UNIVERSITY OF KERALA

COURSE STRUCTURE AND SYLLABUS

FOR

FIRST DEGREE PROGRAMME

IN

MICROBIOLOGY

UNDER

CHOICE BASED CREDIT- SEMESTER SYSTEM

(w.e.f. 2022 Admission)

THE PROGRAMME

The programme is named as Bachelor of Science (B. Sc.) in Microbiology

ELIGIBILITY FOR ADMISSION

A pass in 10+2 (Higher Secondary/ISC/CBSE) Exam with Biology as one of the papers will beeligible.

OBJECTIVES OF THE PROGRAMME

- To impart knowledge of science is the basic objective of education.
- To develop scientific attitude is the major objective to make the students open minded, critical & curious.
- To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute thescience.
- To understand scientific terms, concepts, facts, phenomenon and their relationships.
- To make the students aware of natural resources and environment.
- To provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest andto make them fit for society.
- The students are expected to acquire knowledge of microbiology and related subjects soas to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.

- To develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self-reliant and sufficient.

- To create the interest of the society in the subject and scientific hobbies, exhibitions and other similar activities.

- To enrich the students with the latest developments in the field of Information Technology, Biotechnology, Bioinformatics and other related fields of research and development
- To create enthusiasm to understand more about the beautiful planet Earth and to give awareness to the public the need to protect the planet from all kinds of exploitation

- To keep the scientific temper which the student acquired from school level and to develop a research culture.

Table 1. General Structure of the First-Degree Programme in Microbiology

Sem No	Course Code	Course Title	Instructional Hours/week		Credits	Uty Exam Duration	Evaluation		Total Credits
			L	P			Internal	Uty Exam	
I	EN 1111	English Language I	5	-	4	3			
	….1111	Additional Language I	4	-	3	3			
	EN1121	Foundation Course I	4	-	2	3			
	MB1141	Core Course I	2	2	3	3	25%	75 %	16
	CH1131	Complementary Course I*	2	2	2	3			
	BT 1131	Complementary Course II**	2	2	2	3			
II	EN 1211	English Language II	5	-	4	3			
	EN1212	English Language III	4	-	3	3			
	1211	Additional Language II	4	-	3	3			
	MB 1221	Foundation Course II	2	2	3	3	25%	75 %	17
	CH 1231	Complementary Course III	2	2	2	3			
	BT 1231	Complementary Course IV	2	2	2	3			
III	EN 1311	English Language IV	5	-	4	3			
	1311	Additional Language III	5	-	4	3			
	MB 1341	Core Course II	3	2	3	3	25%	75 %	17
	CH1331	Complementary Course V	3	2	3	3			
	BT 1331	Complementary Course VI	3	2	3	3			
IV	EN1411	English Language V	5	-	4	3			
	1411	Additional Language IV	5	-	4	3			
	MB1441	Core Course III	3	2	3	3			
	CH1431	Complementary Course VII	3	2	3	3			
	BT1431	Complementary Course VIII (CH/BT)	3	2	3	3	25%	75 %	25
	CH1432	Complementary Course IX (Practical)	-	(8)*	4	3			
	BT1432	Complementary Course X. (Chemistry/Biotechnology Practical)	-	(8)*	4	3			
V	MB1541	Core Course IV	4	3	4	3			
	MB1542	Core Course V	4	2	3	3			
	MB1543	Core Course VI	5	2	4	3			
	MB1544	Core (Practical- 1) VII	-	(5)*	3	3			
	MB1545	Core (Practical- 2) VIII	-	(5)*	4	3	25%	75 %	20
		Open Course I	3	-	2	3			
	MB1551.1	Mushroom Culture							
	MB1551.2	Microbial Waste Management							
	MB1551.3	Biofertilizer Technology							
		Project	-	2	-				
VI	MB1641	Core Course IX	4	3	4	3			
	MB1642	Core Course X	4	2	4	3			
	MB1643	Core Course XI	4	2	4	3			
	MB1644	Core (Practical 3) XII	-	(5)*	3	3			
	MB1645	Core (Practical 4) XIII	-	(4)*	4	3	25%	75 %	**75**
	MB1661	Elective Course	3	-	2	3			
	MB1646	Project	-	3	4	3			
									120

*** CH-Chemistry –Same syllabus of complementary Chemistry offered for Botany/Zoology may be followed**

**** BT-Biotechnology- New syllabus**

Table 2. Semester I

Course Code	Course Title	Instructional hours/week		Credits	Univ. Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ Exam	
EN 1111	English Language I	5		4	3 Hrs	25%	75%	16
….1111	Additional Language I (Hindi/Malayalam)	4		3				
EN1121	Foundation Course I	4		2				
MB 1141	Core Course I Methodology and Perspectives of Science.	2	2	3				
CH 1131	Complementary Course I (Chemistry- I)	2	2	2				
BT 1131	Complementary Course II (Biotechnology I)	2	2	2				

Table 3. Semester II

Course Code	Course Title	Instructional hours/week		Credits	Univ Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ Exam	
EN 1211	English Language II	5		4	3 Hrs	25%	75%	17
EN1212	English Language III	4		3				
1211	Additional Language II (Hindi/Malayalam)	4		3				
MB 1221	Foundation Course II Fundamentals of Microbiology	2	2	3				
CH 1231	Compl. Course III (Chemistry -II)	2	2	2				
BT 1231	Complementary Course IV (Biotechnology II)	2	2	2				

Table 4. Semester III

Course Code	Course Title	Instructional hours/week		Credits	Univ. Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ. Exam	
EN 1311	English Language IV	5		4	3 Hrs	25%	75%	17
1311	Additional Language III (Hindi/Malayalam)	5		4				
MB 1341	Core Course II Microbial Diversity	3	2	3				
CH 1331	Complementary Course V (Chemistry -III)	3	2	3				
BT 1331	Complementary Course VI (Biotechnology III)	3	2	3				

Table 5. Semester IV

Course Code	Course Title	Instructional hours/week		Credits	Univ. Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ. Exam	
EN 1411	English Language V	5		4	3 Hrs	25%	75%	25
1411	Additional Language IV (Hindi/Malayalam)	5		4				
MB 1441	Core Course III Immunology	3	2	3				
CH 1431	Compl. Course V (Chemistry -IV)	3	2	3				
BT 1431	Complementary Course VII (Biotechnology IV)	3	2	3				
CH 1432	Complementary Course VIII (Chemistry Practical)		(8) *	4				
BT 1432	Complementary Course IX Practical (Biotechnology)		(8) *	4				

Table 6. Semester V

Course Code	Course Title	Instructional hours/week		Credits	Univ. Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ. Exam	
MB 1541	Core Course IV Microbial Physiology and Genetics	4	3	4	3 Hrs	25%	75%	20
MB 1542	Core Course V Medical microbiology	4	2	3				
MB 1543	Core Course VI Environmental Microbiology	5	2	4				
MB 1544	Core Course VII Practical (Microbial Physiology and Genetics & Environmental Microbiology)		(5) *	3				
MB 1545	Core Course VIII Practical (Medical Microbiology)		(5) *	4				
MB 1551.1	Open Course – I Mushroom Culture	3		2				
MB 1551.2	Microbial Waste Management							
MB 1551.3	Bio-fertilizer Technology							
	Project		2					

Table 7. Semester VI

Course Code	Course Title	Instructional hours/week		Credits	Univ. Exam Duration	Evaluation		Total Credits
		L	P			Internal	Univ. Exam	
MB 1641	Core Course IX Industrial Microbiology	4	3	4	3 Hrs	25%	75%	25
MB 1642	Core Course X Food & Dairy Microbiology	4	2	4				
MB 1643	Core Course XI Bioinformatics and bioststistics	4	2	4				
MB 1644	Core Course XII Practical (Industrial Microbiology & Food & Dairy Microbiology)		(5)*	3				
MB 1645	Core Course XIII Practical (Bioinformatics & Biostatistics)		(4)*	4				
MB 1661.1	Elective Course Agricultural Microbiology	3		2				
MB 1646	Project		3	4				

L = Lecture P = Practical

( )*Practical hour already distributed in the semester concerned

Table 8. Distribution of Contact Hours and Credits (Core, Foundation & Open courses, Project /Dissertation)

Course Code	Course Title	Semester I			Semester II			Semester III			Semester IV			Semester V			Semester VI			Total	
		Contact Hours		Credits	Contact Hours		Credits	Contact Hours		Credits	Contact Hours		Credits	Contact Hours		Credits	Contact Hours		Credits	Contact Hours	Credits
		T	P	C	T	P	C	T	P	C	T	P	C	T	P	C	T	P	C		
MB1141	Methodology & Perspectives of Science	3		3																3	3
MB1221	Fundamentals of Microbiology				3	1	3													4	3
MB1341	Microbial Diversity							3												3	3
MB1441	Immunology										3									3	3
MB1442	Practical (MB1141, MB1221, MB1341 & MB1441)		1						2			2	4							5	4
MB1541	Microbial Physiology and Genetics													4		4				4	4
MB1542	Medical Microbiology													4		3				4	3
MB1543	Environmental Microbiology													5		3				5	4
MB1544	Practical II (MB1541, MB 1542 &MB1543)														5	4				5	4
MB1551.1 MB1551.2 MB1551.3	Mushroom Culture Microbial Waste Management Biofertilizer Technology													3		2				3	2
MB1641	Industrial Microbiology																4		4	4	4
MB1642	Food & Dairy Microbiology																4		4	4	4
MB1643	Bioinformatics & Biostatistics																4		4	4	4
MB1644	Practical III (MB 1641 & MB 1642)																	5	4	5	4
MB1645	Practical IV (MB 1643)																	4	3	4	3
MB1661	Agricultural Microbiology																3		2	3	2
MB1646	Project, Tour Diary, Viva Voce														2				3	5	4

