B.Sc. MICROBIOLOGY

SYLLABUS

(2021 -22 Onwards)

MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI – 12
TAMILNADU,INDIA

B.Sc. MICROBIOLOGY
(FOR AFFILIATED COLLEGES)

CURRICULUM
(Effective from the academic year 2021-2022 onwards)

MANONMANIAM SUNDARANAR UNIVERSITY

ABHISHEKAPATTI, TIRUNELVELI– 627 012, TAMILNADU, INIDA

B.Sc. MICROBIOLOGY (CBCS PATTERN)

FOR AFFILIATED COLLEGES

(EFFECTIVE FROM THE ACADEMIC YEAR 2021-2022 ONWARDS)

REGULATIONS OF SYLLABUS

Vision

To provide quality education to reach the un-reached.

Mission of the University

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

VISION AND MISSION OF THE DEPARTMENT

VISION

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

MISSION

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

PREAMPLE: -

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

Eligibility:

A pass in Higher Secondary examinations or its equivalent in Science Stream with Biology / Botany / Zoology / Microbiology as one of the course or a course from general stream course (Biotechnology, Biochemistry, Microbiology) or vocational stream course (covering Life Sciences, Agriculture chemicals, Agrobased industries, Environment, Medical / Para medical, Agriculture, Apiculture, Aquaculture, Crop protection, Diarying, Floriculture and Medicinal plants, Farm mechanics and post-harvest techniques, Poultry, Plant protection, Sericulture and Apiculture, Soil conservation, Small farm management, Spices and plantation crops, Vegetable and fruits, Hospital care / Management, Ophthalmic, Medical lab technology, Dental studies, Forestry, Home

science, Siddha, Nutrition and Dietitics, Nutritious meal organizer / Food Management and Child care / Agriculture practicals- (Core / Interdisciplinary) is eligible to apply.

Course Duration:

The duration of the Programme shall be for minimum of three consecutive years and with six semesters

Regulation:

The rules and regulation as followed for six semesters Under Graduate (UG) programme under CBCS would be followed

Student Intake: Maximum 48

Credits

The term credit is used to describe the quantum of syllabus for various programmes in term of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The total number of credits for undergraduate programme is not less than 140.

Medium of instruction and examination

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

Theory examination

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

Practical examination

Practical examinations will be conducted every semesters.

Evaluation

A. Each paper carries an internal component

B. There is a pass minimum of 40% for UG. external and overall components

Theory: External : internal Assessment = 75:25

Practical: External : Internal Assessment = 50:50

Internal Assessment

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

COMPONENTS	MARKS
The average of the best two tests from the 3 compulsory tests (Off line / Online Tests)	20 Marks
Assignment	05 Marks
Total	25 Marks

The question paper pattern for all theory papers shall be as follows

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

The question paper pattern for all practical papers shall be as follows

Practical Examination : 3 hrs **Max. Marks: 50**

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

Course Project

1. During the final semester, Project work is assigned
2. It could be done in a group of 4 or 5 students related to issues pertaining to the area of Microbiology under the guidance of department faculty.
3. Student could be permitted to go for the collection of samples / data along with staff members
4. A Scientific report in the form of a thesis should be submitted.

The marks for Project shall be allotted in the following manner

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

Note:

i) Student should carry out group projects.

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

iii) In house projects are encouraged.

iv) Faculty members of the respective colleges must serve as guides

v) Project report evaluation will be done and Viva-voce will be conducted by both the external examiner and the guide at the end of the SIXTH SEMESTER itself.

vi) Dissertation have to be submitted 15 days before the actual schedule of the exam.

vii) Evaluation of dissertation has to be done by the external examiner(s) appointed by the University for 50 Marks.

INDUSTRIAL AND INSTITUIONAL VISIT

To give exposure on the scope and developments in the field of Microbiology for students, Industrial / Institutional visits are promoted. It helps the students to make themselves aware of the demands in the fields, expectations of the concerned and the qualifications to be developed in them. The report of the visit must be added to the practical record.

The performance of the students are indicated by the SEVEN POINTS SCALE GRADING SYSTEM as per the UGC norms given below

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

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

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

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

Industrial Visits

Academic visits to institutions and industries related to the courses during the semesters of study will form part of the curriculum to strengthen the understanding of concepts and applications taught theoretically and practically.

Model Question Paper: -

QUESTION PAPER SETTING – INSTRUCTIONS TO QUESTION PAPER SETTERS

Outcome Based Education (OBC) is being followed in the University from 2022 – 2023 and different learning levels of students are assessed through Terminal Examinations in

addition to Continuous Internal Assessment (CIA). Therefore, the question setters are required to go through this instruction manual and table showing the choice of action verbs attached herewith while framing questions carefully and then set the questions for each paper accordingly.

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

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

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

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

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

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

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

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

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

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

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

Understanding	**K2**	**Ability of the Students** * To understand information * To interpret facts * To compare and contrast * To predict consequences * To translate knowledge into new context, etc.,	Describe, explain, paraphrase, demonstrate, extend, differentiate, illustrate, outline, restate, associate, contrast, interpret, discuss, translate, etc.,
Applying	**K3**	**Ability of the Students** * To use information, methods, concepts, laws, theories in new situations * To solve problems using required skills or knowledge * To demonstrate correct usage of a method of procedure	Apply, identify, make use of, organize, plan, calculate, predict, solve, illustrate, demonstrate, determine, experiment with model, compute, utilize, show, examine, etc.,
Analyzing	**K4**	**Ability of the Students** * To break down a complex problem into parts * To identify the relationships and interaction between the different parts of complex problems * To identify the missing information, redundant information and contradictory information	Classify, outline, break down, categories, analyze, illustrate, infer, select, compare, contrast dissect, distinguish, divide, examine, inspect, etc.,
Evaluating	**K5**	**Ability of the Students** * To compare and discriminate between ideas * To assess the values of theories and presentations * To verify value of evidence * To recognize subjectivity * To make use of definite criteria for judgments	Assess, decide, choose, rank, grade, test measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate, agree, appraise, criticize, determine, disprove, estimate, influence, interpret, etc.,
Creating	**K6**	**Ability of the Students** * To use old ideas to create new ones * To combine parts to make new whole. * To generalize from given facts, relate knowledge from several areas, draw conclusions.	Adapt, build, change, combine, compose, construct, create, delete, derive, design, develop, elaborate, formulate, generate, improve, integrate, invent, maximize, minimize, modify, etc.,

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

OBE ELEMENTS FOR

B.Sc., MICROBIOLOGY PROGRAMME

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To enhance in-depth knowledge in the field of Microbiology

PEO2: To carryout practicals, project and scientifically interpret the results .

PEO 3: To prepare themselves for employment in the field of Microbiology

PEO 4: To meet International Standards by updating their knowledge .

PEO 5: To propagate the knowledge due to the applications of Microbiologyin human life.

PROGRAMME OUTCOMES (PO)

DEPARTMENT OF MICROBIOLOGY

Programme Outcome (POs)

By the Completion of the B.Sc. Microbiology Program, the students will be able to:

PO 1. Execute their professional roles in society as Microbiology Professionals, employers and employees in various industries, researchers and educators in State, National and International firms.

PO 2. Acquire in -depth analytical and Practical knowledge to identify, formulate and solve the issues related to Microbiology and Biotechnology Industry, Pharmaceutical industry, Food,Dairy, Agricultural and Medical or hospital related organizations and Academia.

PO 3. Apply responsibilities to promote health and safety of the society and the nation.

PO 4. Develop softskills, attitude and values required for self-directed, lifelong learning and Professional development.

PO 5. Maintain Professional ethics and prepare to work individually or as group to excecute project works associated with relevance to the area of study.

Programme Specific Outcomes:

The students of B.Sc., Microbiology should be able to:

PSO 1.Apply their knowledge and skills in Practical based on aseptic procedures, isolation and identification of microbes from different sources.

PSO 2. Acquire knowledge on the concept of disease development, spread, control and eradication from society and also understand the basic concepts of gene and their regulation of action.

PSO 3. Learn the process of various Industrial fermentations and Bioinstrumentation.

PSO 4. Update their knowledge in Immunology, Microbial Genetics, Genetic Engineering, Bioinformatics, Microbial Biotechnology and Diagnostic Microbiology.

PSO 5. Relate scientific knowledge to research on various topics in Microbiology and perform experimentation, collect, analyze and present data and to develop social responsibility.

MANONMANIAM SUNDARANAR UNIVERSITY – TIRUNELVELI – 12

B.Sc Microbiology (CBCS)

(For those who joined the course from the academic year 2022-2022)

Semester- Wise Credit Distribution for B.Sc., Microbiology 2021- 22

Semester (1)	Part (2)	Sub No. (3)	Course Status (4)	Course Title (5)	Contact Hrs/ Week (6)	L Hrs./week (7)	T Hrs./week (8)	P Hrs./week (9)	C Credits (10)
I	I	1	Language	Tamil / Other Language	6	6	0	0	4
	II	2	Language	Communicative English	6	6	0	0	4
	III	3	Add on Major (Compulsary)	Professional English for Life Sciences – I	4	4	0	0	4
	III	4	Core – I Major	Fundamentals of Microbiology and Microbial Diversity	4	4	0	0	4
	III	5	Major Practical – I	Lab in Fundamentals of Microbiology and Microbial Diversity	2	0	0	2	2
	III	6	Allied – I	Bioinstrumentation	4	3	1	0	3
	III	7	Allied Practical – I	Lab in Bioinstrumentation	2	0	0	2	2
	IV	8	Common	Environmental Studies	2	2	0	0	2
				SUB TOTAL	30	25	1	4	25
II	I	9	Language	Tamil / Other Language	6	6	0	0	4
	II	10	Language	English	6	6	0	0	4
	III	11	Add on Major (Compulsory)	Professional English for Life Sciences – II	4	4	0	0	4
	III	12	Core – II Major	Microbial Physiology and Biochemistry	4	4	0	0	4
	III	13	Major Practical - II	Lab in Microbial Physiology and Biochemistry	2	0	0	2	2
	III	14	Allied – II	General Biology	4	3	1	0	3
	III	15	Allied Practical - II	Lab in General biology	2	0	0	2	2
	IV	16	Common	Value Based Education/Social Harmony	2	2	0	0	2
				SUB TOTAL	30	25	1	4	25

SEMESTER I

MAJOR – I

FUNDAMENTALS OF MICROBIOLOGY AND MICROBIAL DIVERSITY

Course Objectives
The course aims

1. To enrich the students' knowledge on the development of Microbiology as a discipline.
2. To give an overview on the basic microbiological techniques.
3. To enhance the students knowledgeable on the Principles and application of Microscopy.
4. To make the students to learn the morphology and functions of the structures within the prokaryotes and eukaryotes.
5. To enhance the basic knowledge on Microbial diversity.

Course Outcomes

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

Course Outcomes		Cognitive level
CO 1.	Understand the contributions of the Pioneers in the field of microbiology	K-2, K-4, K5
CO 2.	Understand the Ultra structure of bacterial cell and compare the difference between Prokaryotic and Eukaryotic cell.	K-2,K-3,K-4
CO 3.	Describe the basic principles of Microscopy, Structure and applications of different types of microscopes and demonstrate the Basic microbiological laboratory Techniques.	K-1,K-2,K-3,K-4
CO 4.	Understand the structure, characteristics, Morphology and importance of diversity of bacterial forms	K-2,K-4,K-5
CO 5.	Understand the structure, characteristics, Morphology and importance of Eukaryotic organisms.	K-2,K-4,K-5

Unit I

Development of Microbiology as a discipline –Spontaneous generation vs Biogenesis – Contributions of Anton von Leeuwenhock, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, MartinusBeijerinck, Sergei N Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit –II

Basic Microbiological Techniques – Microscopy – Principles and Applications – Bright field and Dark Field Microscopy- Electron Microscopy- SEM and TEM,Sterilisation Techniques – Principles and Types – Culture Media – Preparation and Types.

