical Chemistry, (2013), 9th edition, Brooks/Cole Cengage learning; ISBN; 9780495558286.

Supplementary Books:

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

Web references:

1. Pharmacology; action and Uses of Drugs by Maurice Vejux Tyrode.
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.

Course Outcomes (COs):

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.

Outcome Mapping:

COURSE	PROGRAMME OUTCOME	PROGRAMME SPECIFIC OUTCOME

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 - I **Credits: 04**

Hours: 04

19MIBC103: IMMUNOLOGY & IMMUNO TECHNOLOGY

Learning Objectives (LO):

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

Unit – 1: Immunity And Immune System

Types of immunity: Innate and Acquired – Humoral immunity and Cell mediated Immunity: Central and Peripheral Lymphoid Organs. Thymus, Bonemarrow, Spleen, Lymphnodes and other Peripheral lymphoid tissue - GALT. Cells of the immune system – Detailed aspects of T -cell and B- cell, Macrophages, Phagocytes, NK cells, 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. Hypersensitivity reactions - Immunological tolerance, Immunosuppression, Immunodeficiency disorders. Tumors: Immune response to tumors - Type of tumor antigens. Immunity to infection. Vaccines - DNA Vaccines and Edible vaccines.

Unit – 4: Sample Collection And Processing

Guidelines for the collection, Transport, Processing and analysis of clinical specimens - Blood, Urine, CSF, Swabs, Fluids. Detection and identification of pathogens and reporting of cultures from specimens. NABL, CISL regulations.

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.

Unit – 6: (Not for final Examination)

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. Microbiology Lab Manual [2007] John P.Harley 7thedition McGraw Hill Medical publication division.
2. Ramanisood Laboratory technology [Methods and interpretation] 6thEd.2009J.P.Bros, New Delhi.
3. Owen, J., Punt, J and Strandford, S. “Kuby Immunology”, 7th Ed., W. H. Freeman Publication, New York, USA, 2012.

Supplementary Books:

4. P.J.Delves, SJ.Martin, DR.IM.Roitt [2011]. Roitt’s Essential Immunology. Blackwell Scientific Publications, Oxford.
5. Rao,C.V[2008], Immunology, Narosa Publishing House, India.
6. T.J.Kindt, RA.Goldsby, BA.Osborne, Janis Kuby 2008.Cuby Immunology III Edn. Panima Book 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

Course Outcomes (COs):

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.

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 - I **Credits: 06**

Hours: 12

19MIBP104: PRACTICAL I

(GENERAL MICROBIOLOGY, PHARMACEUTICAL CHEMISTRY & PHARMACEUTICAL MICROBIOLOGY, IMMUNOLOGY & IMMUNO TECHNOLOGY)

Learning Objectives (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.

Practicals:

1. Different methods of sterilization.
2. Preparation of Media: Nutrient broth, Nutrient agar, plates, Slants, Soft agar, Blood agar, Selective Media.
3. Determination of growth - Growth curve.

4. Pure culture techniques Streak plate, Spread plate &Pour plate methods.
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.
8. Staining methods: Simple, Negative, Acid fast, Gram staining, Spore, Capsule, Metachromatic granular staining, Lactophenol Cotton Blue staining, Fungal slide culture.
9. Antibiotic fermentation.
10. Sterility testing by *Bacillus sterothermophilus.*
11. Sampling of pharmaceuticals for microbial contamination and load (Syrups, Suspensions, creams and ointments, ophthalmic preparations)
12. Determination of antimicrobial activity of a chemical compound (Phenol, Resorcinol, Thymol, Formaldehyde) to that of phenol under standardized experimental conditions.
13. Blood group typing.
14. Identification of leukocytes from blood smear.
15. RPR test.
16. Anti- Streptolysin O test.
17. ELISA-HIV [Demonstration].
18. Counter Immuno Electrophoresis.
19. Pregnancy test

References:

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

Course Outcomes (COs):

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.

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 - II **Credits: 04**

Hours: 04

19MIBC201: BIOPROCESS TECHNOLOGY

Learning Objectives (LO):

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

Unit – 1: Fermentation Process

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

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, Temperature - Computer application in fermentation technology.

Unit – 3: Mass Transfer and Types

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 Of 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.