Duration of Examination (Theory & Practical): 3 Hours

Continuous Evaluation (CE): 25%; End Semester Evaluation (ESE): 75%

Total Weightage for Each Course (Theory & Practical): 30

Total credits for the entire programme: 120

Table 9. Scheme of Evaluation of Foundation Course II, Core Courses, Open Courses & Project

Semester	Course Code	Course Title	Weightage		Duration of Univ. Exam
			CE	ESE	
I	MB 1141	Methodology and Perspectives of Science	4	30	3 Hours
II	MB 1221	Fundamentals of Microbiology	4	30	3 Hours
III	MB 1341	Microbial Diversity	4	30	3 Hours
IV	MB 1441	Immunology	4	30	3 Hours
V	MB 1541	Microbial Physiology and Genetics	4	30	3 Hours
	MB 1542	Medical Microbiology	4	30	3 Hours
	MB 1543	Environmental Microbiology	4	30	3 Hours
	MB 1544	Microbial Physiology and Genetics & Environmental Microbiology (Practical)	4	30	3 Hours
	MB 1545	Medical Microbiology (Practical)	4	30	3 Hours
	MB 1551.1 MB 1551.2 MB 1551.3	Mushroom Culture Microbial Waste Management Bio-fertilizer Technology	4	30	3 Hours
VI	MB 1641	Industrial Microbiology	4	30	3 Hours
	MB 1642	Food & Dairy Microbiology	4	30	3 Hours
	MB 1643	Bioinformatics & Biostatistics	4	30	3 Hours
	MB 1644	Industrial Microbiology & Food & Dairy Microbiology (Practical)	4	30	3 Hours
	MB 1645	Bioinformatics & Biostatistics (Practical)	4	30	3 Hours
	MB 1661.1	Agricultural Microbiology	4	30	3 Hours
	MB 1646	Project, Tour Diary Viva Voce		20	3 Hours

CE= Continuous Evaluation ESE= End Semester Evaluatio

PATTERN OF THEORY QUESTION PAPER

Salient features:

- Question paper is set up based on grading system/marks
- The duration of exam for each course is fixed to 3 hours
- The question paper consists of five sections A, B, C & D Section A consists of 16 questions and a bunch of 4 questions carries 1 weightage
- Section B contains 12 very short answer questions of which the candidate can choose 8 and carries 1 weightage each
- Section C has 8 short answer type questions of which the candidate has to answer 5 with a weightage of 1 each
- The last section D consists of 3 questions and the candidate gets the freedom to answer 2 questions with a weightage of 4 each
- Total weightage is 30/paper

EVALUATION AND GRADING

The Evaluation of each course shall consist of two parts 1) Continuous Evaluation (CE) 2) End Semester Evaluation (ESE). The CE and ESE ratio shall be 1:4 for both courses with or without practical. There shall be a maximum of 80 marks for ESE and maximum of 20 marks for CE. For all courses (Theory and Practical), Grades are given on a 7-point scale based on the total percentage of mark (CE+ESE) as given below:

Criteria for Grading

Percentage of marks	CCPA	Letter Grade
90 and above	9 and above	A+ Outstanding
80 to < 90	8 to<9	A Excellent
70 to <80	7to<8	B Very Good
60 to < 70	6to<7	C Good
50 to < 60	5to<6	D Satisfactory
40 to < 50	4to<5	E Adequate
Below 40	<4	F Failure

Theory

Component	Weightage
Attendance	1
Assignment/ Seminar	1
Test paper	2
Total	**4**

Practical

Component	Weightage
Attendance	1
Viva-voce	1
Test	2
Total	**4**

End Semester Assessment (ESA)

Details of Papers	Duration of Exam	Weightage		
Theory & Practical		External	Internal	Total
Microbiology (Core) Courses	3 Hours	30	4	34
Complementary Courses	3 Hours	30	4	34
Open Courses	3 Hours	30	4	34

Consolidation of Grades for CE for Theory course:

Component	Weightage (W)	Grade awarded	Grade points (G)	Weighted Grade points(W×G)
Attendance	**1**	**B**	**3**	**3**
Assignment/Seminar	**1**	**C**	**2**	**2**
Test paper	**2**	**A**	**4**	**8**
Total	**4**			**13**
CE Grade	Total weighted grade points/Total weights=13/4=3.25=**Grade B**			

• With regard to the **attendance** (weight=1), the following grading scheme shall be followed:
Below 75% -**E**; 75-79%- **D**; 80-89% - **C**; 90-94%- **B**; 95-100%- **A**.
• For **assignment/ Seminar** (weight -1), the teacher shall define the quality in terms of **structure, content, presentation** and **punctuality** in submission.
• **Test papers** (weight=2) shall be graded by the same procedure adopted for theory exam evaluation

The students are required to write a minimum of 2 class tests in every semester for each course. Grades for the test component in CE shall be awarded on the basis of calculating average of the grades secured for the two class tests. Each student shall be required to do one assignment or one seminar for each Course. Valued assignments shall be returned to the students. The seminars shall be organized by the teacher/teachers in charge of CE and the same shall be assessed by a group of teachers including the teacher/teachers in charge of that Course.

CONSOLIDATION OF THE GRADE OF A COURSE
The grade of a course is consolidated by combining the ESE and CE grades taking care of their weights

Exam awarded	**Weight points(G)**	**Grade Points (W x G)**	**Grade**	**Weighted grade**
ESE	3	2.47	C	7.41
CE	1	3.20	B	3.20
Total	4			10.61
Grade of Course	Total weighted grade points/Total weights=10.61/4=2.65=Grade B			

END SEMESTER ASSESSMENT (ESA)
The University shall conduct the external examinations for all semesters. There will not be any supplementary exams. The practical examinations for **Core courses** shall be conducted at the end of 4^{th}, 5^{th} and 6^{th} semesters and **Complementary** courses at the end of 4^{th} semester according to the common calendar and questions set up by the University. The Board of Examiners constituted by the University will have the right to make necessary changes in the pattern of practical examination as and when needed.

ELIGIBILITY TO APPEAR FOR PRACTICAL EXAMINATION
Submission of the following
• Certified and *bona fide* practical record
• Certified field work
• Certified tour report

• Project report/Dissertation (certified and *bona fide*)

PROJECT

Project work/Dissertation is compulsory. It can be carried out either individually or by a group not exceeding 15 students. The topics shall either be allotted by the supervising teacher or be selected by the student in consultation with the supervising teacher. The project report/dissertation duly attested by the Supervising teacher and Certified by the Head of the Department, has to be submitted on the day of examination of **Practical - II (Core)**. The project shall be evaluated by an external examiner. The project report/ Dissertation (not less than 40 pages) shall be prepared as per the format given below.

1. Title page /Front page (Certified by the **HOD**)
2. Declaration by the candidate
3. Certificate attested by the Supervising teacher
4. Acknowledgement, if any
5. Table of contents
6. Abbreviation, if any
7. Abstract/ Summary
8. Introduction & Review of Literature (10pages)
9. Material and Methods
10. Results and Discussion (Not less than 10 pages)
11. Conclusion
12. References

Tables, Graphs, Photographs etc. can be used to present the data. Topics selected once should not be repeated.

STUDY TOUR

- Visit to a Microbiology Laboratory/Distillery /Biofertilizer unit etc. within or outside Kerala with a minimum duration of 3 days is compulsory
- A brief report of the trip has to be submitted, along with appropriate photographs

CORE COURSES

Semester	Course Code	Title of the Course	Contact hrs./week L	P	Credits
I &II	MB1141	Methodology and Perspectives of Science	3	1	3
III	MB1341	Fundamentals of Microbiology	3	2	3
IV	MB1441	Microbial Genetics & Immunology	3	2	3
V	MB1541	Instrumentation in Microbiology	4	3	4
	MB1542	Environmental Microbiology	4	2	3
	MB1543	Medical Microbiology & Molecular Biology	5	2	3
	MB1544	Practical I (MB1141, MB1341 & MB1441	-	(5)	4
	MB1545	Practical II (MB1541 & MB1542)	-	(5)	4
VI	MB1641	Industrial Microbiology	4	3	4
	MB1642	Bioinformatics & Biostatistics	4	2	4
	MB1643	Food & Dairy Microbiology	4	2	4
	MB1644	Practical III (MB1543 & MB1641	-	(5)	4
	MB1645	Practical IV (MB1642 &MB1643)	-	(4)	3

FOUNDATION COURSE II - (VOCATIONAL)
COURSE TITLE: METHODOLOGY AND PERSPECTIVES OF SCIENCES

CREDITS-3 **Total lecture hours- 36 hours (2hours/week)**

PRE- REQUISITE:

Basic knowledge of principles in science gained during H. Sc.