Unit – III

Bacteria – Cell Structure- Flagella – Fimbriae – Pili- Cell membrane- Cytoplasm- Nucleoid – Spore- Structure of Cell wall – Gram Positive – Gram Negative Cell wall Structure- Bacteria – Type study – Staphylococcus, Clostridium, Neisseria, E.coli.

Unit – IV

Archae bacteria and Special groups – Methanogens- Gliding – Budding and Appendaged Bacteria – Sulphur bacteria – Spirochaetes – Mycoplasma – Actinomycetes – Streptomyces.

Unit - V

Other Microbes – Type study
Fungi – General Characteristics – Ultra structure – Type study – Aspergillus.
Algae- General Characteristics – Ultra structure – Type study – Chlamydomonas.
Protozoa – General Characteristics Ultra Structure – Type study – Amoeba.
Viruses - General Characteristics - Structure – Type study – TMV, Rabies Virus.

Textbooks Recommended

1. PrescottLMHarleyJPandKleinDA(2013)MicrobiologyMcGrawhill,NewYork.
2. Salle A.J (1996) Fundamental Principles ofBacteriology.
3. R.C.DubeyandMaheswari-2014ATextBookofMicrobiology–ChandandCoNewDelhi.

Web resources:

1 http://www.bac.wise.edi/microtextbook/index.php
2 http://www.microbeworld.org.uk
3 http://www.microbiologyonline.org.uk/links.html
4 http://www.bac.wise.edi/microtextbook/index.php
5 http://www.microbeworld.org.uk
6 http://www.staff.ncl.ac.uk/n.y.morris/lectures/class2007.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Unit	Topics covered	Hours
I	1.1Development of Microbiology as a discipline –Spontaneous generation vs biogenesis	2
	1.2 Spontaneous generation vs biogenesis Contributions of Anton von Leeuwenhock, Louis Pasteur,	2
	1.3 Louis Pasteur Robert Koch, ,	2
	1.4 Joseph Lister, Alexander Fleming,Selman A. Waksman	1
	1.5 MartinusBeijerinck, Sergei N Winogradsky, Paul Ehrlich, Elie Metchnikoff, Edward Jenner.	1
	1.6Selman A. Waksman, Paul Ehrlich	1
	1.7 Elie Metchnikoff, Edward Jenner.	1
	Total Hours	**10 hrs**
	2.1 Basic Microbiological Techniques, Sterilization-Physical methods. Moist heat and Dry heat Sterilization, Filtration	3

II	2.2 Radiation,ChemicalSterilization– Chemicalagents–Modeofaction– phenolcoefficienttest	1
	2.3 Cultureandmediapreparation–solidandliquid	1
	2.4Typesofmedia-semisynthetic, Enrichment,Selective,transportanddifferentialmedia,Naturalcomponentsasmediaandspecial purposemedia.	2
	2.5 Microscopy – Principles and Applications	2
	2.6 Principles and applications of Bright fieldMicroscopy	1
	2.7 Principles and applications of Dark Field Microscopy	1
	2.8 Principles and applications of Electron Microscopy	1
	2.9 Principles and applications of SEM	2
	2.10 Principles and applications of TEM	1
	Total hours	**15hrs**
III	3.1 Bacteria – General Characteristics – Cell Structure	2
	3.2 Flagella – Fimbriae- Pili	2
	3.3 Cell membrane- Cytoplasm- Nucleoid – Spore- Structure of Cell wall – Gram Positive – Gram Negative Cell wall Structure	5
	3.4 Type study – Staphylococcus, Clostridium, Neisseria, E. coli.	4
	Total hours	**13hrs**
IV	4.1 Archae bacteria and Specialgroups.	3
	4.2 Gliding – Budding and Appendaged Bacteria	2
	4.3 Sulphur bacteria – Spirochaetes	3
	4.4 Mycoplasma – Actinomycetes	3
	4.5 Streptomyces	1
	Total hours	**12hrs**
V	Fungi – General Characteristics – Ultra structure – Type study – Aspergillus	3
	Algae- General Characteristics – Ultra structure – Type study – Chlamydomonas- Protozoa – General Characteristics Ultra Structure – Type study – Amoeba	3
	Viruses - General Characteristics - Structure – Type study – TMV, Rabies Virus	4
	Total hours	**10hrs**
	Total hours for Units I to V	**60hrs**

MAJOR PRACTICALS- I

LAB INFUNDAMENTALS OF MICROBIOLOGY, MICROBIAL DIVERSITY AND CLASSIFICATION

Course Objectives

The Course aims

1. To enhance the student's knowledge and a better understanding of the important aspects of microorganisms.
2. To understand the working procedure and principles of microscopes.
3. To practise and improve the skill in the isolation and handling of microorganisms and instruments.
4. To carryout pure culture techniques and other methods of culturing microorganisms.
5. To study the morphology and functions of the cell structures of prokaryotes by staining techniques.

Course Outcomes

By the completion of the course the students are able to

Course Outcomes		Cognitive level
CO 1	Demonstrate the important aspects of microorganisms	K-2,K-3,K-4
CO 2	Expertise in working procedure and principles of microscopes.	K-2, K-4, K-5
CO 3	Develop skills in the isolation and handling of microorganisms and Laboratory Instruments	K-3, K-4,
CO 4	Pure culture the microorganisms by various culture techniques.	K-2,K-3,K-4,K-5
CO 5	Distinguish the cell structures of Prokaryotes by staining techniques	K-3,K-4,K-5,

Experiments

1. LaboratoryPrecautions.
2. Methods ofSterilization.
3. Handling of Microscope – Parts of a microscope and its application.
4. Micrometry - Determination of size of bacteria oryeast.
5. MotilityofBacteria–Wetmount/hangingdropmethod.
6. Preparationanddispensingofculturemedia– Solidandliquid(NutrientbrothandAgar).
7. PreparationofAgarslant,AgarstabandAgarplates.
8. Serial dilutiontechnique.
9. Isolation and enumeration of Bacteria- P ourplate and Spread plate technique
10. Pure culture technique- Streak plate method.

11. Simple stainingmethod.
12. Gram's Stainingmethod.
13. NegativeStainingMethod.
14. Acid fastStaining method.
15. Spore Stainingmethod.
16. Anaerobic culture technique - Alkaline pyrogallol(Demonstration).

Text books recommended

1. J.G.CappuccinoandN.Sherman1996Microbiology–Alaboratorymanual– Benjamin Cumins , NewYork.
2. M.Kannan1996,LaboratoryManualinGeneralMicrobiology.
3. P.Gunasekaran-LaboratoryManualinMicrobiology.
4. Dr.S.RajanandMrs.R.SelviChristy–ExperimentalproceduresinLifeSciences– Ajanthabook house,Chennai.
5. Dr.S.M.ReddyandDr.S.RamReddy-MicrobiologyAlaboratorymanual- BSCPublishers and Distributors -Hyderabad.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Practical	Topics covered	Hours
1	Safety practices in Microbiological laboratory – Laboratory Precautions	1
2	Cleaning of glassware's and Preparation of cleaning solutions	1
3	Methods ofSterilization - Autoclave, Hot air oven, Laminar air flow pH meter, Petri plates	4
4	Handling of Microscope – Parts of a Microscope and its application	1
5	Micrometry - Determination of size of bacteria oryeast	1
6	MotilityofBacteria–Wetmount/hangingdropmethod	2
7	Preparationanddispensingofculturemedia– solidandliquid(Nutrientbrothandagar) Liquid media-Nutrient broth, Solid media-Nutrient agar, Semisolid media-Nutrient semisolid medium, Differential media-Mac Conkey agar, Selective medium-EMB	4
8	Preparationofagarslant,agarstabandagarplates	2
9	Serial dilutiontechnique.	2
10	Isolation and enumeration of Bacteria- P ourplate and Spread plate technique	4
11	Pure culture technique- Streak plate method	2
12	Simple stainingmethod	**2**
13	Gram's Stainingmethod	**4**
14	NegativeStainingMethod	**2**
15	Acid fastStaining method and Spore staining method	**2**
16	Anaerobic culture technique - Alkaline pyrogallol(Demonstration).	**3**

ALLIED -1

BIOINSTRUMENTATION

Course Objectives

Course aims

1. To enhance the student's knowledgeable and impress upon them the important aspects of preparing buffers, molar and normal solutions
2. To understand the working procedure and principles of Sterilization equipment's
3. To provide practical knowledge and skill in the handling of Chromatographic techniques
4. To learnElectrophoretic techniques and its applications
5. To acquire an overall knowledge on the principles and application of calorimetric and Spectrophotometric methods

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

Course Outcomes	Cognitive level
CO 1. Prepare the Buffers, Molar and Normal solutions.	K-3,K-4
CO 2. Understand the Principle and working of sterilization equipment's in a microbiology laboratory.	K-2, K-3,K-4
CO 3. Demonstrate the concepts of Chromatography.	K-3, K-4,K-5
CO 4. Describe the basic principles of Calorimetry and Spectrophotometry.	K-1,K-2,
CO5. Demonstrate the concepts of Spectroscopy.	K-3,K-4

Unit–I

Buffers-PreparationofBuffers–StandardBuffers–MolarandNormalSolutions PH-PHmeter(PHelectrode_Calomelandglasselectrode)-Titrationscurve-Techniques of PH measurement.

UnitII

PrinciplesandapplicationsofAutoclave–Hotairoven–Incubator,Laminarairflow

chamber/Biosafetycabinets,BODIncubator,Lyophilizer.

Unit–III

Chromatography-Paper,Thinlayer,column,Ion-exchange,gasandHPLC,
Centrifuge - Types of centrifuge and itsapplication.

Unit–IV

Electrophoresis-Principle-PAGE-SDS-Verticalandslabgel-Horizontaland tubegeltypes–Paperelectrophoresis-Applications-Immunoelectrophoresis.

Unit–V

Colorimetry, Flame photometry - spectrometry - UV and Visible spectrophotometer-IRSpectroscopy-RamanSpectroscopy–Xrayspectrometry(Principle, Components, generationanddetection)NMR(PrincipleandConstruction)Continuous and pulsedtypes anduses.

Text Books Recommended

1.J.Jayaraman,1985LaboratoryManualinBiochemistrywileyEasternLtd.,NewDelhi.
2. D.T.Plummer1998,AnIntroductiontopracticalBiochemistry,TataMaCrawHil,NewDelhi.
3.P.Palanivelu,2001AnalyticalBiochemistryandseparationtechniques.
4. Keith Wilson and J walker - 2003 PracticalBiochemistry.