Unit – 6: (Not for final Examination)

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. Industrial Microbiology 2/e. LAXMI PUBLICATIONS-NEW DELHI (2015)
3. W. Clarke. Biotechnology: Industrial Microbiology A Textbook 1/e 2016.
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:

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

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

Course Outcomes (COs):

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.

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 - II **Credits: 04**

Hours: 04

19MIBC202: BACTERIOLOGY & VIROLOGY

Learning Objectives (LO):

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

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, Neisseriae [Gonococci &*

Meningococci], 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. 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 disease causing - 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. Viral vaccines and Antiviral agents.

Unit – 6: (Not for final Examination)

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:

5. Paul G Western, MV Michael Valentine, Essentials of Bacteriology, Wentworth press, 2016.
6. Paul Hyman & Stephen T. Adedon, Coasster, Viruses of Microorganisms, Academic Press, 2018.

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/

Course Outcomes (COs):

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

CO1:	Demonstrate 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.

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 - II **Credits: 04**

Hours: 04

19MIBC203: MYCOLOGY & PARASITOLOGY

Learning Objectives (LO):

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

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 cruzi and T.brucei, Haemosporina* - Malarial parasite. Coccidian – *Toxoplasma gondi, Cryptosporidium parvum.*

Unit – 4: Parasites – Helminths

Infection of helminthes -*Taenia solium, T.saginata, Echinococcus granulosus, Fasciola hepatica, Paragonimus westermani* and *Schistosoma haematobium, S. mansoni, 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.

Unit – 6: (Not for final Examination)

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

Supplementary Books:

4. Errolraiss H. Jeanshadorry, G. Mashallyon, Fundamental Medical Mycology, Weiley Blackwell, 2014.
5. Russel F. Cheadle and Ruth Leventhal, Medical Parasitology, 2011.

Web References:

1. http://dmoz.org/Science/Biology/Microbiolgy//
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.htm
5. http:// www. Pitt.edu/-super1/lecture/lec4771/

Course Outcomes (COs):

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 helminths**.**
CO5:	Understand common lab techniques used in the identification of parasites.

Outcome Mapping:

COURSE	PROGRAMME OUTCOME	PROGRAMME SPECIFIC OUTCOME

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 - II **Credits: 06**

Hours: 12

19MIBP204: PRACTICAL II

(BIOPROCESS TECHNOLOGY, BACTERIOLOGY & VIROLOGY, MYCOLOGY & PARASITOLOGY)

Learning Objectives (LO):

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

Practicals:

1. Wine production- Total acidity, Alcohol Estimation and Sugar Estimation.
2. Production and quantification of
    a. Alcohol
    b. Citric acid
    c. Protease
    d. Amylase
    e. Lipase
3. Identification of pathogenic microorganisms from a given samples
    a. Pus
    b. Blood
    c. *Salmonella typhi*
    d. Urine
    e. Stool
    f. Sputum
4. Isolation and characterization of bacteriophage from natural sources.

5. Egg inoculation techniques[All routes][Demonstration].
6. Spotters of Viral inclusions and CPE –stained smears.
7. Skin/nail scrapings for fungi isolation.
8. Lactophenol Cotton Blue mount for identification of fungi.
9. Germ tube test for yeast.
10. Sugar assimilation test for yeast.
11. Cultivation of following fungi and their identification in SDA and Corn Meal Agar - *Mucor, Rhizopus, Penicillium, Candida, Aspergillus*.
12. Isolation of ova /cyst in faeces [Direct and concentration methods].
13. Spotters of Anopheles, Glossina, Ticks, Mites, Sand fly.
14. 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).

Course Outcomes (COs):

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

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 - III **Credits: 04**

Hours: 04

19MIBC301: MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY

Learning Objectives (LO):

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

Unit – 1: Structure And Properties Of DNA

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

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 (Prokaryotes and Eukaryotes) - Types of DNA polymerase in bacteria and their role – Inhibitors of DNA replication. DNA damage and repair.

Unit – 3: Transcription And Translation

Transcription, Translation (Brief account only), 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 termination. 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, Gene therapy - Recombinant products - Recombinant hormones - Recombinant vaccines - Genetic engineering guidelines - Containment levels - Indian guidelines. Applications of Genomics - Proteomics.