COURSE OBJECTIVES:

The major objective of this paper is to develop clear understanding of the methodology and perspectives of science in general so as to enable the students to systematically pursue their particular discipline in science in relation to the other disciplines that come under the rubric of sciences.

COURSE OUTCOMES:

1. To identify what is science, cite the basis of scientific laws, recognize and discuss the different applications of science in human activity.
2. To explain the theories and laws in science and describe the importance of hypothesis, models, simulations and virtual testing.
3. To restate in own words about types of experiments and summarize how to plan an experiment-design, observations, documentation and interpretation.
4. To apply statistical testing to accept or reject a hypothesis and analyze scientific correlation, pattern and trends from the data.
5. To illustrate and distinguish the different modes of data presentation and apply varied statistical tools.

   To discuss and practice the principles of ethics in science.

MODULE-I
Science and Science Studies **8hrs**

Types of knowledge: practical, theoretical and scientific knowledge. Information: What is science; what is not science; laws of science; basis of scientific laws and factual truths. Science as a human activity; scientific temper and empiricism, vocabulary of science, science disciplines. Revolution in Science and Technology

MODULE-II
Methods and Tools of Science **8hrs**

Hypotheses; theories and laws in science; Observations, evidences and proofs; Posing a question; formulation of hypothesis; Hypothetico-deductive model; inductive model. Significance of verification (proving)corroboration and falsification(disproving), auxiliary hypothesis; adhoc hypothesis**.** Revision of scientific theories and laws. Importance of models, simulations and virtual testing.

MODULE-III
Experimentation in Science **8hrs**

Design of an experiment: experimentation; observation; data collection; interpretation and deduction. Necessity of units and dimensions: repeatability and replication. Documentation of experiments; record keeping, connection between measurements and underlying theory. Types of Experiments-Experiments to test a hypothesis-to measure a variable or to gather data by preliminary and explorative experiments. Planning of experiments-Design-selection of controls-observational requirements-instrumental requirements.

MODULE-IV
Data handling and Ethics in Science **12hrs**

Documentation of experiments: Nature and types of data-typical examples; Data acquisition; treatment of data; data interpretation. Significance of statistical tools in data interpretation; errors and inaccuracies. Data presentation: graphs, tables, histograms and pie diagrams. Statistical testing of hypothesis, null hypothesis, Significance test. Statistics based acceptance or rejection of a hypothesis; Deduction of scientific correlation; patters and trends. Ethics in Science: Scientific information; depositories of scientific information, primary secondary and digital sources; sharing of knowledge; transparency and honesty; danger of pre conceived ideas.

SEMESTER I
COURSE CODE: MB1141
VOCATIONALCOURSE VII- PRACTICAL-P4
COURSE TITLE: METHODOLOGY AND PERSPECTIVES OF SCIENCE

CREDITS-3 **Total practical hours- 36hrs (2hrs/week)**

PRE- REQUISITE:
Basic knowledge of principles in science gained during H. Sc.

COURSE OBJECTIVES:

The course imparts knowledge to students on various statistical methods used for data analysis. The course also familiarizes the student with different instruments used in biology.

COURSE OUTCOMES:
1. To apply primary statistical methods to data and analyze the results generated.
2. To compile and present some of the great inventions in biology.
3. To represent a statistical data as graphs, diagrams or pie chart.

Practical 36hrs
1. Work out problems on frequency distribution, measures of central tendencies, measures of dispersion.
2. Prepare charts on great biological inventions
3. Familiarizing with different biological instruments.
4. Collection of data, sampling designs and tabulation using biological materials.
5. Graphical representation using statistical data

REFERENCES

1. Gieryn T.F. (1999) *Cultural Boundaries of Science* Univer. Chicago Press.
2. Jeffrey A. Lee (2010) The Scientific Endevor. Pearson Delhi
3. Collins H and T Punch (1993). *The Golem. What everyone should know about science*. Cambridge Univ. Press
4. Hewitt, Paul G, Suzanne Lyons, John A, Suchocki and Jennifer Yeh (2007)
5. *Conceptual Integrated Science*, Addison-Wesley
6. Newton RG: *The truth of science*, 2nd edition
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SEMESTER II
COURSE CODE: MB1221
FOUNDATION COURSE II - (VOCATIONAL)
COURSE TITLE: FUNDAMENTALS OF MICROBIOLOGY

CREDITS-3 **Total lecture hours- 36 hours (2 hours/week)**

PRE– REQUISITE:

Basic knowledge on biology gained during H. Sc.

COURSE OBJECTIVES:

To become familiar with the foundation concepts of history of Microbiology and to understand the structure and functions of a typical prokaryotic cell. To gain the knowledge of microscopy, staining concepts, culture methods and culture media. To understand and implement sterilization techniques and safety measures.

COURSE OUTCOMES:

1. To recall the history of microbiology and cite the contributions of various scientists.
2. To describe and illustrate the general structural characteristics of microorganisms.
3. To explain and apply the principles of various microscopic, staining and disinfecting techniques.
4. To describe and use the basic techniques of microbiology.

MODULEI **6 hrs.**

Definition and scope of microbiology. History of Microbiology: Spontaneous generation theory, Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Alexander Fleming and John Tyndall. Difference between prokaryotic and eukaryotic microorganisms.

MODULEII **10hrs**

Morphology and fine structure of bacteria-size, shape and arrangements. Structure and arrangement of flagella, pili, capsule, cell wall and its composition. Cytoplasmic membrane, protoplasts, spheroplasts, intracellular membrane systems, cytoplasm, vacuoles, nuclear material, bacterial spores, cell inclusions.

MODULE-III **8hrs**

Principles and applications of microscopy. Simple, compound, bright field, dark field, phase contrast, fluorescent and electron microscopy. Principles of staining: Stains –Acidic, basic and neutral stains. Staining techniques-Simple staining, differential staining (Gram staining and acid-fast staining), and structural staining (spore, flagella, capsule and granule).

MODULE-IV **6hrs**

Sterilization and Disinfection: Principles and methods of physical (moist heat, dry heat, filtration, pasteurization, tyndallization, radiations) and chemical (alcohols, aldehydes, phenols, halogens and hypochlorites) sterilization.

MODULE-V **6hrs**

Culture media and methods-Solid, Liquid, semisolid, semisynthetic and synthetic media. Selective media, Differential media, Enriched media, Enrichment media, Indicator media, Transport media and Anaerobic media. Cultivation of bacteria: Aerobic &Anaerobic culture methods.

SEMESTER II
COURSE CODE:1221
VOCATIONALCOURSE VII- PRACTICAL-P4
COURSE TITLE: FUNDAMENTALS OF MICROBIOLOGY

CREDITS-3 **Total practical hours- 36 hrs. (2hrs/week)**

PRE- REQUISITE:
Basic knowledge of microorganisms gained during the first semester of this programme.

COURSE OBJECTIVES:
This course develops the concepts of various techniques and instruments used in the Microbiology laboratory with respect to isolation, handling and culture techniques in Microbiology.

COURSE OUTCOMES:

1. To review and practice the general rules and precautions to be followed in a microbiology laboratory.
2. To describe and apply the various techniques in cleaning and sterilization of glassware in a microbiology laboratory.
3. To explain the working principle and operate various instruments used in a microbiology laboratory.
4. To distinguish different types of microbial culture media.
5. To prepare different types of culture media used in microbiology.
6. To use the standard techniques employed for isolation of microorganisms.
7. Develop a skill for the isolation of pure cultures.
8. To discuss and summarize the colony morphology of microorganisms.

PRACTICAL

1. General rules in Microbiology laboratory
2. Cleaning and sterilization of glass wares
3. Instrumentation and working principle of
   I. Microscopy
   II. Incubator
   III. Hot air oven

IV. Autoclave
V. Laminar Air Flow Bench

4. Preparation of media
I. Solid media
II. Liquid media
III. Semisolid media

5. Isolation methods.
I. Serial dilution
II. Pour plate
III. Spread plate
IV. Streak plate
V. Lawn culture
VI. Stab culture

REFERENCES

1. Lim, D.1998.*Microbiology*. 2nd Edition; McGraw-Hill Publication.
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5. Alcamo Fundamentals of Microbiology, 5thEdition.
6. Gerald J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology–An Introduction, Pearson Publication
7. Salle A.J. 1971. *Fundamental Principles of Bacteriology*. 7th Edition. Tata Mac Graw Hill Publishing Co.
8. Black, J. G. 2013. *Microbiology: Principles and Explorations*. 6th Edition, John Wiley and Sons, Inc.
9. Aneja, K. R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4thEdition. New Age International (P) Limited, New Delhi.
10. Dubey R.C and Maheswari, D.K. 2002.*PracticalMicrobiology*.2nd Edition, S. Chand & Co. New Delhi.
11. Kannan, N. 2002. *Laboratory manual in general Microbiology*. 2nd Edition, Panima Publishing Co., New Delhi

SEMESTER III
COURSE CODE: MB1341
FOUNDATION COURSE II - (VOCATIONAL)
COURSE TITLE: MICROBIAL DIVERSITY

CREDITS-3 **Total lecture hours- 54 hours (3hours/week)**

PRE- REQUISITE:

Basic knowledge of microorganisms gained during the second semester of this programme.