Web Resources

1. http://nptel.ac.in/syllabus.php?subject Id= 102107028.
2. http://b-ok.xyz/book/674611/288bc3
3. http://www.researchgate.net/publication/317181728- Lecture Notes on Laboratory Instrumentation and Techniques.
4. iiscs.wssu.edu/drupal/node/4673

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Buffers-PreparationofBuffers–StandardBuffers	2
	1.2 MolarandNormalSolutions	1
	1.3 PH-PHmeter(PHelectrode_Calomelandglasselectrode)	1
	1.4 Titrationscurve	2
	1.5 Techniques of PH measurement.	1
	Total Hours	**7hrs**
II	2.1 PrinciplesandapplicationsofAutoclave	1
	2.2 Hotairoven–Incubator	1
	2.3 Laminarairflow chamber/Biosafetycabinets	2
	2.4 BODIncubator	2
	2. 5 Lyophilizer.	2
	Total hours	**8hrs**
III	3.1 Chromatography– Introduction	1
	3.2 Paper,Thinlayer	1
	3.3 Column,Ion–exchange	3
	3.4 GasandHPLC	3
	3.5 Centrifuge - Types of centrifuge	1
	3.6 Applications of Centrifuge	1
	Total hours	**10hrs**

IV	4.1 Electrophoresis-Principle	1
	4.2 –PAGE	2
	4.3 SDS-Verticalandslabgel	2
	4.4 Horizontaland tubegeltypes–	1
	4.5 Paperelectrophoresis–Applications	1
	4.6 Immunoelectrophoresis	1
	Total hours	**8hrs**
V	5.1 Colorimetry	1
	5.2 Flame photometry	1
	5.3 Spectrometry	1
	5.4 UV and Visible spectrophotometer	2
	5.5 Spectroscopy-RamanSpectroscopy	1
	5.6 Xrayspectrometry(principle,Components,generationanddetection)	2
	5.7 NMR(PrincipleandConstruction)	2
	5.8 Continuous and pulsedtypes anduses	1
	Total hours	**12hrs**
	Total hours for Units I to V	**45hrs**

ALLIED PRACTICAL –I

LAB IN BIOINSTRUMENTATION

Course Objectives

The Course aims

1. To enhance the student's knowledge and a better understanding of the Principles and working of basic instruments used in Microbiology laboratory
2. To learn the preparation of Buffers, Molar and Normal Solutions.
3. To practise the separation of biomolecules like amino acid and lipid by chromatographic techniques
4. To demonstrate the separation of Plant pigments by Column Chromatography
5. To learn the handling of Micropipette and Centrifuge

Course Outcomes

By the completion of the course the students are able to

Course Outcomes		Cognitive level
CO 1	Demonstrate the Principles and Application of Different instruments used in a Microbiology Laboratory	K-2, K-3, K-4
CO 2	Expertise in working principle and preparation of Molar and Normal Solutions	K-3, K-4
CO 3	Develop skills in the Paper and Thin layer Chromatography	K-2,K-3,K-4
CO 4	Expertise in separation of Biomolecules like amino acids, lipids and Plant pigments	K-3,K-4,
CO 5	Demonstrate Paper Electrophoresis.	K-2,K-3

Experiments

1. Cleaning of Glass wares
2. Microscopy- Light, Bright Field and Dark Field
3. Principles and Application of Incubator/hot air oven/Autoclave/centrifuge/Laminar air flow/filtration unit
4. Preparation of Buffers – Acid and Alkaline range
5. Preparations of Molar solutions
6. Preparation of 0.1and 1Normal Solutions
7. Separation of Amino acid by Paper Chromatography
8. Estimation of free Amino acid by Ninhydrin method
9. Separation of lipid by Thin layer Chromatography
10. Separation of Plant pigments by Column Chromatography (Demonstration)
11. Beer Lambert's Law Verification
12. Handling of Micro Pipette and checking their accuracy
13. Separation of Water and Oil using Centrifuge
14. Paper Electrophoresis

Text Books Recommended

1.J.G.CappuccinoandN.Sherman1996Microbiology-ALaboratorymanual Benjamin Cummins, NewYork.

2.M.Kannan1996,LaboratoryManualinGeneralMicrobiolog.

3.P. Gunasekaran - Laboratory Manual inMicrobiology.

4.Dr.S.RajanandMrs.R.SelviChristy–ExperimentalproceduresinLifeSciences-AjanthaBook house,Chennai.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Practical	Topics covered	Hours
1	Cleaning of Glass wares	1
2	Microscopy- Light, Bright Field and Dark Field	4
3	Principles and Application of Incubator/hot air oven/Autoclave/centrifuge/Laminar air flow/filtration unit	3
4	Preparation of Buffers – Acid and Alkaline range	1
5	Preparations of Molar solutions	1

6	Preparation of 0.1and 1Normal Solutions	2
7	Separation of Amino acid by Paper Chromatography	2
8	Estimation of free Amino acid by Ninhydrin method	2
9	Separation of lipid by Thin layer Chromatography	3
10	Separation of Plant pigments by ColumnChromatography (Demonstration)	2
11	Beer Lambert's Law Verification	2
12	Handling of Micro Pipette and checking their accuracy	1
13	Separation of Water and oil by using Centrifuge	3
14	Paper Electrophoresis	3
TOTAL – 30 Hrs		

SEMESTER - II

MAJOR – II, MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

Course Objectives

The course aims

1. To enhance the students' knowledge on the basic concepts of bacterial metabolism
2. To give an outline on the processes of Alcoholic fermentation
3. To give an in-depth knowledge on phototropic microbes and nitrogen fixation
4. To study different families of monosaccharides and polysaccharides
5. To learn the biochemistry of amino acids and lipids.

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

Course Outcomes		Cognitive level
CO 1.	Explain the basics of Metabolism in microbes	K-1,K-2,K-3
CO 2.	Demonstrate the Fermentation process, types and applications.	K-2,K-3,K-4
CO 3.	Explain the different types of Respiration in bacteria and other microbes.	K-1,K-2,K-3
CO 4.	Demonstrate the structure, types and functions of different types of Carbohydrates	K-2,K-3,K-4
CO 5.	Demonstrate the structure, types and functions of different types of Aminoacids, Proteins and lipids	K-2,K-3,K-4

Unit – I

Basic Concepts of Metabolism – Respiratory Pathways – Glycolysis – Kreb's Cycle – ETS – ATP generation - Fermentation Pathways – Alcohol Fermentation - Anaerobicrespirationwithspecial referenceto dissimilatory nitrate reduction (Denitrification: nitrate / nitrite and nitrate / Ammonia respiration)

Unit – II

Introduction to Phototrophic metabolism – groups of phototrophic microorganisms, Anoxygenicvs,oxygenicphotosynthesiswithreferencetophotosynthesisingreen bacteria and cyanobacteria – Introduction to nitrogen fixation (Ammonia assimilation / Assimilatory nitratereduction).

Unit – III

Families of Monosaccharides; Aldoses and Ketoses, Trioses, Pentoses and Hexoses – Disaccharides - Reducing and Non-reducing Sugars -Polysaccharides- Starch and Glycogen – Structural Polysaccharides – Cellulose - Peptidoglycan – Chitin

Unit – IV

Amino acids: ,NonProteinamino acids–D-alanineandD-glutamicacid,oligopeptides - Proteins – Primary – Secondary – Tertiary and Quaternary structure of Proteins. Enzymes – Basic Biochemistry.

Unit-V

Lipids: MajorclassesofStorageandStructural lipids–storagelipids–fatty acids

Structureandfunctions–Essentialfattyacid–Saponification–sphingolipids-Lipid functions(cellsignals,cofactors,prostaglandins)-Introductionof lipidmicelles.

Text books Recommended.

1) Caldwell,D.R.(1995),MicrobialPhysiologyandMetabolism,Wm.C.BrownPublishers,USA.

2) PrescottLM.HarleyJPandKleinDA(2013)MicrobiologyMccrawttill,NeweYork.

3) SalleA.J.(1996)FundamentalPrinciplesofBacteriology.
4) Styrer,L.1995,Biochemistry,Ed.W.H.FreemanandCompany,NewYork.

5) BergJMTymoczkoJLandStryerL(2011)Biochemistry,W.H.FreemanandCompany.

Web Resources

1 http://www.microbiologyonline.org.uk/links.html
2 http://www.edu.pe.ca/southernkings/microbacteria.html
3 https://ocw.mit.edu/courses/biology/
4 https://en.wikipedia.org/wiki/Biochemistry
5 https://www.britannica.com/science/biochemistry

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Basic Concepts of Metabolism	1
	1.2 Respiratory Pathways – Glycolysis	1
	1.3 Krebs Cycle	1
	1.4 ETS – ATP generation	1
	1.5 Fermentation Pathways	2
	1.6 Alcohol Fermentation	1
	1.7 Anaerobicrespiration	2
	1.8 Dissimilatory nitrate reduction	1
	1.9 Denitrification: nitrate / nitrite and nitrate / ammonia respiration)	2
	Total Hours	**12hrs**
II	2.1 Introduction to Phototrophic metabolism	2
	2.2 Groups of phototrophic microorganisms,	1
	2.3 Anoxygenicvs,oxygenicphotosynthesis	1
	2.4 Photosynthesisingreen bacteria and cyanobacteria –	4
	2. 5 Introduction to nitrogen fixation (Ammonia assimilation / Assimilatory nitratereduction).	4
	Total hours	**12hrs**
III	3.1 Monosaccharides - Introduction	2
	3.2 Aldoses and Ketoses, Trioses, Pentoses and Hexoses	3

	3.3 Disaccharides - Reducing and Non reducing Sugars	2
	3.4Polysaccharides- Starch And Glycogen	2
	3.5 Structural Polysaccharides – Cellulose - Peptidoglycan – Chitin	3
	Total hours	**12hrs**
IV	4.1 Amino acids - Introduction	2
	4.2 Nonproteinamino acids–D-alanineandD-glutamicacid, Oligopeptides	3
	4.3 Proteins – General Characteristics and Functions	3
	4.4 – Primary – Secondary – Tertiary and Quaternary structure of Proteins.	4
	Total hours	**12hrs**
V	5.1 Lipids , General Characteristics, Functions	1
	5.2 Majorclassesof storageandstructural lipids– storagelipids	2
	5.3 Fatty acids -Structureandfunctions	2
	5.4 Essentialfattyacid–Saponification–sphingolipids	4
	5.5 Lipid function s(cellsignals,cofactors,Prostaglandins)-Introductionof lipidmicelles.	3
	Total hours	**12hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR PRACTICAL -II
LAB IN MICROBIAL PHYSIOLOGY AND MICROBIALBIOCHEMISTRY

Course Objectives
The course aims

1. To impart a practical knowledge on how to perform IMVic test and other biochemical test for the identification of Bacteria.
2. To perform quantitative test for carbohydrates and estimate Protein in the given sample.
3. To measure the growth of bacteria and determine the growth curve.
4. To determine the factors influencing the growth of bacteria

Course Outcomes

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

Course Outcomes		Cognitive level
CO 1	Identify unknown bacteria based on biochemical tests.	K-2,K-3
CO 2	Quantitatively estimate Carbohydrates and Proteins in the given sample.	K-1,K-2,K-3,K-4,K-5
CO 3	Determine the measurement of growth in bacteria and draw the growth curve.	K-1,K-2,K-3
CO4	Demonstrate the effects of environmental factors on growth of bacteria.	K-2,K-3,K-4
CO 5	Determine the effect of disinfectants like Phenol by Phenol Coefficient test.	K-1,K-2,K-3,K-4

Experiments

1.IMViC test series

2. Carbohydrate Fermentation Glucose and Lactose

3. TSI – H2S Production

4. Quantitative test for Carbohydrates (DNSA method)

5. Protein Estimation (Lowry method)

6.Catalase Test

7. Oxidase test

8.Urease test

9. Decarboxylase test

10. Measurement of growth and Growth curve.

11.Effect of pH on growth

12.Effect of temperature on growth

13.Effect of salinity on growth

14. Effect of disinfectant - Phenol Coefficient test

Text books Recommended

1. M.Kannan1996, Laboratory Manual in GeneralMicrobiology.
2. P.Gunasekaran–LaboratoryManualinMicrobiology.
3. Dr.S.RajanandMrs.R.SelviChristy–ExperimentalproceduresinLifeSciences– Ajanthabook house ,Chennai.
4. Dr.S.M.ReddyandDr.S.RamReddy–MicrobiologyAlaboratorymanual–BSCPublishers
5. J.G.CappuccinoandN.Sherman1996Microbiology–AlaboratoryManual–Benjamin Cummins, New York.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Practical	Topics covered	Hours
1	IMViC test series	5
2	Carbohydrate Fermentation Glucose and Lactose	5
3	TSI – H2S Production	2
4	Quantitative test for Carbohydrates (DNSA method)	4
5	Protein Estimation (Lowry method)	4
6	Catalase Test	1
7	Oxidase test	1
8	Urease test	2
9	Decarboxylase test	2
10	Measurement of growth and Growth curve.	4
	TOTAL	30

ALLIED –II -GENERALBIOLOGY

Course Objectives

The course aims

1. To enhance the students' knowledge on the basics of Prokaryotic and Eukaryotic Cell structures
2. To give an outline on the processes of Bacterial and Eukaryotic Cell division and Reproduction.
3. To give an in-depth knowledge on Plants cell, Different types of plants and their adaptations along with their economic importance
4. To learn the basics of Vertebrate and Invertebrate characteristics and Economic Zoology.