Unit – 6: (Not for final Examination)

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.Manorama Singh, 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, StephenP. 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

Course Outcomes (COs):

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.

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 - III **Credits: 04**

Hours: 04

19MIBC302: BIOFUEL & BIOENERGY

Learning Objectives (LO):

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

Unit – 1: Classification And Types Of Biofuels

Introduction Classification of biofuels - liquid and gaseous. Gaseous biofuels: 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 - Manure 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.

Unit – 6: (Not for final Examination)

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.

Supplementary Books:

4. V. K. Gupta, M. Tuohy, C. P Kubicek, J Saddler, Feng Xu, Bioenergy Research: Advances and Applications, 2014, Elsevier press.
5. Vaughn C. Nelson, Kenneth L. Starcher. Introduction to Bioenergy 2016 CRC Press.

Web References:

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

Course Outcomes (COs):

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.

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 - III **Credits: 04**

Hours: 04

19MIBC303 - CORE 11: MICROBIAL INOCULANTS AND MUSHROOM TECHNOLOGY

Learning Objectives (LO):

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

Unit – 1: Bacterial Biofertilizers

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

Unit – 2: Fungal Biofertilizers

Fungal Biofertilizers - Ectomycorrhizal association with pines: Vescicular Arbuscular Mycorrizal Association (VAM) – *Glomus* sp: Actimomycetes as Biofertilizers - Actinomycetes associations - *Frankia* sp.

Unit – 3: Mushroom and its types

Edible and non-edible mushroom (Historical account, most commonly cultivated mushrooms in the world, Distribution and production in various countries).

Unit – 4: Mushroom Cultivation - I

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

Unit – 5: Mushroom Cultivation - II

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

Unit – 6: (Not for final Examination)

Mushroom research and development; National and international agencies; present status of mushroom industry in India - Novel technologies for preservation - Marketing values in India; Export value (Discussions) - Debate on biofertilizers v/s chemical fertilizers(All aspects).

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. Biofertilizer 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

Course Outcomes (COs):

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

CO1:	Appreciate the importance of microbial inoculants and biofertilzers 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.

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 - III **Credits: 04**

Hours: 04

19MIBC304: BIOINSTRUMENTATION & RESEARCH METHODOLOGY

Learning Objectives (LO):

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

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.

Unit – 6: (Not for final Examination)

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. R H. Baltz Demain, A.L. and Davies, J.E. (2010). Manual of Industrial Microbiology & Biotechnology, ASM Press.
2. D B. Murphy, M W. Davidson. (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:

4. John G. Webster. (2008). Bioinstrumentation. University of Wisconsin, John Wiley & Sons, Inc.
5. 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

Course Outcomes (COs):

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.

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 - III **Credits: 06**

Hours: 12

19MIBP305: PRACTICAL III

(MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY, BIOFUEL & BIOENERGY, MICROBIAL INOCULANTS AND MUSHROOM TECHNOLOGY, BIOINSTRUMENTATION & RESEARCH METHODOLOGY)

Learning Objectives (LO):

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

Practicals:

1. Genomic DNA Isolation.
2. Plasmid DNA Isolation.

3. Restriction digestion.
4. Transformation.
5. Conjugation.
6. PCR
7. RAPD Fingerprinting (Demo).
8. Southern and Northern Blotting (Demo).
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. pH Measurements.
17. Protein estimation (Lowry et.al/ Brad ford).
18. Paper Chromatography.
19. Thin Layer Chromatography.
20. Preparation of molar solutions.

References:

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

Course Outcomes (COs):

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

CO1:	Isolate genomic and plasmid DNA and undertake Molecular biology e-periments.
CO2:	Quantify biogas and analyse biogas slurry.
CO3:	Cultivate Mushrooms
CO4:	Undertake biomass briquetting uses coirpith, groundnut cake and bagasse.

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 - IV **Credits: 04**

Hours: 04

19MIBC401: MEDICAL DIAGNOSTIC TECHNOLOGY

Learning Objectives (LO):

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

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 (Dehydration, clearing, embedding, blocking). 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

Unit – 6: (Not for final Examination)

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

Supplementary Books:

2. Todd and Sanford, Clinical Diagnosis by laboratory method.2011, Nabu Press.
3. G. Orchard, B Nation Histopathology (Fundamentals of Biomedical Science), 2011, OUP Oxford.
4. Culling -Histopathology techniques.
5. Bain, Dacie and Lewis Practical Haematology.2011, Elsevier.
6. Ramani Sood. Laboratory Technology (Methods and interpretations) 6th Ed.2009 J.P. Bros, New Delhi.