COURSE OBJECTIVES:

The major objective of this paper is to develop a clear understanding of the taxonomical classification of microorganisms and gain knowledge on the distinguishing morphological features of bacteria, actinomycetes, viruses, fungi and algae.

COURSE OUTCOMES:

1. To recall the principles of classification and review the taxonomical classification of microorganisms.
2. To distinguish between the different classes of microorganisms and their general characteristics.
3. To compare and distinguish the morphological features of different microorganisms.

MODULE-I **10hrs**

Principles of classification. Principles of bacterial taxonomy. Whittaker' Five Kingdom classification. Classification and characterization of bacteria according to Bergey's Manual of Systematic Bacteriology. Classification based on molecular techniques-G+C % and RNA, DNA hybridization. Classification of bacteria based on morphological and biochemical characteristics.

MODULE-II **12hrs**

Archaea bacteria and extremophiles. General properties and cultural characteristics of Mycoplasma, Rickettsia, Spirochetes, Treponema and Leptospira. General characteristics and classification of Actinomycetes.

MODULE-III **12hrs**

Morphology and fine structure of virus, size, shape capsid and capsomeres. Virions, Viroid's and Prions. Capsid symmetry - helical, icosahedral and complex, Structure of TMV. Viral multiplication-lytic and lysogenic cycle.

MODULE-IV **12hrs**

Morphological features, classification and economic importance of Fungi. Characteristics of Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Distinguishing characteristics of *Rhizopus* sp., *Mucor* sp., *Aspergillus* sp., *Penicillium* sp. and *Fusarium* sp. Yeasts – a brief account on *Candida* sp and *Saccharomyces* sp.

MODULE-V **8hrs**

Morphological features, classification and economic importance of Algae. Ultra-structure of cyanobacterial cell.

SEMESTER III
COURSE CODE: MB1341
VOCATIONALCOURSE VII- PRACTICAL-P4
COURSE TITLE: MICROBIAL DIVERSITY

CREDITS-3 **Total practical hours- 36hrs (2hrs/week)**

PRE- REQUISITE:
Basic knowledge of microorganisms gained during the second semester of this programme.

COURSE OBJECTIVES:
This course develops the concepts of various staining techniques for the basic identification of unknown bacteria and fungi.

and instruments used in the Microbiology laboratory with respect to isolation, handling and culture techniques in Microbiology.

COURSE OUTCOMES:

1. To practice simple and differential staining techniques for the identification unknown bacteria.
2. To practice fungal identification based on lactophenol cotton blue staining method.
3. To study motility of bacteria.
4. To practice anaerobic cultivation of microorganisms.

PRACTICAL

1. Bacterial Staining Methods
   a. Simple Staining
   b. Gram's staining
   c. Spore staining
   d. Negative staining
   e. Capsule staining

2. Fungal staining-Lactophenol cotton blue mounting

3. Examination of microbes in living condition
   a. Wet mount
   b. Hanging drop method

4. Cultivation of anaerobic bacteria

REFERENCES

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. ***Microbiology: An Introduction*****.** 11th Edition. Pearson Education Pvt. Ltd. Singapore.
2. Black, J.G. 2005. ***Microbiology, Principles and exploration.*** 6th Edition. John Wiley & Sons
3. ***Principles of Bacteriology, Virology and Immunology***. 8th Edition. Edward Arnold, London
4. Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R. 1986. ***Microbiology*****.** McGraw Hill Book Company**,** London.
5. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. ***Microbiology***. 9th Edition. Mac Graw Hill Companies Inc.
6. Aneja, K.R .2003. ***Experiments in Microbiology, Plant Pathology and Biotechnology*****.** 4th Edition. New Age International (P) Limited, New Delhi.
7. Dubey, R. C. and Maheswari, D. K. 2002. ***Practical Microbiology***. 2nd Edition, S. Chand & Co., New Delhi.
8. Kannan, N. 2002. ***Laboratory manual in General Microbiology***. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER IV
COURSE CODE: MB 1441
COURSE TITLE: Immunology

CREDITS-4Total lecture hours- 54 hours (3 hours/week)

PRE- REQUISITE:
Basic knowledge of immunology studied during HSc and first, second year of this programme.

COURSE OBJECTIVES:
To understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. To understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

COURSE OUTCOMES:
After the completion of this course, the student will be able to:

1. Understand various immune mechanisms.
2. Describe various immune cells and organs involved in immunity.
3. Understand different immunological techniques for the serological diagnosis of infectious diseases.
4. Understand the basis of allergy reactions, auto immune mechanisms, transplantation and preparation of various vaccines.

MODULEI **8 hrs.**

History and scope of immunology; Infection and immunity. Types of immunity-innate immunity, adaptive immunity, Active and Passive immunity, Mechanisms of innate immunity.

MODULEII **10 hrs.**

Antigens and Types of Antigens, Epitopes, Haptens, Antigenicity, Immunogenicity, Factors influencing antigenicity. Basic structure of immunoglobulin. Immunoglobulin classes and functions.

MODULEIII **8 hrs.**

Antigen-antibody reactions, Precipitation reactions, Agglutination reactions, Complement fixation test, ELISA, Western Blotting, Immunofluorescence.

MODULEIV **14 hrs.**

Primary and secondary lymphoid organs. Cells of the immune system. MHC, HLA Complement system and its biological importance, Humoral immune response, primary and secondary responses, Cell Mediated Immunity, Cytokines -Interferon, Interleukins and TNFs. Monoclonal antibodies– production and applications.

MODULE V **14 hrs.**

Immuno-hematology, Immunology of blood transfusion, Erythroblastosis fetalis. Immunodeficiency disease – AIDS. Hypersensitivity reactions and types, Anaphylaxis and atopy, immune complex disease, Arthus reaction, Serum sickness and delayed type of hypersensitivity. Autoimmune diseases. Immunology of transplantation- graft rejection. Vaccines – types, toxoids and adjuvants.

SEMESTER IV
COURSE CODE: MB1441
COURSE – PRACTICAL-P4
COURSE TITLE: Immunology

PRE- REQUISITE: **Total practical hours- 36 hrs. (2hrs/week)**

Basic knowledge of Immunology studied during the first &second year of this programme.

COURSE OBJECTIVES:
To understand blood grouping, Rh factor and diagnostic tests used in clinical microbiology lab.

COURSE OUTCOME:
1. To summarize the standard laboratory procedures in immunology.
2. To understand how to handle blood and infectious samples
3. To identify and differentiate blood groups and Rh factor.
4. To describe and use different diagnostic tests

Practical

1. Determination of ABO blood groups and Rh factor
2. ELISA-Demonstration
3. WIDAL Test
4. VDRL test

Reference

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. *Microbiology: An Introduction*. 11th Edition. Pearson education Pvt. Ltd. Singapore.
2. Black, J.G. 2005. *Microbiology, Principles and exploration*. 6th Edition. John Wiley & Sons
3. *Principles of Bacteriology, Virology and Immunology*. 8th Edition. Edward Arnold, London
4. Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R. 1986. *Microbiology*. McGraw Hill Book Company**,** London.
5. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. *Microbiology*. 9th Edition. Mac Graw Hill Companies Inc.
6. Aneja, K.R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology* .4th Edition. New Age International (P) Limited, New Delhi.
   Dubey, R. C. and Maheswari, D. K. 2002. *Practical Microbiology*. 2nd Edition, S. Chand & Co., New Delhi.
7. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER V
COURSE CODE: MB 1541
COURSE TITLE: MICROBIAL PHYSIOLOGY AND GENETICS

CREDITS-3Total lecture hours- 72hrs (4hrs/week)

PRE- REQUISITE:
Basic knowledge of microorganisms during the first year of this programme.

COURSE OBJECTIVES:
To gain knowledge in nutritional requirements of bacteria and different methods for the isolation of microorganisms from various samples. In addition, become familiar with the microbial metabolism and concepts of microbial genetics and to understand the importance of recombination in bacteria along with their resistance to antibiotics.

COURSE OUTCOMES:

After the completion of this course, the student will be able:

1. To understand the nutritional diversity among microorganisms and use of different inorganic sources for energy production.
2. To understand how carbohydrates are metabolized in the microbial cells and the diverse metabolic pathways leading to energy production.
3. To illustrate different methods of bacterial recombination.
4. To understand different plasmids in bacteria.
5. To discuss regulation of gene expression in bacteria.
6. To correlate and predict the different types of mutations and molecular mechanism involved.
7. To describe various mechanisms and significance of drug resistance in bacteria.

MODULE I **12 hrs.**

Microbial Nutrition-Nutritional requirements-C, N, P, S, and minerals, Nutritional classification of bacteria. Uptake of nutrients - passive diffusion, facilitated diffusion, Active transport, Group translocation.

MODULEII **12 hrs.**

Physiology of microbial growth and nutrition. Growth Curve and generation time. Batch, continuous and synchronous cultures, Diauxic growth. Influence of environmental factors on microbial growth. Enumeration methods of bacteria-SPC, Direct microscopic count, turbido metric

estimation.

MODULEIII **16 hrs.**

Microbial Metabolism- Glycolysis, Krebs's cycle, Pentose Phosphate Pathway, gluconeogenesis, ED pathway. Electron transport Chain, oxidative Phosphorylation and Substrate level phosphorylation, Fermentation-Alcoholic fermentation, Homo and hetro-lactic acid fermentation, Propionic acid fermentation and mixed acid fermentations.