Course Outcomes

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

Course Outcomes		Cognitive level
CO 1.	Explain the basics of cell structures of Prokaryotes and Eukaryotes	K-2,K-3,K-4
CO 2.	Demonstrate the Cell division and reproduction in Bacteria and Eukaryotes	K-1,K-2,K-3,K-4
CO 3.	Explain the different types of Plants and their economic importance...	K-1,K-2,K-3
CO 4.	Explain the basic concepts of different systems of Vertebrates and Invertebrate	K-1,K-2,K-3,K-4
CO 5.	Learn and update the valuable information on Economic application of fishes, silkworms and honeybees.	K-2,K-3,K-4,K-5,K-6

Unit -1

Ultrastructure of Eubacteria – Cell Membrane – Extra mural Layer- Slime – Capsule – Cytoplasmic inclusions –Mesosomes – Nuclear material – Reserve materials – Pigments

Unit–II

UltrastructureandfunctionsofEukaryoticCellorganelles–cellwall–cellmembranes – Mitochondria – Chloroplast- Endoplasmic reticulum – Golgi complex – Nucleus – Ribosomes- Other cell inclusions and Flagella.

Unit – III

Cell Divisions in bacteria – Binary Fission – Cell divisions in Eukaryotes – Mitosis – Meiosis – Reproduction in Microbes.

Unit–IV

Botany – Ultrastructure of Plant cell – General characters of Thallophyta - Bryophyta,Pteridophyta and Gymnosperms, plant adaptations in Hydrophytes, Xerophytes, Halophytes, Economic Botany – Economic importance of cereals , Ragi, Pulses – Cowpea – Beverage- Coffee, Oil- Sunflower, Biodiesel – Jatropha, importance, Propagating methods of horticultural plants.

Unit V

Zoology – General Characteristics of Vertebrates and Invertebrates (Type study- Human beings, Earthworm) Human Physiology- Digestive System and Respiratory System, Economic Zoology- Aquaculture, Sericulture, Apiculture.

Text BooksRecommended.

1.PrescottL.M.J.P.Harley and C.A.Klein 2014 BrownPublishers

2.JainVK(2000)FundamentalsofPlantPhysiology5th Edition,SchandCo.Ltd.,

NewDelhi.

3. PandeyB.P.(2007)PlantAnatomyS.ChandandCo.De-NewDelhi.

4.EkambaranthaAyyarandAnanthakrishnanTN1993outlinesofZoology

VolIandIIViswanathanandCo.Chennai.

5.SambasivamI,KamalakaraRaoA.P.AugustineChellappaS(1983)TextbookofAnimal

PhysiologyS.ChandandCo.,NewDelhi.

Web Resources

https://courses.lumenlearning.com/microbiology/chapter/unique-characteristics-of-eukaryotic-cells/

https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod1.pdf

https://nptel.ac.in/courses/102/103/102103012/

https://spiroacademy.com/pdf-notes/study-meterials/Biology/cell-division.pdf

https://gurukpo.com/Content/B.SC/Pteridophytes_Gymnosperms_&_Palaeobotany.pdf

https://books.google.co.in/books/about/Botany_for_Degree_Students_Gymnosperms

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 UltraStructure of Bacteria	1
	1.2 Cell Membrane	1
	1.3 Extra mural Layer- Slime – Capsule	1
	1.4 Cytoplasmic inclusions –Mesosomes	1
	1.5 Nuclear material	2
	1.6 Reserve materials	1
	1.7 Pigments	1
	Total Hours	**8hrs**

II	2.1 UltrastructureandfunctionsofEukaryoticCell	1
	2.2 Cell organelles–Cellwall	1
	2.3 Cellmembranes	1
	2.4Mitochondria – Chloroplast	1
	2. 5 Endoplasmic reticulum – Golgi complex	1
	2. 6 Nucleus – Ribosomes	2
	2. 7Other cell inclusions and Flagella.	1
	Total hours	**8hrs**
III	3.1 Cell Divisions in bacteria - Binary Fission	2
	3.2 Cell divisions in Eukaryotes -Introduction	2
	3.3 Mitosis – Meiosis	3
	3.4 Reproduction in Microbes.	2
	Total hours	**9hrs**
IV	4.1 Botany – Ultrastructure of plant cell	1
	4.2 General characters of Thallophyta	2
	4.3 Bryophyta, Pteridophyta	2
	4.4 – Gymnosperms,	2
	4.5 Plant adaptations in hydrophytes, xerophytes, Halophytes,	2
	4.6 Economic Botany – Economic importance of cereals , Ragi, Pulses – Cowpea	1
	4.7Beverage- Coffee, Oil- Sunflower, Biodiesel – Jatropha, importance	1
	4.8 Propagating methods of horticultural plants.	1
	Total hours	**12hrs**

V	5.1 Zoology – General Characteristics of Vertebrates and Invertebrates (Type study- Human beings, Earthworm)	3
	5.2 Human Physiology- Digestive System and Respiratory System,	3
	5.3 Economic Zoology- Aquaculture, Sericulture, Apiculture.	2
	Total hours	**8 hrs**
	Total hours for Units I to V	**45 hrs**

ALLIED PRACTICAL –II

GENERALBIOLOGY

Course Objectives

The course aims to:

To conduct experiments to study thedifferent forms of prokaryotic and eukaryotic organisms.

To perform mitosis and meiosis to observe the cell division process.

To gain indepth knowledge on organization of cellular structures through staining techniques

To demonstrate the production of Biodiesel.

To make the students to learn the steps involved in Aquaculture and Sericulture Practices.

Course Outcomes

By the completion of the course the students will be able to

Course Outcomes		Cognitive level
CO 1	Explain the different forms of prokaryotic and eukaryotic organisms.	K-1,K-2,K-3
CO 2	Differentiate mitosis and meiosis, the cell division process.	K-2,K-3,K-4
CO 3	Identify the different cellular structures through staining techniques	K-2,K-3,K-4
CO 4	Demonstrate the production of Biodiesel.	K-3,K-4,K-5
CO 5	Expertise in the steps involved in Aquaculture and Sericulture and Horticulture Practices	K-2,K-4
CO 6.	Observe the fish digestive system and study the parts	K-1,K-2,K-3

Experiments

1. Capsulestaining

2. Relationship between OD and CFUmeasurement

3. Observation of representative forms of Algae-Diatoms-*Clamydomonas*,*Volvox*Cyanobacteria (*Oscillatoria*,*Nostoc*,*Anabaena*)

4. Mitosis in Onionroot

5. Meiosisinflowerbudsof *Alliumcepa*(Onion)

5. Isolation of Chloroplast from spinach leaves

6. Silverstainingforflagella

7. Albertstaining

8. Bio diesel preparation (Demonstration)

9. Identification of invertebrate andvertebrates

10. Aquaculture (Demonstration)

11. Sericulture (Demonstration)

12. Apiculture (Demonstration)

13. Horticulture (Demonstration)

14. Observation offishdigestivesystem

Text Books Recommended

J.G.CappuccinoandN.Sherman1996Microbiology–AlaboratoryManual–Benjamin Cummins, NewYork.

Dr.S.RajanandMrs.R.SelviChristy–ExperimentalproceduresinLifeSciences–Ajanthabook house,Chennai.

Dr.S.M.ReddyandDr.S.RamReddy–MicrobiologyAlaboratorymanual–BSCPublishersand Distributers – Hyderabad.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

Lecture Schedule

Practical	Topics covered	Hours
1	Capsulestaining	2
2	Relationship between OD and CFUmeasurement	2
3	Observation of representative forms of Algae-Diatoms-*Clamydomonas*,*Volvox*Cyanobacteria (*Oscillatoria*,*Nostoc*,*Anabaena*)	3
4	Mitosis in Onionroot	2
5	Meiosisinflowerbudsof *Alliumcepa*(Onion)	3
6	Isolation of Chloroplast from spinach leaves	2
7	Silverstainingforflagella	2
8	Albertstaining	2
9	Bio diesel preparation (Demonstration)	2
10	Identification of invertebrate andvertebrates	2
11	Aquaculture Demonstration)	2
12	Sericulture (Demonstration)	2
13	Apiculture (Demonstration)	2
14	Horticulture (Demonstration)	2
	TOTAL	30

END OF I AND II SEMESTER SYLLABUS

MANONMANIAM SUNDARANAR UNIVERSITY – TIRUNELVELI – 12

B.Sc Microbiology (CBCS)

(For those who joined the course from the academic year 2021-2022)

Semester- Wise Credit Distribution for B.Sc., Microbiology 2021- 22

Semester (1)	Part (2)	Sub No. (3)	Course Status (4)	course Title (5)	Contact Hrs/ Week (6)	L Hrs./week (7)	T Hrs./week (8)	P Hrs./week (9)	C Credits (10)
III	I	17	Language	Tamil / Other Language	6	6	0	0	4
	II	18	Language	English	6	6	0	0	4
	III	19	Core – III Major	Fundamentals of Immunology	4	4	0	0	4
	III	20	Major Practical – III	Lab in Fundamentals of Immunology	3	0	0	2	2
	III	21	Allied– III	Allied Chemistry I or Allied Biochemistry I	3	3	1	0	3
	III	22	Allied practical – III	Lab in Chemistry I or Biochemistry I	2	0	0	2	2
	III	23	Skilled based core	A. Medical Lab Technology or B. Clinical Biochemistry	4	4	0	0	4
	III	24	Non Major Elective	A.General Microbiology or B.Applied Food Microbiology	2	2	0	0	2
	IV	25	Common	Yoga	0	0	0	0	0
				SUB TOTAL	30	25	1	4	25
IV	I	26	Language	Tamil / Other Language	6	6	0	0	4
	II	27	Language	English	6	6	0	0	4
	III	28	Core – IV Major	Molecular Biology and Microbial Genetics	4	4	0	0	4
	III	29	Major practical – IV	Lab in Molecularbiology and Microbial Genetics	3	0	0	2	2
	III	30	Allied-IV	Allied Chemistry II or Biochemistry II	3	3	1	0	3
	III	31	Allied practical - IV	Lab in Chemistry II or Biochemistry II	2	0	0	2	2
	III	32	Skill based core – II	A.Nano Biotechnology or Entrepreneurial Microbiology	4	4	0	0	4
	III	33	Non major Elective	A.Microbes and Infections or B.Basics of Biotechnology	2	2	0	0	2
	IV	34	Common	Computer for digital era	0	0	0	0	0
	V	35	Extension Activity	NCC, NSS, YRC, YWF	0	0	0	0	0

				SUB TOTAL	30	25	1	4	25
V	III	36	Core-V Major	Environmental and Agricultural Microbiology	6	4	2	0	4
	III	37	Core-VI Major	Virology	6	4	2	0	4
	III	38	Core- VII Major	Medical and Diagnostic Microbiology	6	3	2	0	4
	III	39	Elective	A1. Bioinformatics or A2. Biostatisticsor A3. Pharmaceutical Microbiology	4	3	2	0	4
	III	40	Major Practical – V	Lab in Environmental and Agricultural Microbiology	3	0	0	3	2
	III	41	Major practical- VI	Lab in Virology and Medical and Diagnostic Microbiology	3	0	0	3	2
	IV	42	Skill Based, Common	Personality Development/ Effective Communication/ Youth Leader ship	2	2	0	0	2
				SUB TOTAL	30	16	8	6	22
VI	III	43	Core - VIII Major	Food and Dairy Microbiology	6	4	2	0	4
	III	44	Core - IX Major	Industrial Microbiology and Bioprocess Technology	6	4	2	0	4
	III	45	Elective	A1. Biotechnology and Genetic Engineering or A2. Clinical Research and Drug Discovery	4	3	1	0	4
	III	46	Major Practical- VIII	Lab in Food and Dairy Microbiology	4	0	0	4	2
	III	47	Major practical –IX	Lab inIndustrial Microbiology and Bioprocess Technology	4	0	0	4	2
	III	48	Project	Project	6	0	0	6	4
				SUB TOTAL	30	11	5	14	20