Course outcomes (COs):

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 fi-ation and staining

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 - IV **Credits: 04**

Hours: 04

19MIBC402: APPLIED MICROBIOLOGY

Learning Objectives (LO):

To learn the applications of microbiology in diverse fields.

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 free living Azolla. Phosphate Solubilising Bacteria. Soil anaerobic 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, TMV, Cauliflower mosaic Virus. Organic farming - Management of nutrient weed, Insect pest and Diseases. Advantages, Limitations and Implications of Organic Farming.

Unit – 4: Air & Water Microbiology

Aero microbiology - A brief account on 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.

Unit – 6: (Not for final Examination)

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. BalaNarsaiah, S. Srinu Naik 2017. Innovative Te
7. chnologies 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

Course outcomes (COs):

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.

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 - IV **Credits: 06**

Hours: 12

19MIBP403: PRACTICAL IV

(MEDICAL DIAGNOSTIC TECHNOLOGY & APPLIED MICROBIOLOGY)

Learning Objectives (LO):

To learn the medical diagnostic techniques, methods to enumerate soil microorganisms, aero microbiology and water 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” tets
5. CRP
6. RPR
7. WIDAL
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. Study of Mycorrhizae, Cyanobacteria and *Azolla.*
14. Seed Health testing by using standard Blotter method.
15. Study of associative and antagonistic relationship between microorganisms.

16. Demonstration of air samplers – Membrane filter technique.
17. Microscopic observation of different water samples for biological indicator microorganisms of water pollution.
18. Visit to water treatment plant/sewage treatment plant/industrialEffluent treatment plant and agricultural research station.

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).

Course outcomes (COs):

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

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

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 ELECTIVE COURSES

SEMESTER - II **Credits: 03**

Hours: 03

19MIBE 215.1: ENTREPRENEURSHIP AND MANAGEMENT FOR MICROBIOLOGY

Learning Objectives (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

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, 49ork49n-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. Holger Patzelt and Thomas Brenner, Handbook of Bioentrepreneurship, 2008, Springer press.
2. Subba Rao, N.S., 1995. Biofertilizer in agriculture and forestry. Oxford and IBH, New 50ork.

Supplementary Books:

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

Web References:

1.https://www.worldscientific.com

2.https://careerdevelopment.aaas.urg

3.www.livescience.com

4.https://www.omicsoline.org

5.https://www.scincedirect.com

Course Outcomes (COs):

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

CO1:	Gain knowledge about institutions and schemes of government of India.
CO2:	Understand the required skills for entrepreneurs
CO3:	Gain knowledge about composting methods.
CO4:	Evaluate methods of production of Teaching kits and Diagnostic kits.

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 - II **Credits: 03**

Hours: 03

19MIBE 215.2: BIOREMEDIATION

Learning Objectives (LO):

To acquire knowledge about principles of bioremediation, process design for bio -treatment studies and types of bioremediation.

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

Supplementary Books:

3. Microbial Ecology, IV Ed., Atlast, R.M and Bartha,R.,(2000) Addison Wesley Longman Inc.
4. Brock Biology of Microorganisms, Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap, David P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Bioremediation: Principles and Applications (Biotechnology Research), R L. Crawford, D L. Crawford (2005). Cambridge University Press.

Web References:

1.https://WWW.nap.edu>read>chapter
2.www.environmentalpollution.in.
3. www.academia.edu.
4.https://study.com>academy>lession
5.https://archive.epa.gov>

Course Outcomes (COs):

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.

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 - II **Credits: 03**

Hours: 03

19MIBE 215.3: MICROBIAL NANOTECHNOLOGY

Learning objectives (LO):

To acquire knowledge about biological research with various fields 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 Nano scale 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, Isha Publication.

2. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool Publishers.

Supplementary Books:

3. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.

4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects. CRC Press.

5. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.