MODULEIV **16 hrs.**

Bacterial Genetics- Plasmids- brief account on pBR 322, pUC 8. Phage vectors- M13, lamda and cosmid. Bacterial recombination- transformation, transduction, conjugation (Fertility factors, F+ and F- cells, Fpili, high frequency recombination). Regulation of gene expression in prokaryotes -Operon concept: Lac operon and Trp operon.

MODULEV **16 hrs.**

Mutations: Chemical and physical mutagens. Types and Molecular mechanism–Point mutations-transition and transversion. Chromosomal mutations. Forward and reverse mutation. Biological significance of mutations-silent mutation, missense mutation and nonsense mutations. Ames test. Mechanism of drug resistance in bacteria.

SEMESTER V
COURSE CODE: MB1541
VOCATIONALCOURSE VII- PRACTICAL-P5
COURSE TITLE: MICROBIAL PHYSIOLOGY AND GENETICS

CREDITS-3 **Total practical hours - 126 hrs. (7 hrs./week)**

PRE- REQUISITE:
Basic knowledge of microorganisms gained during the third semester of this programme.

COURSE OBJECTIVES:
To gain knowledge and skill in different factors that affects the growth of microorganisms and to understand basic biochemical and growth characteristics of bacteria.

COURSE OUTCOMES:
After the completion of this course, the student will be able to:

1. To explain the nutritional diversity among microorganisms for the selective isolation of microorganisms.
2. To discuss the effect of environmental factors on the growth rate of bacteria.
3. To describe the different biochemical tests for the identification of unknown bacteria.
4. To describe fermentation of carbohydrates.

PRACTICAL

1. Effect of pH on the growth of bacteria on solid media
2. Effect of salts on the growth of microorganisms.
3. Effect of temperature on growth of microorganisms.
4. **Biochemical tests:**
   a. IMViC Test
   b. Triple sugar iron agar test
   c. Urease test
   d. Catalase test
   e. Amylase production test
   f. Oxidase test
   g. H_2S production
5. Sugar fermentation tests
6. Determination of growth curve of bacteria

REFERENCES

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. *Microbiology: An Introduction*. 11thEdition.Pearson education Pvt. Ltd. Singapore.
2. Black, J.G. 2005. *Microbiology, Principles and exploration*. 6th Edition. John Wiley & Sons
3. *Principles of Bacteriology, Virology and Immunology*. 8th Edition. Edward Arnold, London
4. Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R. 1986. *Microbiology*. McGraw Hill Book Company**,** London.
5. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. *Microbiology*. 9th Edition. Mac Graw Hill Companies Inc.
6. Aneja, K.R.2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th Edition. New Age International (P) Limited, New Delhi.
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8. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER V
COURSE CODE: MB 1542
COURSE TITLE: MEDICAL MICROBIOLOGY

CREDITS-4 Total lecture hours- 72hrs (4hrs/week)

PRE- REQUISITE:
Knowledge of microorganisms during the first & second year of this programme.

COURSE OBJECTIVES:
To learn the basic concepts of medical microbiology and microbial pathogenesis: study of microbes, antimicrobial agents, epidemiology, and virulence factors associated with the pathogenic microorganisms.

COURSE OUTCOMES:
On the successful completion of the course, student will be able to:

1. Understand the details of major human infections caused by pathogenic bacteria, virus, fungi and protozoa.
2. Define epidemiological aspects of microbial diseases.
3. Discuss about important prophylactic measures of microbial diseases.
4. Realize applications of antibiotic sensitivity tests.
5. Understand laboratory diagnostics for the identification of infectious agents.
6. Review antimicrobial agents

MODULEI **8 hrs.**

General properties of medically important bacteria. Recommendation for collection, transport of specimens, isolation of bacteria from clinical specimens. Antibiotic sensitivity tests-Disc diffusion, Well diffusion and Tube dilution testing procedures and their quality control.

MODULEII **18 hrs.**

Systematic study of *Staphylococcus aureus, Streptococcus pyogenes, Bacillus anthracis, Neisseria meningitidis, Cornybacterium diphtheriae, Mycobacterium tuberculosis, Vibrio cholerae., Pseudomonas aeruginosa. Enterobacteriaceae-Escherichia coli, Salmonella typhi, Salmonella paratyphi, Shigella dysenteriae, Proteus sp., Klebsiella pneumoniae.*

MODULEIII **16 hrs**

Structure and clinical importance of Pox, Adeno, Herpes, Reo, Rota, hepatitis, Rabies, HIV, influenza and polio virus. An overview of emerging viral diseases- Dengue, Ebola, SARS, Nipah,

H1N1 and chikungunya. Cultivation of Viruses. Antiviral agents -Vaccines and interferons.

MODULEIV **15 hrs.**

Fungal diseases-isolation of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. Opportunistic mycoses- Candidiasis, Aspergillosis. Systemic mycoses-Coccidioidomycosis, Blastomycosis. Subcutaneous mycoses-Sporotrichosis, Mycetoma. Mycotoxins. Antifungal agents.

MODULEV **15hrs**

Introduction to medical Parasitology–Protozoa–*Entamoeba histolytica*, Plasmodium, Leishmania, Trypanosoma, Giardia, Trichomonas. Platyhelminthes – Taenia – Fasciola – Schistosoma. Nemathelminthes –Ascaris–Ankylostoma, Wuchereria. Laboratory techniques in parasitology.

SEMESTER V
COURSE CODE: MB1542
COURSE – PRACTICAL –P5
COURSE TITLE: MEDICAL MICROBIOLOGY

PRE- REQUISITE: **Total practical hours - 126 hrs. (7 hrs./week)**

Basic knowledge of microorganisms studied during the first &second year of this programme.

COURSE OBJECTIVES:

To evaluate methods used to identify common infectious agents in the clinical microbiology lab. To assess treatment strategies including the appropriate use of antimicrobial agents and common mechanisms of antimicrobial action and resistance and to perform various serological and immunological diagnostic tests.

COURSE OUTCOME:

1. To learn standard laboratory procedures in clinical microbiology.
2. To understand how to handle and identify medically important bacteria.
3. To perform antimicrobial sensitivity tests.
4. To gain knowledge on various staining and identification techniques of different bacteria

PRACTICAL

1. General requirements of collection, transport and handling of clinical Specimens.
2. Study of the morphology, staining characters, cultural characters and identification of *Staphylococcus aureus,* E.coli, *Klebsiella sp., Proteus sp.* and *Pseudomonas sp.*
3. Isolation and identification of bacterial pathogens from clinical specimens and their biochemical reactions.
4. Culture methods for isolation and identification of fungi.
5. Antimicrobial Sensitivity testing by disc-diffusion method.

Reference

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. *Microbiology: An Introduction*. 11thEdition.Pearson education Pvt. Ltd. Singapore.
2. Black, J.G. 2005. *Microbiology, Principles and exploration*. 6th Edition. John Wiley & Sons
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   Dubey, R. C. and Maheswari, D. K. 2002. *Practical Microbiology*. 2nd Edition, S. Chand &Co., New Delhi.
7. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER V
COURSE CODE: MB1543
VOCATIONALCOURSE–V
COURSE TITLE: ENVIRONMENTAL MICROBIOLOGY

CREDITS - 4 **Total lecture hours- 72hrs (4hrs/week)**

PRE- REQUISITE:
Basic knowledge of microorganisms during the first year of this programme.

COURSE OBJECTIVES:

To impart knowledge about the structure, composition and functioning of microbial communities of diverse environment and to become familiar with basics of water-borne and air-borne diseases, and also to understand the role of microbial population in waste management, mineral recovery, bioremediation, and management of various types of xenobiotics and environmental impact of genetically modified organisms.

COURSE OUTCOME:
On the successful completion of the course, student will be able to:

1. Describe the role of microorganisms as components of ecosystem.
2. Explain the principles of microbial interactions and its importance with suitable examples.
3. Review the major microorganisms present in air and aquatic environments, distinguish air-borne and water-borne diseases and discuss various methods to check air and water quality
4. Compare the various methods of treatment of solid and liquid wastes.
5. Describe the role of microorganisms in biodegradation & bioremediation.
6. Discuss environmental and ethical aspects of genetically modified organisms.

MODULE I **12 hrs.**

Organization of the biosphere and components of ecosystem. Natural habitats of microorganisms. Microorganisms as components of ecosystem as producers and decomposers. Food chains, food webs and trophic structures.

MODULE II **14 hrs.**

Microbes in air: Number and kinds of microorganisms in air, droplet and drop let nuclei. Distribution and sources of airborne organisms; Assessment of air quality, Air-borne diseases and Air sanitation.

MODULE III **15 hrs.**

Microbes in aquatic environments: Microbiology of water, Water-borne diseases. Water quality criteria-Indicator organisms, Bacteriological examination of drinking water-membrane filtration, MPN, Total plate count–pour plate and spread plate methods. Sewage microorganisms, BOD and COD. Purification and disinfection of water.

MODULEIV **16 hrs.**

Environmental application: Waste –types; Treatment of solid wastes –composting, Vermiform composting, silage, Pyrolysis and scarification; Treatment of liquid wastes: Sewage (wastewater) treatment: primary treatment, secondary treatment (Oxidation Pond Trickling Filter, the activated sludge, Anaerobic digesters), Tertiary treatment.