SEMESTER- III
MAJOR III : FUNDAMENTALS OF IMMUNOLOGY

Course Objectives
The course aim:

1. To gain knowledge on thebasic concepts of Immunohaematology.
2. To give an insight on the cells of the Immune system.
3. To impart basic knowledge on Antigen and Antibody.
4. To give an insight on the concepts of Antigen and Antibody reactions
5. To gain an in depth knowledge on Hypersensitivity reactions, Tumour and Transplantation Immunology

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

Course Outcomes		Cognitive level
CO1	Explain the haematopioesis process and the development of stem cells to functional Immune cells.	K-1,K-2.
CO2	Determine the structure and function of different types of immune cells like polymorphonuclear leukocytes, Killer cells, Natural Killer cells, Dendritic cells, Bcells, Tcells.	K-2, K-3
CO3	Understand the Structure, Types and Functions of Immunoglobins, Structure of Antigen.	K-1,K-2,K-3
CO4	Master the serological techniques and its applications in Disease diagnosis.	K-2,K-3,K-4
CO5	Elaborate the MHC, Transplantation Immunology, Auto immune diseases and Hypersensitivity associated diseases.	K-2,K-3,K-4

UNIT – I:
Basic concepts of Immunology
History of Immunology - Immunohaematology, structure, composition, functions of the cells in immune system - Blood groups, blood transfusion - Rh - Incompatibilities - Immunity - Types of immunity: Innate and acquired.

UNIT –II:
Immune system
Immune systems - Anatomy of Lympho reticular systems - Primary lymphoid organs - Secondary lymphoid tissues - Cells of immune system - Detailed aspects of T Cells and B Cells - Receptors - Activation and functions - Humoral immune response - Cell mediated immune response - Lymphokines, cytokines.

UNIT – III

Antigen and Antibody

Antigens - Types - Properties - Haptens - Adjuvents - Vaccines - Types, toxoids, antitoxins - Immunoglobulins - Structure, types, properties and functions - Complements : Components and pathways.

UNIT – IV

Antigen and Antibody reactions

Antigen - Antibody reactions – Invitro methods: Precipitation reactions, agglutination and complement fixation - Immunofluorescence - ELISA- RIA - In vivo methods - Skin test - Immune complex in tissue demonstration. Monoclonal antibodies (Hybridoma Technology)

UNIT –V:

Hypersensitivity

Hypersensitivity reactions - Antibody mediated - Type I: Anaphylaxis - Type II: Antibody - dependent cell cytotoxicity - Type III: Immune complex reactions - Respective diseases and immunological methods of diagnosis - Type IV: Hypersensitivity reaction - MHC and Transplantation Immunology. Immune deficiency Diseases, Tumour Immunology.

Textbooks Recommended:

1. Donald. M. Weir and John Steward. (1993). Immunology (7^{th} Edition) ELBS, London
2. Hue Davis. (1997). Introductory Immunology (1^{st} Edition) Chapman & Hall Publisher, London.
3. Ivan M. Roit. (1998). Essential Immunology - Blackwell Scientific Publications, Oxford
4. Paul (1998). Fundamental Immunology, (2^{nd} Edition), Raver Press, New York.
5. Peter J. Delves and Ivan M. Roit (Eds) (1998) Encyclopeida of Immunology - (2^{nd} Edition) Academic Press.

Web resources:

1. https://www.microbe.net/resources/microbiology/web-resources/
2. guides.emich/immunology
3. http://oew.mit.edu/courses/.../hst-176-cellular-and molecular.Immunology -fall-2005

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Immunology – Scope and Importance History of immunology	2
	1.2 Immunohaematology	3
	1.3 Structure, composition, functions of the cells in immune system	4
	1.4 Blood groups, blood transfusion - Rh - Incompatibilities	2
	1.5 Immunity - Types of immunity: Innate and acquired	2
	Total Hours	**13hrs**
II	2.1 Immune systems - Anatomy of lympho reticular systems - Primary lymphoid organs - Secondary lymphoid tissues	3
	2.2 Cells of immune system	2
	2.3 Detailed aspects of T Cells and B Cells - Receptors - Activation and functions	3
	2.4Humoral immune response	2
	2. 5 Cell mediated immune response	3
	2. 6 Lymphokines, Cytokines.	1
	Total hours	**14hrs**
III	3.1 Antigens - Types - Properties - Haptens–Adjuvents	2
	3.2 Vaccines - Types, toxoids, antitoxins	2
	3.3 Immunoglobulins - Structure, types, properties and functions	3
	3.4 Complements: Components and pathways	3
	Total hours	**10 hrs**

IV	4.1 Antigen - Antibody reactions	2
	4.2 Invitro methods :Precipitation reactions, agglutination	2
	4.3 Complement fixation - Immunofluorescence - ELISA- RIA	3
	4.4Invivo methods - Skin test - Immune complex in tissue demonstration.	2
	4.5 Monoclonal antibodies (Hybridoma Technology)	2
	Total hours	**11hrs**
V	5.1 Hypersensitivity reactions - Antibody mediated - Type I: Anaphylaxis	3
	5.2 Type II: Antibody - dependent cell cytotoxicity -.	2
	5.3 Type III: Immune complex reactions - Respective diseases and immunological methods of diagnosis - Type IV: Hypersensitivity reaction	3
	5.4 MHC and Transplantations. Immune deficiency Diseases	3
	5.5 Tumour Immunology	1
	Total hours	**12hrs**
	Total hours for Units I to V	**60hrs**

SKILL BASED I - A - MEDICAL LAB TECHNOLOGY

Course Objectives
The course aim:

1. To expose the students about principle and applications of commonly employed techniques in Medical lab technology to make them employable.
2. To make the students knowledgeable on the Collection of clinical specimens.
3. To give an outline on the methods in urine examination.
4. To give an in-depth knowledge on blood count.
5. To make students learn Histo pathological and serological Examination.
6. To expose the students on clinical diagnosis and pathology.

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

Course Outcomes		Cognitive level
CO1	Discuss the method of Collection of clinical specimens	K-2,K-3,K-4
CO2	Outline the methods in urine examination	K-2,K-3,K-4,K-5
CO3	Explain total and differential blood count.	K-2,K-3,K-4,K-5
CO4	Expertise the histo pathological sample preparation andSerological examination.	K-2,K-3,K-4,K-5
CO5	Expertise in clinical pathological techniques and routine sample examination.	K-2,K-3,K-4,K-5

Unit – I:
Clinical measurements-Organization of the clinical laboratory - Role of medical lab technician - Safety regulation - first aid - clinical lab records - units of measurements- laboratory calculations – Qualitycontrol of lab findings, Acid- base balance, Electrolytes, Buffer and pH Preparation, Preparation of Normal and Molar Solution, Collection and Transport of clinical specimen.

Unit –II:

Haematology-Specimen collection - Routine haematological tests - Haemoglobin - Haematocrit - RBC - MCV - MCH - MCHC - Differential counts, Reticulocyte count - ESR - Eosinophil count, Blood clotting mechanisms - Bleeding time - Clotting time determination.

Unit –III:

Serology - Blood grouping, Principles of immunologic reactions - Specimen collection - Preservation - Serological test for Syphilis and Typhoid, Agglutination tests - C reactive protein (CRP) test - RA test - Serodiagnosis of *Streptococcal* infections.

Unit –IV:

Clinical Diagnosis -- Pregnancy test, Enzyme assays - Phosphatase - Transaminases - Creatine kinase - Lactic dehydrogenase - Blood gases and bicarbonate, Blood Pressure(Cystolic and Diastolic), lipid profile (Cholesterol and Triglycerides,HDL, LDL estimation) and their importance.

Unit – V:

Clinical pathology - Urine analysis - routine examination of urine - rapid chemical test of urineCSF - Semen analysis - routine biochemical tests - Glucose, Protein, urea, Creatinine and Bilirubin.

Text book Recommended

1. Ananthanaryanan R and Panikar J (200) Text book of Microbiology, Orient Longmans
2. Rajan (2007) Medical Microbiology MJP Publisher, Chennai
3. Kani L Mukherjee, Medical Lab technology Hill Publishing Co., Ltd., New Delhi Vol I-III

Web Resources

1. https://www.microbe.net/resources/microbiology/web-resources/
2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php
3. https://currentprotocols.onlinelibrary.wiley.com/
4. https://clinlab.ucsf.edu/
5. https://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html
6. http://www.hematologyatlas.com/principalpage.htm
7. https://www.bloodline.net/
8. http://www.protocol-online.org/prot/Histology/index.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Clinical measurement, Organization of the clinical laboratory - Role of medical lab technician - Safety regulation - first aid - clinical lab records	3
	1.2 Units of measurements- laboratory calculations - Quality control of lab findings, Acid- base balance, Electrolytes, Buffer and pH Preparation	2
	1.3 Preparation of Normal and Molar Solutions	2
	1.4 Collection and Transport of clinical specimen	3
	Total Hours	**10 hrs**
II	2.1 Haematology - Specimen collection - Routine haemaological tests	2
	2.2 Haemoglobin -Haematocrit - RBC - MCV - MCH - MCHC - Differential counts	3
	2.3 Reticulocyte count - ESR - Eosinophil count	2
	2.4 Blood clotting mechanisms - Bleeding time - Clotting time determination	3
	Total hours	**10 hrs**
III	3.1 Serology - Blood grouping, Principles of immunologic reactions -	2
	3.2 Specimen collection and Preservation	3
	3.3 Serological test for Syphilis and Typhoid,	3
	3.4 Agglutination tests - C reactive protein (CRP) test	3
	3.5 RA test - Serodiagnosis of *Streptococcal* infections	3
	Total hours	**14hrs**

IV	4.1 Clinical Diagnosis- Pregnancy test, Enzyme assays - Phosphatase - Transaminases - Creatine kinase - Lactic dehydrogenase	4
	4.2 - Blood gases and bicarbonate, Blood Pressure (Cystolic and Diastolic)	5
	4.3 Lipid profile (Cholesterol and Triglycerides, HDL, LDL estimation) and their importance.	5
	Total hours	**14hrs**
V	5.1 Clinical pathology - Urine analysis - routine examination of urine - rapid chemical test of urine	4
	5.2 CSF and Semen analysis	4
	5.3 Routine biochemical tests - Glucose, Protein, urea, Creatinine and Bilirubin	4
	Total hours	**12 hr**
	Total hours for Units I to V	**60 hrs**

SKILL BASEDI - B - CLINICAL BIOCHEMISTRY

Course Objectives:

The course aims

1. To give basic awareness about the concepts and physical aspects in Clinical biochemistry.
2. To develop analytical skills in students in order to prepare them to use diagnosing instruments.
3. To make the students knowledgeable on the collection of clinical specimens
4. To give an outline on the respective laboratory tests for organ function
5. To give an in-depth knowledge on metabolic disorders
6. To make students perform Organ function test
7. To expose the students to techniques in clinical enzymology.