Web References:

1. https://en.m.wikibooks.org>wiki>introduction....
2. https://www.nanowerk.com>spotlight...
3. https://nptel.ac.in>module9>lecture2
4. https://www.ncbi.nlm.nih.gov>articles
5. https://www.ncbi.nlm.nih.gov>books

Course outcomes (COs):

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

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

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 - II **Credits: 03**

Hours: 03

19MIBE 215.4: FOOD AND DAIRY MICROBIOLOGY

Learning Objectives (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.

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 (Ice cream and other products).

Unit – 4: Food Borne Diseases

Foodborne diseases, intoxication and food poisoning - *Staphylococcus, Clostridium, Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiosis and Mycotoxins. Encounter of *Aeromonas* in food. EHEC and Enteropathogens.

Unit – 5: Food Preservation

Food preservation: Principles - Methods of preservation - Physical and chemical methods, Food sanitation. Good manufacturing process - Hazard analysis, Critical control Points and Personnel hygiene.

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:

4. Jay, J.M.2013. Modern Food Microbiology. 7th Edn. CBS Publishers and Distributors, New Delhi.
5. 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
3. http://www.eolss.net/sample-chapters/c10/E5-08-06-01.pdf
4. https://ubblab.weebly.com/uploads/4/7/4/6/47469791/handbook_of_hygiene_control_in_the_food_industry.pdf

Course Outcomes (COs):

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:	Evaluate foodborne diseases.
CO5:	Demonstrate food preservation methods.

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

SEMESTER - III **Credits: 03**

Hours: 03

19MIBE 315.1: MICROBIAL DIVERSITY AND EXTREMOPHILES

Learning Objectives (LO):

To learn the concept of microbial diversity and characteristics of microorganisms in extreme conditions.

Unit – 1: Microbial Diversity

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

Unit – 2: Extremophilic Archaebacteria

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 Barophiles

Halophiles and Barophiles 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).

Text Books:

1 C Gerday, N Glansdorff, Physiology and Biochemistry of Extremophiles, 2007, ASM Press.

2 R P Anitori, Extremophiles: Microbiology and Biotechnology, 2012, Caister Academic Press.

Supplementary Books:

3 Om V. Singh, Extremophiles: Sustainable Resources and Biotechnological Implications, 2012, Wiley-Blackwell.
4 H Breidahl, Extremophiles: Life Extr. Envirn. 2001, Chelsea House Publications
5 F Rainey, A Oren, Extremophiles (Methods in Microbiology), 2006, Academic Press.
6. K Horikoshi, G Antranikian, A T. Bull, F T. Robb, K O. Stetter, Extremophiles Handbook, 2011, Springer.

Course outcomes (COs):

After completion of course students will be able to:

CO1:	Understand the Microbial diversity
CO2:	Understand the characteristics of microorganisms in extremes
CO3:	Acquire knowledge about space Microbiology

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

SEMESTER - III **Credits: 03**

Hours: 03

19MIBE 315.2: ENVIRONMENTAL MICROBIAL TECHNOLOGY

Learning Objectives (LO):

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

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

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 Techniques

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: Microbiology Of Degradation

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.

Text Books:

1. Bioremediation: Principles and Applications (Biotechnology Research) by R L. Crawford , D L. Crawford 2005.. Cambridge University Press

2. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
3. Wastewater Microbiology: A Handbook for Operators, T. Glymph.(2005) Amer Water Works Assn.

Supplementary Books:

4. Environmental Biotechnology. B.C. Bhattacharyya, R Banerjee.(2007) Oxford University Press
5. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2001 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
6. A Manual of Environmental Microbiology. 2nd Edition. 2007 by Christon J. Hurst (Chief Editor), ASM Publications.

Course Outcomes (Cos):

After completion of course students will be able to:

CO1:	Demonstrate an understanding of key concepts in ecosytems
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

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 - III **Credits: 03**

Hours: 03

19MIBE 315.3: VERMITECHNOLOGY

Learning Objectives (LO):

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

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

Vermicompost -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. Nicholas Whitley (2015). The Application of Geology to Agriculture, Palala Press.
2. Satyendra M Singh Priyasankar Chaudhuri (2014). Biology and Ecology of Tropical Earthworms, Discovery Publishing House Pvt. Ltd.