MODULE V **15 hrs.**

Role of microbes in biodegradation, bioremediation of dyes, oil, pesticides and petroleum pollutants. Biodegradation of xenobiotic compounds; lignin, cellulose and plastics. Role of microbes in bioleaching, biomining. Biogas. Genetically Modified Organisms released and its environmental impact assessment and ethical issues.

SEMESTER V
COURSE CODE: MB1543
VOCATIONALCOURSE VII- PRACTICAL-P5
COURSE TITLE: ENVIRONMENTAL MICROBIOLOGY

CREDITS – 3 **Total practical hours - 126 hrs. (7 hrs./week)**

PRE- REQUISITE:
Basic knowledge of microorganisms during the first year of this programme

COURSE OBJECTIVES:

To provide knowledge on water quality analysis, isolation and enumeration of microorganisms from water and air samples.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Demonstrate, apply the various techniques used for assessing water and air quality as well as analyze and interpret the findings
2. Use the taught techniques to isolate and enumerate microorganisms from various environmental samples.
3. Describe Indian Standard Institute specification for drinking water

PRACTICAL

1. Standard plate count technique for the isolation and enumeration of microorganisms in water.
2. Water quality analysis by MPN method.
3. Bacterial examination of water using membrane filters.
4. Isolation and identification of *E. coli* from water samples.
5. Estimation of BOD of water.
6. Estimation of COD of water.
7. Indian standard Institute specification for drinking water.
8. Quantificationofmicroorganismsinairbysettleplateandairsamplermethods.

Reference

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. *Microbiology: An Introduction*.11th Edition. Pearson education Pvt. Ltd. Singapore.
2. Black, J.G. 2005. *Microbiology, Principles and exploration*. 6th Edition. John Wiley& Sons *Principles of Bacteriology, Virology and Immunology*. 8th Edition. Edward Arnold, London
3. Pelczar, M. J. Jr., Chan, E.C.S., Krieg, N.R. 1986. *Microbiology*. Mc Graw Hill Book Company**,** London.
4. Prescott, L.M., Harley, J. P and Klein, D.A. 2005. *Microbiology*. 9th Edition. Mac Graw Hill Companies Inc.
5. Aneja, K. R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th Edition. New Age International(P) Limited, New Delhi.
6. Dubey, R. C. and Maheswari, D. K. 2002. *Practical Microbiology*. 2nd Edition, S. Chand &Co., New Delhi.
7. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi

SEMESTER VI
COURSE CODE: MB1641
VOCATIONAL COURSE –IX
COURSE TITLE: INDUSTRIAL MICROBIOLOGY

CREDITS - 4 **Total lecture hours- 72hrs (4hrs/week)**

PRE- REQUISITE:
Basic knowledge of microorganisms and laboratory techniques studied during the first & second year of this programme.

COURSE OBJECTIVES:

To make the students knowledgeable on screening, strain improvement and preservation of industrially important microbes, industrial production of various microbial products by fermentative process, downstream processing of the products and to understand various techniques and types of fermenters used in fermentation industries.

COURSE OUTCOME:

After the completion of this course, the student will be able to:

1. Review the various stages of and techniques used in fermentation industries.
2. Discuss and compare the different types of fermentative processes, fermenters, and downstream processing techniques used in industry.
3. Asses and apply isolation, screening, and preservation techniques of microbes.
4. Summarize and give examples of fermentative production of organic acids, amino acids, enzymes and antibiotics.

MODULE I **12 hrs.**

History and scope of industrial microbiology. Screening of industrially important microorganisms- Primary and Secondary Screening. Strain Improvement–Mutation, Recombination and protoplast Fusion.

MODULE II **18 hrs.**

Types of fermentation process- Surface, submerged and solid state. Basic Design &

instrumentation of Fermenter. Types of fermenters- Batch Fermenter, Continuous Stirred Tank Fermenter, Fluidized Bed Fermenter, Solid State Fermenter, Air Lift Fermenter, Tubular Fermenter. Development of inoculum for industrial fermentation. Fermentation media – carbon source, nitrogenous materials and antifoams. Industrial sterilization-batch and continuous sterilization.

MODULE III **10 hrs.**

Preservation of microbes - serial subculture, preservation by overlying culture with mineral oil, lyophilization, storage of microbes at a very low temperature or in liquid nitrogen. Methods for preservation of fungi.

MODULE IV **12 hrs.**

Downstream Processing, Intracellular and extracellular product recovery. Physical and chemical methods. Cell disruption methods, solvent extraction, and purification. Product recovery. Computer control of fermentation process.

MODULE V

20hrs

Fermentative Production of organic acids: acetic acid, citric acid, lactic acid. Production of amino acid: lysine and glutamic acid, production of enzymes: proteases and amylases. Production of antibiotics: Penicillin, Streptomycin, Production of vitamins -Vitamin B_{12} & Riboflavin.

SEMESTER VI
COURSE CODE: MB1641
VOCATIONAL COURSE –IX- PRACTICAL-P6
COURSE TITLE: INDUSTRIAL MICROBIOLOGY

CREDITS - 4 **Total practical hours - 126 hrs. (7 hrs./week)**

PRE- REQUISITE:
Basic knowledge of microorganisms and laboratory techniques studied during the first & second year of this programme.

COURSE OBJECTIVES:

To make the students knowledgeable on production of various industrial products and to understand various techniques used in fermentation industries such as screening, isolation, enumeration, immobilization and preservation of industrially important microorganisms.

COURSE OUTCOME:

After the completion of this course, the student will be able to:

1. Describe the methodology to isolate and identify microbial antibiotics from environmental samples.
2. Discuss to isolate and enumerate microorganisms from food samples.
3. Illustrate wine production from grapes.
4. Describe the immobilization and preservation techniques of microbes.

PRACTICAL

1. Crowded plate technique for screening microbial antibiotics.
2. Enumeration and isolation of Lactobacillus from curd.
3. Enumeration and isolation of Bacteria and mold from fermented foods.
5. Wine Production from grapes.
6. Immobilization of yeast cells by sodium alginate method.
7. Preservation techniques:
   a. Serial subculturing
   b. Overlaying with mineral oil

c. Lyophilization

d. Liquid nitrogen storage.

e. Methods for the storage of Fungi

Reference

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. *Microbiology: An Introduction*. 11thEdition.Pearson education Pvt. Ltd. Singapore.
2. Black, J.G.2005. *Microbiology*, *Principles and exploration*. 6th Edition. John Wiley & Sons
3. *Principles of Bacteriology, Virology and Immunology*. 8th Edition. Edward Arnold, London
4. Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R. 1986. *Microbiology*. McGraw Hill Book Company**,** London.
5. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. *Microbiology*. 9th Edition. Mac Graw Hill Companies Inc.
6. Aneja, K.R.2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th Edition. New Age International (P) Limited, New Delhi.
   Dubey, R. C. and Maheswari, D. K. 2002. *Practical Microbiology*. 2nd Edition, S. Chand & Co., New Delhi.
7. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER VI
COURSE CODE: MB1642
FOUNDATION COURSE II - (VOCATIONAL)
COURSE TITLE: FOOD AND DAIRY MICROBIOLOGY

CREDITS-4 **Total lecture hours- 72 hours (4hours/week)**

PRE- REQUISITE:
Basic knowledge of microorganisms gained during the first year of this programme.

COURSE OBJECTIVES:

The course will enable students to understand the importance of microorganisms in food and allied industries. The course will teach the role of microbes in food spoilage, contamination and various food borne diseases. The course will also provide an insight into the principles of food preservation and methods for microbial examination of food.

COURSE OUTCOMES:

1. To describe the various factors affecting microbial growth and categorize the different groups of microorganisms associated with food.
2. To explain the different sources of contamination and summarize the general principles underlying spoilage of food.
3. To describe different methods for the preservation of food.
4. To understand basics of dairy microbiology microbial spoilage of milk, milk borne diseases and preservation methods.
5. To describe the beneficial role of microbes in fermented foods and fermented dairy products and other indigenous fermented foods.
6. To paraphrase on food poisoning and food borne diseases.
7. To discuss the basis of food safety regulations and HACCP.

MODULEI **12 hrs.**

Food as a substrate for microorganisms. Factors affecting microbial growth in food – hydrogen ion concentration (pH), water activity, oxidation reduction potential, nutrient content, inhibitory substance. Microorganisms important in food microbiology – Important groups of bacteria, molds and yeast associated with different foods.

MODULE II **12 hrs.**

General principles underlying spoilage of food - Causes of spoilage, classification of food by ease of spoilage. Contamination and spoilage of vegetables and fruits, meat and meat products, sea foods and canned foods.

MODULE III **18 hrs.**

Principles of food preservation, Asepsis, removal of microorganism, maintenance of anaerobic conditions, preservation by the use of high temperature, low temperature, drying, food additives and irradiation.

MODULEIV **16 hrs.**

Dairy microbiology - Sources of microorganisms in milk. - Contamination and spoilage of milk and milk products. Milk borne diseases. Bacteriological examination of milk. Preservation of milk – Pasteurization (different methods and advantages), sterilization (Ultra high temperature processed milk) dehydration. Fermented dairy products and other fermented food.