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

Course Outcomes		Cognitive level
CO1	Explain the concepts and physical aspects in Clinical biochemistry.	K-2,K-3,K-4
CO2	Prepare to use diagnosing instruments.	K-3,K-4
CO3	Familiarize with the technique of collection of clinical specimens	K-3,K-4,K-5
CO4	Perform respective laboratory tests for organ function	K-3,K-4,K-5
CO5	Acquire knowledge on metabolic disorders and Clinical Enzymology.	K-2,K-3,K-4

Unit I

Basic concepts of Clinical Biochemistry: Definition and scope of clinical Biochemistry in diagnostics, collection and preservation of biological fluids (blood, serum, plasma, urine and CSF), normal values of important constituents of blood, CSF, urine, etc. Biochemical principles of water and electrolyte imbalance, acid base homeostasis, Preliminary concept of cardiovascular, liver and kidney disorders including laboratory test for respective markers.

Unit II

Diseases related to carbohydrate metabolism: Regulation of blood sugar, Glycosuria – types of glycosuria. Oral glucose tolerance test in normal and diabetic condition, Diabetes mellitus and diabetes incipidus – hypoglycemia, hyperglycemia, ketonuria, ketosis.

Unit III

Inborn errors of metabolism: Introduction – clinical importance, Phenyl ketonuria, Cystinuria, Alkaptonuria, Fanconi's syndrome, Galactosemia, Albinism, Tyrosinemia and Haemophilia.

Unit IV

Organ function test: Lipid and lipoproteins: Classifications, composition, mode of action – Cholesterol. Factors affecting blood cholesterol level.IHD, Atherosclerosis, risk factor and fatty liver. Liver function test: Metabolism of Bilirubin, jaundice – types, differential diagnosis. Icteric test, Vandenberg test, plasma protein changes, Renal function test: Clearance test – Urea, Creatinine, Inulin, PAH test, concentration and dilution test. Gastric function test: Collection of gastric contents, examination of Gastric residuum, Fractional Test Meal (FTM), Stimulation test, tubeless gastric analysis.

Unit V

Clinical Enzymology: Functional and non-functional plasma enzymes, Isoenzymes with examples, Enzyme patterns in acute pancreatitis, liver damage, bone disorder, myocardial infarction and muscle wasting.

Textbooks recommended

1. Text book of Clinical Biochemistry – Carl A. Bordis and Edward R. Ashwood
2. Text book of Medical Biochemistry – Dr. M.N. Chatterjee and RaneShinde
3. Clinical Chemistry in diagnosis and treatment – Philip D. Mayne
4. Clinical chemistry – William Hoffman
5. Clinical Biochemistry with clinical correlation – Devin, Wiley
6. Practical Clinical Biochemistry – Harold Varley, CBS, New Delhi

Web resources:

1. https://clinlab.ucsf.edu/
2. https://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html
3. http://www.hematologyatlas.com/principalpage.htm
4. https://www.bloodline.net/
5. http://www.protocol-online.org/prot/Histology/index.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Basic concepts of Clinical Biochemistry: Definition and scope of clinical Biochemistry in diagnostics, collection and preservation of biological fluids (blood, serum, plasma, urine and CSF)	3
	1.2 Normal values of important constituents of blood, CSF, urine, etc.	2
	1.3 Biochemical principles of water and electrolyte imbalance, acid base homeostasis	2
	1.4 Preliminary concept of cardiovascular, liver and kidney disorders including laboratory test for respective markers.	3
	Total Hours	**10 hrs**
II	2.1 Diseases related to carbohydrate metabolism: Regulation of blood sugar, Glycosuria – types of glycosuria	3
	2.2 Oral glucose tolerance test in normal and diabetic condition,	3
	2.3 Diabetes mellitus and diabetes insipidus – hypoglycemia, hyperglycemia	4
	2.4 Ketonuria, Ketosis.	2
	Total hours	**12 hrs**
III	3.1 Inborn errors of metabolism: Introduction – clinical importance, phenyl ketonuria, cystinuria, alkaptonuria	4
	3.2 Fanconi's syndrome, galactosemia	2
	3.3 Albinism, tyrosinemia and hemophilia.	4
	Total hours	**10hrs**
	4.1 Clinic Organ function test: Lipid and lipoproteins: Classifications, composition, mode of action – Cholesterol. Factors affecting blood cholesterol level.	4

IV	4.2 IHD, atherosclerosis, risk factor and fatty liver. Liver function test: Metabolism of Bilirubin, jaundice – types, differential diagnosis.	4
	4.3 Liver function test – Icteric test, Vandenberg test, plasma protein changes.	3
	4.4 Renal function test: Clearance test – Urea, Creatinine, Inulin, PAH test, concentration and dilution test.	3
	4.5 Gastric function test: Collection of gastric contents, examination of gastric residuum, FTM, stimulation test, tubeless gastric analysis.	2
	Total hours	**16hrs**
V	5.1 Clinical enzymology: Functional and non-functional plasma enzymes, Isoenzymes with examples.	4
	5.2 Enzyme patterns in acute pancreatitis, liver damage,	4
	5.3 Enzyme patterns in bone disorder, myocardial infarction and muscle wasting.	4
	Total hours	**12hrs**
	Total hours for Units I to V	**60hrs**

NON-MAJOR ELECTIVE I

A - GENERAL MICROBIOLOGY

Course Objectives:

The course aims:

1. To introduce ambitious students about the history, scope, basics and components of microbiology to explore more about microbial world.
2. To give an overview on microscopy and microbial growth
3. To make the students knowledgeable on the various microbial techniques involved.
4. To acquire an overall knowledge on Microbial nutrition.

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

Course Outcomes		Cognitive level
CO1	Understand about the history, scope, basics and components of microbiology to explore more about microbial world.	K-1,K-2,K-3,
CO2	Explain microscopy and microbial growth	K-2,K-3,K- 4,K-5
CO3	Demonstrate various microbial techniques involved.	K-3,K-4
CO4	Acquire an overall knowledge on Microbial nutrition.	K-3,K-4,K-5
CO5	Understand the concept of growth of microorganisms and growth curve.	K-2,K-3

Unit –I:
Basic concepts in Microbiology-History and scope of microbiology: Discovery of microbes - spontaneous generation - Role of microbes in disease - Industrial microbiology and microbial ecology

Unit –II:
Microscopy - Basic types - sterilization methods - Disinfectants – Types

Unit –III:
Staining and its methods-Principles of staining procedure- simple, Gram's, Negative, Capsule, Spore.

Unit –IV:
Techniques of microbiology- Components of growth media - General, selective and differential - Pure culture techniques and Preservation of cultures.

Unit –V:
Microbial nutrition- Cell structure - Microbial nutrition Growth curve.

Textbooks recommended

1. Prescott LM Harley JP and klein DA (2013) Microbiology Mccrawttill, New yourk
2. Salle A.J (1996) Fundamental Principles of Bacteriology
3. R.C Dubey and Mahewari – 2014 A Text Book of Microbiology – chand and Co New Delhi.

Web resources:

1. http://www.bac.wise.edi/microtextbook/index.php
2. http://www.microbeworld.org.uk
3. http://www.microbiologyonline.org.uk/links.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Basic concepts in Microbiology - History and scope of microbiology	1
	1.2 Discovery of microbes - spontaneous generation	1
	1.3 Role of microbes in disease	2
	1.4 Industrial microbiology	1
	1.5 Microbial ecology.	1

	Total Hours	**6 hrs**
II	2.1 Microscope - Microscopy - Basic types	2
	2.2 Sterilization methods	2
	2.3 Disinfectants – Types	2
	Total hours	**6hrs**
III	3.1 Staining and its method -Principles of staining procedure	2
	3.2 Simple, gram's staining	2
	3.3 Negative, Capsule, Spore staining	2
	Total hours	**6hrs**
IV	4.1 Techniques of microbiology - Components of growth media	1
	4.2 General, selective and differential media	2
	4.3 Pure culture techniques	2
	4.4 Preservation of cultures	1
	Total hours	**6hrs**
V	5.1 Microbial - Cell structures	2
	5.2 Microbial Nutrition	2
	5.3 Growth curve	2
	Total hours	**6hrs**
	Total hours for Units I to V	**30hrs**

NON-MAJOR ELECTIVE I

B- APPLIED FOOD MICROBIOLOGY

Course Objectives:
The course aims

1. To introduce the important microbes in food
2. To give anoverview on food spoilage.
3. To highlight the Principles of preservation of foods.
4. To create awareness among the students about food preservation
5. To impart knowledge on Food Borne diseases

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

Course Outcomes		Cognitive level
CO1	Explain the important microbes in food	K-1,K-2,K-3
CO2	Understand the principles of food spoilage.	K-2,K-3
CO3	Acquire knowledge on preservation of foods.	K-2,K-3,K-4
CO4	Understand the causative agents of Food Borne diseases	K-3,K-4,

Unit –I:
Food fermentation-Food as a substrate for microorganisms - mold, yeast and bacteria - General characteristics and importance.

Unit –II:
Preservation of food- Principles of food preservation - Asepsis - Removal of microorganisms - Anaerobic conditions.

Unit –III
Spoilage of food - Food spoilage - fruits - vegetables - meat - canned food - sources - control - spoilage problems

Unit –IV
Methods of Preservation - Preservation techniques - freezing and refrigeration - Heat - Vacuum packing - Addition of chemicals –Pasteurization.

Unit –V
Intoxications of food -Food poisoning - Bacterial, viral, fungal, protozoa and Chemical.

Textbooks Recommended

1. Adams, M.R and Moss Food Microbiology
2. Frazier w.c and westhoff D.C (2012) Food migobiology
3. Jay. J.M (2010) Modern Food Microbiology CBS publishers
4. BanwartGj (1989) Basic Food Microobiology Chapman, Hall New York
5. Vijaya Ramesh K (2007 Food Microbiology, MJP Publishers, Chennai

Web resources:

1. http://www.microbes.info
2. http://www.microbes.info/ resource/food microbiology
3. http://www.binewsonline.com/1/what is food microbiology.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Food as a substrate for microorganisms	1
	1.2 General characteristics and importance of Mold and Yeast and bacteria - General characteristics and importance	3
	1.3 General characteristics and importance of bacteria	2
	Total Hours	**6hrs**

II	2.1 Principles of food preservation– Asepsis	2
	2.2 Removal of microorganisms	2
	2.3 Anaerobic methods of preservation	2
	Total hours	**6hrs**
III	3.1 Sources - control - spoilage problems in Vegetables	1
	3.2 Sources - control - spoilage problems in Fruits	1
	3.3 Sources - control - spoilage problems in Meat	2
	3.4 Sources - control - spoilage problems in Canned foods	2
	Total hours	**6hrs**
IV	4.1 Preservation techniques - Freezing and Refrigeration	1
	4.2 Preservation techniques - Heat - Vacuum packing	1
	4.3 Preservation techniques - Addition of chemicals –Pasteurization	2
	4.4 Preservation techniques – Pasteurization	2
	Total hours	**6 hrs**
V	5.1 Food poisoning – Bacterial Food Poisoning	2
	5.2 Food poisoning – Viral Food Poisoning	1
	5.3 Food poisoning – Fungal Food Poisoning	1
	5.4 Food poisoning – Protozoan Food Poisoning	1
	5.5 Food poisoning – Chemical Food Poisoning	1
	Total hours	**6hrs**
	Total hours for Units I to V	**30 hrs**

MAJOR PRACTICALS III- LAB IN FUNDAMENTALS OF IMMUNOLOGY

Course Objectives
The course aims

1. To gain practical knowledge on Collection of blood and Blood grouping
2. To perform Total and Differential count from Blood sample.
3. To demonstrate Antigen and Antibody preparation.
4. To Perform and Familiarise with Serological test like Widal, Immunodiffusion and ELISA tests.