3. Satchell, J.E., (2012). Earthworm ecology: From Darwin to Agriculture. Chapman and Hall, London.
4. Madhab Chandra Dash (2012). Charles Darwin's Plough Earthworm Biology, Ecology and Tool for Vermitechnology, I K International Publishing House.

Supplementary Books:

1. Thomas J. Barrett (2018). Harnessing the Earthworm, Forgotten Books.
2. Shweta Yadav and V. K. Singh (2014). Vermitechnology: Rebuilding of Sustainable Rural Livelihoods, Nova Science Publishers.

Web References:

1. https://biologywise.com/earthworm-biology
2. http://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html
3. https://www.wikihow.com/Prepare-Vermicompost
4. http://www.agrsci.jp/ras/article/view/13/27
5. http://blog.agrivi.com/post/vermicompost-s-role-in-farming

Course outcomes (COs):

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

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 - III **Credits: 03**

Hours: 03

19MIBE 315.4: IPR, BIOSAFETY & BIOETHICS

Learning Objectives (LO):

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

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.

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:

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

Course Outcomes (COs):

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.

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

INTER DEPARTMENTAL ELECTIVE COURSE

MICROBIOLOGY FOR OTHER DEPARTMENTS

19MIBX315.1: MICROBIOLOGY

Learning Objectives (LO):

To learn in detail about the various classes of microbes, microbial metabolism and recombination, food and medical microbiology.

Unit – 1: Bacterial Taxonomy

Classification of microbes, molecular taxonomy- Bacteria, Eubacteria, Cyanobacteria, Archaebacteria. Ultrastructure of bacterial cell (Gram- positive and Gram- negative) Cell wall- and cell membrane- structure. Flagella and motility, cell inclusions, endospore and capsule.

Unit – 2: Fungi & Viruses

Fungi; Classification and morphology of yeast and molds. Algae: occurrence, characteristics, classification, Protozoa: occurrence, morphology, characteristics. Viruses: Classification (Baltimore) and ultrastructure. Bacteriophage- ultra structure lytic cycle and lysogeny. Viroids and Prions.

Unit – 3: Bacterial Growth

Microbial growth- growth curve, factors affecting growth Culture media- types. Sterilization – physical, and chemical methods. Isolation of pure culture, incubation, streak, spread, pour- plate methods. Enrichment techniques for aerobic and anaerobic bacteria, Culture collection, preservation, lyophilization and freeze drying

Unit – 4: Microbial Metabolism

Microbial metabolism Photosynthesis in microbes. Role of chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy; nitrate and sulfate reduction; Methanogenesis and acetogenesis. Biogeo cycle- carbon, sulfur, phosphorous, and nitrogen. Nitrogen metabolism, nitrogen fixation,

Unit – 5: Food Microbiology

Types and sources of microorganisms in food. Factors influencing microbial growth in food. Estimation of microorganisms in food. Fermented foods- yoghurt, cheese, Production of beer, wine, Probiotics and prebiotics.

Infectious diseases- methods of transmission. Antimicrobial agents- physical and chemical. Antibiotics and mode of action. Antibiotic resistance.

Unit – 6: (Not for final Examination)

Review on Numerical and chemotaxonomy, morphological, biochemical and molecular taxonomy- Types of rRNA, Importance of 16sRNA in microbial identification and taxonomy. G+C content, DNA-DNA, DNA–RNA hybridization.

Awareness program on Worlds AIDS day, Worlds TB day - personal hygiene, vaccination, contagious and emerging microbial diseases. 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. Tortora et. al. Microbiology: An introduction 11th ed. Benjamin Cummings, 2012.
2. Pelczar *et. al.* Microbiology 5th ed. McGraw Hill, 2000.

Supplementory Books:

3. Black JG Microbiology: Principles and Explorations Wiley s" ed. 2012.
4. Madiagan *et. al.* Brock Biology of microorganisms 13th ed. Prentice Hall, 2011.
5. Schaechter M ed. Encyclopedia of Microbiology- 3rd ed. Acad Press 2009.

Course Outcomes (COs):

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

CO1:	Classify microbes and understand their ultra structure.
CO2:	Understand the Growth and Culture of Microorganisms.
CO3:	Analyze the various metabolic pathways and cycles in microbes.
CO4:	Evaluate the sources of microorganisms in food, microbial fermentation of foods and antibiotic resistance.