MODULEV **14 hrs.**

Food borne Diseases- Food born infections and intoxication - Bacterial – *Staphylococcus aureus, Clostridium botulinum, Salmonella typhi, Clostridium perfringens, Vibrio parahaemolyticus, Vibrio cholera, E. coli, Shigella sp., Bacillus cereus, Listeria monocytogenes,* and *Yersinia enterocolitica*. Nonbacterial – Mycotoxins, Viruses- Hepatitis, Poliomyelitis, viral gastroenteritis. Food borne parasites. Food sanitation- good manufacturing practices, Hazard Analysis Critical Control Points (HACCP).

SEMESTER VI
COURSE CODE: MB1642-P09
VOCATIONALCOURSE VII- PRACTICAL-P6
COURSE TITLE: FOOD AND DAIRY MICROBIOLOGY

CREDITS-3 **Total practical hours - 126 hrs. (7 hrs./week)**

PRE- REQUISITE:
Basic knowledge of microorganisms gained during the first and second year of this programme

COURSE OBJECTIVES:

The course imparts knowledge to students on various methods of microbial analysis of food mainly with respect to quality testing and detection of bacteria in milk.

COURSE OUTCOMES:
1. To examine the role of microorganisms in in spoilage of different varieties of food.
2. To apply different techniques for the detection of bacteria in milk.
3. To apply different techniques for quality testing of milk and analyze the results obtained.
4. To demonstrate the methods employed for mushroom cultivation.

PRACTICAL

1. Isolation and Enumeration of bacteria from spoiled food–a) Curd b) fruits and vegetables c) meat d) fish.
2. Detection of number of bacteria in milk by standard plant count.
3. Determination of quality of milk sample by methylene blue reduction test.
4. Detection of number of bacteria in milk by breed count.
5. Quality testing of milk by resazurin test.
6. Determination of phosphatase activity of milk.
7. Mushroom cultivation

Reference

1. Lim, D. 1998. *Microbiology*.2nd Edition; McGraw-Hill Publication.
2. Madigan, M.T. and Martinko, J. M. 2006. *Brock's Biology of Microorganisms*. 11thEdition. Pearson Education Inc.
3. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. *Microbiology*, 5th Edition, Tata

Mac Graw Hill Press.

4. Prescott, L.M., Harley, J.P. and Klein, D.A. 2005. *Microbiology*. 9thEdition. Mac Graw Hill Companies Inc.

5. Alcamo Fundamentals of Microbiology,5thEdition,

6.Gerald J. Tortora, Berdell. R. Funke, Christine L. case, Microbiology–An Introduction. Pearson Publication

6.Salle, A.J. 1971. *Fundamental Principles of Bacteriology*. 7th Edition. Tata Mac Graw Hill Publishing Co.

7.Black, J. G. 2013. *Microbiology: Principles and Explorations*. 6th Edition, John Wiley and Sons, Inc.

8.Aneja, K. R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4thEdition.New Age International (P) Limited, New Delhi.

9. Dubey, R.C. and Maheswari, D.K.2002.*PracticalMicrobiology*.2nd Edition, S. Chand & Co., New Delhi.

10. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

SEMESTER VI

COURSE CODE: MB 1643

COURSE TITLE: BIOINFORMATICS & BIOSTATISTICS

CREDITS-4 Total lecture hours- 72hrs (4hrs/week)

PRE- REQUISITE:

Knowledge of biological data bases during the first & second year of this programme.

COURSE OBJECTIVES:

To learn the basic concepts of bioinformatics and biological databases. To distinguish molecular modeling, sequence analysis and alignment. To gain knowledge in statistical tools in data interpretation, significance test and sampling methods.

COURSE OUTCOMES:

1. Adapt the basic concepts of biological databases.
2. Integrate comparative genomics with pharmacogenomics.
3. Justify molecular phylogeny and phylogeny trees.
4. Construct graphs, tables, histograms and pi diagrams for data interpretation.
5. Compile data generated from sampling methods and evaluate tests of significance based on T and Chi square test.

MODULE I **15hrs**

Bioinformatics**:** Introduction: Definition, Origin of concept of Bioinformatics; Brief history, Importance of bioinformatics; Web lab and Wet lab. Biological databases: Brief account on Model/organism databases, Biodiversity data bases and Biomolecular Databases-Nucleic acid databases Eg: EMBL, Gen Bank - Protein sequence databases. Eg: PIR, SWISS PROT.

MODULE II **12 hrs.**

Protein structure databank- PDB -Molecular visualization- use of Rasmol- Molecular modeling (Brief account only). Molecular docking and computer aided drug design (Brief account only)**.** Basics of Genomics and Proteomics, Comparative genomics and Pharmacogenomics.

MODULE III **15 hrs.**

Sequence analysis and alignment (brief account only). Pair wise sequence alignment. Multiple

sequence alignment: Molecular Phylogeny and Phylogenetic trees. Advantages of Molecular phylogeny and phylogenetic analysis. Bioinformation Tools: BLAST, CLUSTAL X.

MODULE IV **12 hrs.**

Documentation of experiments. Nature and types of data. Significance of statistical tools in data interpretation: graphs, tables, histograms and pi diagrams. Statistical testing of hypothesis, null hypothesis. Significance test -Statistics based acceptance or rejection of a hypothesis.

MODULE V **18 hrs.**

Nature and scope of statistical methods and their limitation. Measure of average and dispersion mean, medium, mode. Sampling methods-simple random, stratified, systematic and cluster sampling procedures. Sampling distribution, Probability, Tests of significance based on T, Chi-square and f test.

SEMESTER VI
COURSE CODE: MB 1643
COURSE – PRACTICAL –P6
COURSE TITLE: BIOINFORMATICS & BIOSTATISTICS

PRE- REQUISITE: **Total practical hours - 108 hrs. (6 hrs./week)**

Knowledge of computer and software applications during the first & second year of this programme.

COURSE OBJECTIVES:

To learn how to download nucleotide and protein sequence files from databases and its visualization. To compare different sequence analysis and nucleic acid database. To compose mean, median. mode and compare different tests of significance,

COURSE OUTCOMES:

1. Compare nucleotide and protein sequence files from database.
2. Distinguish between different sequence analysis platforms and nucleic acid databases.
3. Create graphical representation from data generated from different sampling methods.
4. To compose mean. Median, mode and compare significance using different tests of significance.

PRACTICAL

1. Downloading Nucleotide and Protein sequence files from databases
2. Downloading structure files and visualizing using Rasmol
3. Sequence Analysis using BLAST, CLUSTAL Omega
4. Nucleic acid data bases Eg: EMBL, GenBank
5. Collection of data, sampling designs, tabulation and graphic representation using biological materials.
6. To find mean, mode and median using biological materials.
7. Tests of significance ‘t’ test, ‘chi’ square, standard error and standard deviation to be practically done through SPSS [statistical Package for Social Sciences] programme.

Reference

1. Lim, D.1998.*Microbiology*. 2nd Edition; Mc Graw-Hill Publication.
2. Madigan, M.T. and Martinko, J.M. 2006. *Brock’s Biology of Microorganisms*. 11thEdition.

Pearson Education Inc.

3. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. *Microbiology*, 5th Edition, Tata Mac Graw Hill Press.
4. Prescott, L.M, Harley, J.P. and Klein, D.A. 2005. *Microbiology*. 9thEdition. Mac Graw Hill Companies Inc.
5. Alcamo Fundamentals of Microbiology, 5thEdition,
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8. Salle, A.J. 1971. *Fundamental Principles of Bacteriology*. 7th Edition. Tata Mac Graw Hill Publishing Co.
9. Black, J. G. 2013. *Microbiology: Principles and Explorations*. 6th Edition, John Wiley and Sons, Inc.
10. Aneja, K. R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th Edition. New Age International (P) Limited, New Delhi.
11. Dubey, R.C and Maheswari, D.K. 2002.*PracticalMicrobiology*.2nd Edition, S. Chand &
12. Co., New Delhi.
13. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi

OPEN COURSE –I(a)

MUSHROOM CULTURE

Course Code : MB1551.1
Number of credits:2
Number of contact hours: Lecture: 54 hrs.

MODULEI **9 hrs.**

Introduction: history & scope of edible mushroom cultivation. Types of edible mushroom available in India: *Calacybe indica, Volvariella Volvacea, Pleurotus sp. and Agaricus bisporus.*

MODULEII **10 hrs.**

Pure culture technique: preparation of media & sterilization – Preparation of test tube slants to store mother culture – culturing of *Pleurotus* mycelium on petri plates – Preparation of mother spawn in saline bottle and polypropylene bags and their multiplication.

MODULEIII **15 hrs.**

Cultivation Technology: Infra structure, Substrates (locally available) polythene bag, vessels, Inoculation hood – inoculation loop – low-cost stove – sieves – Culture rack mushroom unit (Thatched house) – Mushroom bed preparation – Paddy straw, sugarcane trash, maize straw, banana leaves.

MODULEIV **10 hrs.**

Storage and nutrition: short term storage – Long term storage (scanning, Pickles, papads, drying, storage in salt solutions) – Nutrition: Proteins, amino acids, mineral elements. Nutrition: Carbohydrates – Crude fiber content, vitamins.