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

Course Outcomes		Cognitive level
CO1	Perform the Collection of blood and Blood grouping tests	K-3,K-4,K-5
CO2	Expertise in determining the Total and Differential count from Blood sample.	K-3,K-4,K-5
CO3	Acquire skill in Antigen and Polyclonal Antibody preparation.	K-3,K-4,K-5
CO4	Perform Serological tests like Widal, Immunodiffusion and ELISA.	K-3,K-4,K-5

Experiments

1. ABO Blood grouping and Rh typing
2. Blood collection and serum separation
3. Perform total RBC and WBC count from blood sample
4. Perform Total Platelets count
5 Antigen preparation (Demonstration)
6. Polyclonal Antibody production (Demonstration)
7. Widal test
8. Single Radial Immunodiffusion test
9. Double Immunodiffusion test (Ouchterlony Double Diffusion tecst)
10. ELISA test (Demonstration)

Textbooks Recommended

1. J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York
2. M. Kannan 1996, Laboratory Manual in General Microbiology
3. P. Gunasekaran - Laboratory Manual in Microbiology
4. Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental procedures in Life Sciences - Ajantha book house, chennai
5. Dr.S.M.Reddy and Dr.S.Ram Reddy - Microbiology A laboratory manual - BSC Publishers and Distributors – Hyderabad.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Practical	Topics covered	Hours
1	ABO Blood grouping and Rh typing	4
2	Blood collection and serum separation	3
3	Perform total RBC and WBC count from blood sample	3
4	Perform Total Platelets count	3
5	Antigen preparation (Demonstration)	3
6	Polyclonal Antibody production (Demonstration)	3
7	Widal test	4
8	Single Radial Immunodiffusion test	3
9	Double Immunodiffusion test (Ouchterlony Double Diffusion test)	2
10	ELISA test (Demonstration)	2
	TOTAL	30

SEMESTER IV
MAJOR –IV – MOLECULAR BIOLOGY AND MICROBIAL GENETICS
Course Objectives:
The course aims

1. To mould the student society with interest in research in the area of life science by teaching with essentials of molecular biology
2. To impart information onthe structure and organization of Genetic material in Prokaryotes and Eukaryotes
3. To make the students knowledgeable on concepts and mechanism of DNA replication, Transcription and Translation in Prokaryotes and Eukaryotes.
4. To expose the students on the plasmids and their applications.
5. To give an in-depth knowledge on Bacterial and Viral Genetics.
6. To enhance student's interest on Mutation genetics and Gene transfer mechanism in microbes.

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

Course Outcomes		Cognitive level
CO1	Acquire interest in research in the area of life science by teaching with essentials of molecular biology and microbial genetics	K-2,K-3,K-4
CO2	Understand the structure and organization of Genetic material in Prokaryotes and Eukaryotes.	K-2,K-3,K-4
CO3	Familiarize on the concepts and mechanism of DNA replication, Transcription and Translation	K-1, K-2,K-3
CO4	Expertise on the concepts of plasmids, Transposons and their applications	K-2,K-3,K-4
CO5	Update the knowledge on Viral Genetics, Mutation and Gene transfer mechanism in microbes	K-2,K-3,K-4,K-5

UNIT- I
Basic Concepts inMolecular Biology – Introduction – Scope – Applications –. Nucleus: Nucleus structure, Nucleoid, Chromatin and Chromosomes, allele, loci, gene. Nucleic acids as genetic material –Discoveryof genetic material-Structure, organization and typesofDNAandRNA–Extrachromosomal DNA(Plasmid), DNA supercoiling,DNAreplication in prokaryotes, Mechanism and enzymology of replication, Rolling circle replication.

UNIT –II
Gene structure and expression
Genes inprokaryotes&Eukaryotes – organization, Molecularmechanismand Enzymologyof TranscriptioninprokaryotesandEukaryotes, Post-transcriptionalmodifications,Geneticcode, Molecularmechaismand Enzymologyof TranslationofproteinsinprokaryotesandEukaryotes,Posttranslationalmodifications.Regulationofgeneexpressionin prokaryotes– Operon concept– lac &trpOperon.

UNIT – III

Mutations:

Spontaneousandinduced, mutagens,basepairchanges,frameshifts,deletions,inversionsandduplications,insertions,usefulphenotypes(auxotrophic,conditionallethal,resistant),reversion vs suppression,Amestest. DNA damage and repairmechanism.

UNIT IV

Bacterial and Viral genetics:

Bacterial plasmids: structure and properties, replication, incompatibility, plasmid amplification. Transposition: structure of bacterial transposons, IS elements, types of bacterial transposons. Organization of viral genome – DNA(Polio Virus) and RNA (Influenza) Retro viral genome, Bacteriophage genome – T4 and T7 life cycle.

UNIT V

Recombination and Gene Transfer mechanisms:

Molecularbasis ofrecombinationinbacteria. Recombination types,Genetransfermechanisms-Transformation:naturaltransformation,competence,DNAuptake,roleof naturaltransformation,artificiallyinducedcompetence,electroporation. Transduction (generalizedand specialized). Conjugation**:** self-transmissibleplasmids,Ffactor,*tra*genes,on T,F'andHfrstrains,stepsinconjugation,chromosome mobilization.

Textbooks Recommended

1. Watson JD., Hopkins N.H., Roberts J.W., Steitz JA and weiner A.A.M (1987) Molecular biology of the Gene. The Benjamin Cumming Publishing Company
2. Lewin B. (2007) Genes IX Oxford University Press UK
3. Maloy S.R. Croman JR. J.E and Freifelder D (1994) Microbial Genetics, Jones and Barlett Publishers.
4. Freifelder D (1991) Molecular Biology, Nanosa Publishing ttouse
5. Jeyanthi, G.P. (2008) Molecular biology, MJP Publisher Chennai.

Web resources

1. www.cellbio.com/education.html
2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html
3. global.oup.com/uk/orc/biosciences/molbio/
4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Introduction and Scope, Structure and organization of Nucleus and Chromosome	2
	1.2 Discovery of Genetic Material – History,	2
	1.3 Bacterial Nucleoid, Supercoiling of DNA, Plasmid	2
	1.4 DNA replication- types	2
	1.5 Rolling circle replication	1
	Total Hours	**9hrs**
II	2.1 Organization of genes in Prokaryotes and Eukaryotes	2
	2.2 Transcription in Prokaryotes and Eukaryotes and Post Transcriptional Modifications, Genetic Code	3
	2.3 Translation in Prokaryotes and Eukaryotes, Post Translational Modifications	3
	2.4 Regulation of Gene Expression, Operon concept, lac and trp operon	2
	Total hours	**10 hrs**
III	3.1 Mutations- Spontaneous and Induced	2
	3.2 Mutagens, Types and Causes of Mutations	3
	3.3Reversion and Suppression, Ames test	3
	3.4 DNA Damage and causes	3
	3.5DNA repair mechanisms	4
	Total hours	**15hrs**

IV	4.1 Bacterial Plasmids – Structure and Properties, Replication and Amplification	3
	4.2 Transposition, Transposons, Types	2
	4.3 Organization of viral genome with its types	5
	4.4 Bacteriophage genome- T4, T7, Genome and lifecycle	2
	Total hours	**12hrs**
V	5.1 Gene transfer mechanisms - Conjugation (cell transmissible plasmids, F factor and Hfr strains)	3
	5.2 Transformation (Natural transformation, competence, DNA uptake, role of natural transformation artificially induced competence and electroporation).	4
	5.3 Transduction (Generalized and specialized transduction)	3
	5.4 Genetic Recombination -Requirements molecular basis and genetic analysis of recombination in bacteria)	4
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

MAJOR PRACTICAL-IV
LAB IN MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Course Objectives
The course aims

1. To learn the techniques of DNA, RNA Isolating the Spontaneous mutants,
2. To Practise the concept of UV mutagenesis, Chemical Mutagenesis.
3. To impart knowledge on the process of Conjugation, Transformation in E. coli
4. To study the techniques of Isolation of Plasmid DNA by Agarose gel Electrophoresis.
5. To be an expert in the quantification of DNA by Diphenyl amine method and Protein by Bradford method
6. To demonstrate the development of antibiotic resistant mutant.

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

Course Outcomes		Cognitive level
CO1	Master the techniques of Isolating DNA, RNA and Plasmids	K-3,K-4,K-5
CO2	Learn and Practise the concept of Spontaneous mutation, UV mutagenesis, Chemical Mutagenesis.	K-3,K-4,K-5
CO3	Understand the process of Conjugation, Transformation in E. coli	K-2,K-3,K-4,K-5
CO4	Master the techniques of Isolation of Plasmid DNA by Agarose gel Electrophoresis.	K-3,K-4,K-5
CO5	Learn and be an expert in the quantification of DNA by Diphenyl amine method and Protein by Bradford method and to demonstrate the development of antibiotic resistant mutants.	K-3,K-4,K-5,K-6

Experiments

1. DNA isolation – (Plant cell, Animal cell or Microbe)
2. Isolation of RNA from Yeast
3. Plasmid DNA isolation
4. Agarose gel electrophoresis
5. Digestion of plasmid DNA with restriction digestion (Demonstration)
6. Ligation of DNA fragment (Demonstration)
7. Isolation of spontaneous mutants
8. UV Mutagenesis- survival studies
9. Chemical mutagenesis- NTG
10. Demonstration of Antibiotic resistant mutant

11. Conjugation in bacteria (Interrupted & Uninterrupted) – Demonstration
12. Transformation in E. coli – Demonstration
13. Quantification of DNA by Diphenylamine method
14. Quantification of Protein by Bradford method
15. Southern blotting technique (Demonstration)

Textbooks Recommended

1. J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York
2. M. Kannan 1996, Laboratory Manual in General Microbiology
3. P. Gunasekaran - Laboratory Manual in Microbiology
4. Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental procedures in Life Sciences - Ajantha book house, chennai
5. Dr.S.M.Reddy and Dr.S.Ram Reddy - Microbiology A laboratory manual - BSC Publishers and Distributors – Hyderabad
6. Molecular Biology by D. Clark, N. Pazdernik and M. McGehee. 3rd edition. Academic Cell, USA. 2018. 2
7. Lewin's Genes XII by J. Krebs, E. Goldstein and S. Kilpatrick. 12th edition. Jones and Bartlett Learning, USA. 2017.
8. Becker's World of the Cell by J .Hardin and G.P. Bertoni. 9th edition. Pearson, USA. 2015.
9. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Cold Spring Harbour Laboratory Press, USA. 2014.
10. Cell and Molecular Biology: Concepts and Experiments by G. Karp. 7th edition.Wiley and Sons, UK. 2013

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Practical	Topics covered	Hours
1	Isolation of DNA , RNA	4
2	Plasmid DNA isolation, Agarose gel Electrophoresis,	5
3	Spontaneous mutants isolation, UV mutagenesis, Chemical mutagenesis – NTG	8
4	Conjugation in bacteria (Interrupted & Uninterrupted) – (Demonstration)	6
5	Transformation in *E.coli*(Demonstration)	6
6	Isolation of Plasmid DNA by Agarose gel electrophoresis	4
7	Digestion by Restriction Enzymes and Ligation	4
8	Quantification of DNA by Diphenylamine method	2
9	Demonstration of antibiotic resistant mutant	4
10	Quantification of Protein by Bradford method.	2
	TOTAL	**45 hrs.**

SKILL BASED COURSE II - A: NANOBIOTECHNOLOGY

Course Objectives
The course aims

1. To create interest in students, to know about the methods and application of modern Nanobiomolecules and their contribution in the various fields of biotechnology and healthcare.
2. To impart knowledge on Protein based Nanostructures and Applications in Biology.
3. To learn the basics of Nano microbiology.
4. To gain ain-depth knowledge on Extraction and applications od Nano technology.