MODULEV **10 hrs.**

Economics of mushroom cultivation (fixed assets, recurring expenditure, labor, economics of cultivation throughout the year and seasonal growing formulation of project report for getting finance from funding agencies). Precautions in mushroom cultivation (precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc.). Mushroom recipes.

Field study: Visit to a mushroom cultivating laboratory

REFERENCES

1. Marimuthu et al., (1991) Oyster Mushrooms, Dept. of Plant pathology, TNAU, Coimbatore.
2. Nita Bahl (1988) Hand book of Mushrooms, II edition, Vol. I &II.
3. Paul Stamets, J.S. and Chilton, J.S. (2004). Mushroom Cultivator: A Practical guide to growing mushrooms at home, Agarikon Press.
4. Shu-Ting Chang, Philip G. Miles, Chang, S.T. (2004). Mushrooms: Cultivation, nutritional value, medicinal effect and environmental impact, 2nd ed, CRC press.
5. Swaminathan M. (1990) Food and Nutrition. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
6. Tewari and Pankaj Kapoor S.C. (1988) Mushroom cultivation, Mittal Publications, Delhi.

OPEN COURSE-I (b)
MICROBIAL WASTE MANAGEMENT

Course Code : MB1551.1

Number of credits:2

Number of contact hours: Lecture: 54 hrs.

MODULE I **20 hrs.**

General concept of sanitation and disinfection. Sanitation of industrial and food processing units Air sanitation, Safe location of animal houses, hospitals, industrial fermentation units etc. based on air sanitation. Air borne diseases and preventive measures.

MODULE II **20 hrs.**

Microbiology of municipal sewage and sewage treatment BOD and COD Concept. Treatment of Industrial effluent- Waste water treatment-Mechanical and biological. Aerobic and anaerobic treatments. Domestic septic tank. Treatment of municipal water supplies water borne diseases

MODULE III **14 hrs.**

Solid waste disposal-sanitary landfills, composting, vermicompost. Disposal of animal and agricultural waste. Methanogenesis and biogas production

REFERENCES

1. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.
2. Ec Eldowney S, Hardman D.J., Waite D.J., Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.
3. Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.
4. Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.
5. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste

OPEN COURSE-I (c)
BIOFERTILIZER TECHNOLOGY

Course Code : MB1551.3
Number of credits:2
Number of contact hours: Lecture: 54 hrs.

MODULE–I **15 hrs.**

General account of the microbes used as biofertilizers for crop plants and their advantages. Symbiotic N2 fixer: *Rhizobium* - Isolation, characterization, identification, Classification, inoculum production and field application. *Frankia* - Isolation, characterization – actinorhizal nodules – non-leguminous crop symbiosis.

MODULE–II **8 hrs.**

Non – Symbiotic N2 fixers – *Azospirillum* – Free living - *Azotobacter* – free isolation, characterization, mass inoculum production and field application.

MODULE–III **8 hrs.**

Symbiotic N2 fixers – Cyanobacteria, Azolla – Isolation, characterization, mass multiplication – Role in rice cultivation – Crop response – field application - immobilization.

MODULE–IV **8 hrs.**

Phosphate solubilizers – Phosphate solubilizing microbes – Isolation, characterization, mass inoculum production, field application – Phosphate solubilization mechanism.

MODULE–V **15 hrs.**

Mycorrhizal bioinoculants – classification – importance of mycorrhizal association Ectomycorrhiza – Endomycorrhiza – Ectendomycorrhiza — Isolation of VA mycorrhiza – Quantification and assessment of VAM in roots – Mass inoculum production of VAM – field applications of Ectomycorrhiza and VAM.

Field study: Visit to a biofertilizer production unit

REFERENCES

1. Kannaiyan, S. (2003). Biotechnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. New Delhi.
5. Subba Rao N.S. (1988) Biofertilizers in Agriculture and forestry Oxford and IBH Publishing

OPEN COURSE-II (a)

COURSE CODE: MB1661
COURSE TITLE: AGRICULTURAL MICROBIOLOGY

CREDITS-2 **Total lecture hours- 54 hours (3hours/week)**

PRE- REQUISITE:

Basic knowledge of microorganisms gained during the first year of this programme.

COURSE OBJECTIVES:

The major objective of this paper is to impart knowledge about the basics of soil microorganisms their interactions and gain insight on biogeochemical cycles. The course will also give an understanding of the use of microbial populations in agriculture, and in the generation of value-added products mainly as bio-pesticides and bio-fertilizers.

COURSE OUTCOME:

1. To paraphrase on the microbiology of the soil and explain microbial interactions.
2. To describe the interaction of soil microbes with plants and categorize the different microbial diseases of plants.
3. To discuss the role of microbes as biopesticides and examine their role in integrated pest management.
4. To describe the role of microbes as biofertilizers and review their application in agriculture.
5. To understand plant disease mechanism and how to control plant diseases and also to get awareness on the impact of chemical fertilizers.

MODULEI **10 hrs.**

Microbiology of soil- microbial flora, factor affecting flora, biogeochemical cycles- nitrogen, carbon, sulfur, phosphorus and its importance. Soil microorganisms and microbial interactions - mutualism, synergism(protocooperation), commensalisms. Amensalism, competition, parasitism, predation, neutralism.

MODULE II **10 hrs.**

Interaction of microbes with plants-Microbes with plant roots-Rhizosphere concept, mycorrhizae, ecto, endo, VAM, actinomycorrhiza, rhizoplane, phylloplane and phyllo sphere concept.

MODULE III **14hrs**

Biofertilizers: Biological nitrogen fixation- Biochemistry and physiology of nitrogen fixation, *nif* genes. PGPR – General account of the microbes used as biofertilizers for crop plants and their advantages: Isolation, characterization, identification, Classification, inoculum production and field application of *Rhizobium Azospirillum*, *Azotobacter*, *Azolla* and *Phosphate solubilizing bacteria.*

MODULE IV **10hrs**

Microbial diseases of plants- Bacterial diseases**:** Bacterial leaf blight of rice, Citrus canker Fungal diseases: Downy mildew of grapes, and Tikka disease of groundnut. Mycoplasmal diseases- Sandal spike, Grassy shoot disease of sugarcane Actinomycetes Diseases-Potato scab disease. Viral Disease – TMV, Bunchy top disease of banana

MODULEV **10 hrs.**

Bio Pesticides: bacterial, viral and fungal pesticides. Biological control of plant diseases. Integrated pest management.

Reference

1. Lim, D.1998.*Microbiology*. 2nd Edition; McGraw-Hill Publication.
2. Madigan, M.T. and Martinko, J.M.2006. *Brock's Biology of Microorganisms*. 11thEdition. Pearson Education Inc.
3. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. *Microbiology*, 5th Edition, Tata Mac Graw Hill Press.
4. Prescott, L.M, Harley, J.P. and Klein, D.A.2005.Microbiology.9th Edition. Mac Graw Hill Companies Inc.
5. Alcamo Fundamentalsofmicrobiology,5th Edition.
6. Gerald J. Tortora, Berdell. R. Funke, Christine L. Case, Microbiology–An Introduction. Pearson Publication
7. Salle, A.J.1971. *Fundamental Principles of Bacteriology*. 7th Edition. Tata Mac Graw Hill Publishing Co.
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11. Kannan, N. 2002. *Laboratory manual in general microbiology*. 2nd Edition, Panima Publishing Co., New Delhi.

OPEN COURSE-II (b)

BIOSAFETY IN MICROBIOLOGY

Course Code : MB1661 Number of credits:2
Number of contact hours: Lecture: 54 hrs.

MODULEI **12 hrs.**

Concept of biosafety: Historical background, principles of biosafety, introduction to biological safety cabinets, selection, installation and use of biological safety cabinets, primary containment for biohazards, biosafety levels, biocontainment, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

MODULE II **12 hrs.**

Biosafety guidelines - Government of India, definition of Genetically Modified Organisms (GMOs) and Living Modified Organisms (LMOs), Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs.

MODULE III **10 hrs.**

Risk Analysis, Risk Assessment, Risk management and communication. Overview of national regulations and relevant international agreements including Cartagena Protocol.

MODULE IV **10 hrs.**

Plant biosafety, risk assessment, laboratory standard operating procedures, safety of laboratory personnel, environmental safety, regulated biosafety and biosecurity. Biosafety regulations and assessment of biotechnology products, drugs/vaccines and GMOs.

MODULE V **10 hrs.**

Biosafety protocols, biological weapons, biosecurity, components of biosecurity program and bioethical issues. Occupational health and immunoprophylaxis, decontamination and disinfection, transportation of infectious substances and, agriculture pathogen biosafety.

REFERENCES

1. Social issues in Science and Technology: An Encyclopedia, David E. Newton (ABC- CLIO, Santa Barbara),1999.
2. Methods for Teaching Science as Inquiry, Bass, Joel, E and et. al., Allyn & Bacon, 2009 The truth of science, Newton R.G.,
3. Biotechnology: Issues, Ethics and Regulations, Tina M. Prow, Communications Specialist, Office of Agricultural Communications and Education.
4. Fleming, D. O. and D. L. Hunt (eds.). 2006. Biological Safety: Principles and Practices, 4th ed. ASM Press, Washington, D.C.\ Tina M. Prow,
5. Centers for Disease Control and Prevention and National Institutes of Health (CDC/NIH). 2007. Biosafety in Microbiological and Biomedical Laboratories, 5th ed.