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

Course Outcomes		Cognitive level
CO1	Understand the methods and application of modern Nanobiomolecules and their contribution in the various fields of biotechnology and healthcare.	K-2,K-3,K-4
CO2	Explain the Protein based Nano structuresand its Applications in Biology.	K-2,K-3,K-4
CO3	Elaborate the basic concepts in the field of Nano microbiology.	K-2,K-3,K-4,K-5
CO4	Expertise in the field of Extraction and applications of Nanomaterials from different sources.	K-2,K-3,K-4,K-5,K-6
CO5	Understand and update the applications of Nanotechnology.	K-2,K-3,K-4,K-5

Unit I
Introduction - Introduction on the theory and concepts of nanotechnology– Nanomaterials in nature- Nanotechnology in history, Scientific revolutions –Significance and applications, Definition of a Nanosystem, Dimensionality- Zero, one- and two-dimensional materials

Unit II
Nano materials – Types of nanomaterials. Quantum Dots, Wells and Wires- Carbon- based Nano materials (buckyballs, nanotubes, graphene)– Metal based Nano materials (nanogold, Nanosilver and metal oxides) - Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics.

Unit III
Synthesis and characterization of Nanomaterials: - Introduction, Synthesis of nanomaterials- Top down and bottom up approaches - Chemical methods, Physical methods, Biological methods. Characterization of nanomaterials- XRD, TEM, SEM, UV, FTIR, Atomic Force Microscopy- Operation advantages of AFM, Magnetic resonance force microscopy.

Unit IV

Biology Inspired concepts - Protein based nanostructures building blocks and templates, DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins, Use of DNA molecules in Nanomechanics and nanocomputing. DNA nanotubes.Applications in Biology- Quantum dots for cell labeling and study of apoptosis- Nanopore sequencing- Nanomotor from DNA.

Unit V

Nano-biotechnology -Application of Nanoparticles - Introduction to Nano-bio sensors and tissue engineering, Targeted nanoparticles for drug delivery, Nanotechnology in agriculture – Fertilizer and pesticides, food, electronics, fabric, solar cells. Future of Bio-nanotechnology.Medical diagnostics and therapeutics.

Textbooks recommended

1. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005.
2. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007.
3. Rolf E. Hummel, "Electronic Properties of Materials", 4th Ed., Springer, New York, 2011.
4. Silver F. and Dillion C., "Biocompatibility: Interactions of Biological and Implantable Materials", VCH Publishers, New York, 1989.

Web Resources

1. https://youtu.be/ebO38bbq0_4
2. http://home.iitk.ac.in/~anandh/MSE694/Introduction_to_Nanomaterials-3.pdf
3. https://maken.wikiwijs.nl/bestanden/427519/Lesson_7_APPENDIX-2_Article2.pdf

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1Introduction to Theory and concepts of Nanotechnology,	2
	1.2 Introduction – Scientific revolutions in Nanotechnology, Significance and applications.	2
	1.3 Definition of a Nano system. Dimensionality	2
	1.4 Zero, one- and two-dimensional materials	3
	Total Hours	**9 hrs**
II	2.1 Types of Nanomaterials.	3
	2.2 Quantum Dots, Wells and Wires- Carbon- based Nano materials (Bucky balls, nanotubes, graphene)	4
	2.3 Metal based Nano materials (nanogold, Nano silver and metal oxides)	4
	2.4 Nanocomposites- Nano polymers – Nano glasses –Nano ceramics.	2
	Total hours	**13hrs**
III	3.1 . Introduction, Synthesis of Nanomaterials- Top down and bottom up approaches.	2
	3.2 Chemical methods, Physical methods, biological methods	2
	3.3 Characterization of nanomaterials, XRD, TEM, SEM,	4
	3.4 UV, FTIR,	3
	3.5 AFM, Operation Advantages of ATM	2
	3.6 Magnetic Resonance Force Microscopy.	2
	Total hours	**15hrs**
IV	4.1 Protein based nanostructures, Building blocks and templates	1
	4.2 DNA based nanostructures, Topographic and Electrostatic properties of DNA and Proteins.	2
	4.3 Uses of DNA molecules in Nano mechanics and Nanocomputing, DNA Nanotubes	3
	4.4 Applications in Biology, Quantum dots for cell labeling and study of Apoptosis,	4
	4.5 Nanopore sequencing, Nano motors from DNA	2
	Total hours	**12hrs**
	5.1 Nano biotechnology -Application of Nanoparticles - Introduction to bio sensors and tissue engineering	3

V	5.2 - Targeted nanoparticles for drug delivery, Nanotechnology in agriculture – Fertilizer and pesticides, food	3
	5.3 Nanotechnology in electronics, fabric, solar cells.	1
	5.4 Future of Bio nanotechnology.	2
	1.5 Bio nanotechnology in medical diagnostics and Therapeutics.	2
	Total hours	**11hrs**
	Total hours for Units I to V	**60hrs**

SKILL BASED COURSEII

B - ENTREPRENEURIAL MICROBIOLOGY

Course Objectives:
The course aims

1. To motivate the students to exploit the microbial techniques and resources to emerge out as an entrepreneur to support the growth of economy of our nation.

2. To make the students know the basic concepts of Entrepreneur development
3. To give an outlineon the contributions of Government and financial institutions in entrepreneurial development.
4. To give an overview on production of fermented food and beverages.
5. To introduce mushroom cultivation as a start-up option.
6. To expose the students on the aspects of IPR and Patent process

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

Course Outcomes		Cognitive level
CO1	Expertise in the basic concepts of Entrepreneur development	K-2,K-3,K-4,K-5,K-6
CO2	Understand the contributions of Government and financial institutions in entrepreneurial development.	K-2,K-3,K-4
CO3	Create interest in the production of fermented food and beverages.	K-4,K-5,K-6
CO4	Undertake mushroom cultivation as a start-up option.	K-4,K-5,K-6
CO5	Understand the concepts of IPR and Patent process	K-2,K-3,K-4,K-5,

Unit – I:
Entrepreneurial society- Entrepreneur development – activity – Institutions involved – Government contributions to entrepreneurs – risk assessment.

Unit – II:
Bread baking - Bread – leavening – Baking process – Rye bread, San Francisco dough Bread – idli – Dosa, Fermented fish products – Ngari,Hentak, Tungtap, Gnuchi .

Unit – III :
Mushroom cultivation - Mushroom cultivation – edible and poisonous mushroom – cultivation of *Agaricuscampestris*, *Agaricusbisporus*, and *Volvariellavolvaciae*, Preparation of compost, filling tray beds, spawning, maintain optimal temperature, casing, watering, harvesting, storage.

Unit – IV:

History of Patenting - Patent and secret process, History of patening, composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent. Patent in india and other countries – Fermentation economics.

Unit – V :

Alcoholic products- Indian alcoholic beverages – Ennog/sai mod- Apong – Kodokojaanr – Xajpani– Zutho – judima – Antingba – Kiad – sujan, Brewing of beer: Grape wine – wine from other fruits.

Textbooks recommended

1. Industrial Microbiology – L.E Caseda New age publication
2. Entrepreneurial development in India – By Arora
3. Experiments in Microbiology, plant pathology Tissue culture and mushroom production technology – K.RAneja, New age international Publication S.Chand publication 6th Edition
4. Food microbiology – William C Frazler, Dennis C Weshoff (2013) – 5th edition (Food of Indian origin)

Web resources

1. https://microbiologysociety.org/uploads/assets/uploaded/37a6e73d-63e4-4411-88524eba20d849fe.pdf
2. https://www.nature.com/bioent/2004/041001/full/bioent831.html?referral=true
3. https://www.genengnews.com/a-lists/top-17-serial-bio-entrepreneurs/

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Entrepreneur development – activity - Institutions involved	3
	1.2 Government contributions to entrepreneurs – risk assessment	3
	1.3 Risk assessment in Entrepreneurship	4
	Total Hours	**10 hrs**
II	2.1 Bread baking - Bread – leavening – Baking process	2
	2.2 Types of Bread - Rye bread, San Francisco dough	3
	2.3 Other Fermented food - Idli – Dosa	3
	2.4 Fermented fish products – Ngari, Hentak, Tungtap, Gnuchi	3
	Total hours	**11hrs**
III	3.1 Mushroom cultivation – edible and poisonous mushroom	4
	3.2 Cultivation of *Agaricuscampestris*, *Agaricusbisporus*, and *Volvariellavolvaciae*,	4
	3.3 Steps Involved - Preparation of compost, filling tray beds, spawning, maintain optimal temperature, casing, watering, harvesting, storage	4
	Total hours	**12hrs**
IV	4.1 History of patening - Patent and secret process	3
	4.2 Composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent.	3
	4.3 Patent in India and other countries	4
	4.4 Fermentation economics	3
	Total hours	**13hrs**
V	5.1 Alcoholic products - Indian alcoholic beverages	3
	5.2 Alcoholic Beverages - Ennog/sai mod- Apong – Kodokojaanr – Xajpani– Zutho – judima – Antingba – Kiad – sujan,	4
	5.3 Brewing of beer:	4
	5.4 Grape wine – wine from other fruits	3
	Total hours	**14hrs**
	Total hours for Units I to V	**60 hrs**

NON-MAJOR ELECTIVE II

A - MICROBES AND INFECTIONS

Course Objectives:

The course aims:

1.To highlight the students about diverse microbial pathogens and its effect and managerial strategies.

2. To study the common bacterial pathogens and their pathogenicity.

3. To know about the fungal, viral and protozoan pathogens

Unit –I

Route of transmission- Sources of infection - Routes of transmission - control measures Testing by Koch's postulates -Antibiotic sensitivity testing.

Unit –II

Bacterial pathogens - *Streptococcal, Staphylococci, E. coli, Vibrio, Salmonella, Shigella and Mycobacterium.*

Unit –III

Fungal pathogens - *Candida, Aspergillus* – Dermatophytes.

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Unit – IV

Viral pathogens - Pox virus, Mumps virus, Rabies virus and HIV.

Unit - V

Protozoan pathogens - Malarial, Amoebic Giardiasis and Yellow fever.

Textbooks recommended

1. Ananthanaryanan R and Panikar J (2000) Text book of Microbiology, Orient Longmans
2. Rajan (2007) Medical Microbiology MJP Publisher, Chennai
3. Kani L Mukherjee, Medical Lab technology Hill Publishing Co., Ltd., New Delhi Vol I-III.

Web Resources

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

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Sources of infection	1
	1.2 Routes of transmission	1
	1.3 Prevention and control measures - Testing by Koch's postulates - Antibiotic sensitivity testing	1
	1.4 Testing by Koch's postulates	1
	1.5 Antibiotic sensitivity testing	2
	Total Hours	**6hrs**
II	2.1 Bacterial pathogens - *Streptococcus, Staphylococci,*	2
	2.2 *E. coli, Vibrio,*	1
	2.3 *Salmonella, Shigella*	2
	2.4 *Mycobacterium*	1
	Total hours	**6 hrs**
III	3.1 Fungal pathogens - *Candida, Aspergillus* – Dermatophytes	3
	3.2 *Aspergillus*	3
	3.3 Dermatophytes	3
	Total hours	**6hrs**
	4.1 Viral pathogen - Pox virus	1

IV	4.2 Viral pathogen Mumps virus	1
	4.3 Viral pathogen Rabies	2
	4.4 Viral pathogen HIV	2
	Total hours	**6hrs**
V	5.1 Protozoan pathogens – Malarial parasite	2
	5.2 Protozoan pathogens –Entamoeba	1
	5.3 Protozoan pathogens – Giardia	1
	5.4 Protozoan disease - Yellow fever	2
	Total hours	**6hrs**
	Total hours for Units I to V	**30hrs**

NON - MAJOR ELECTIVE- II

B- BASICS OF BIOTECHNOLOGY

Course Objectives:
The course aims

1. To inculcate the history, components, techniques and applications of biotechnology for effective usage of natural resources to produce valuable products friendly for mankind.
2. To gain an in-depth knowledge in microbial Fermentation Process
3. To impart an interest to produce various fermented products and Vaccines.

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

Course Outcomes		Cognitive level
CO 1	Understand diverse microbial pathogens and its effect and managerial strategies.	K-2,K-3,K-4,K-5
CO 2	Be an expert in understanding thecommon bacterial pathogens and their pathogenicity.	K-1,K-2,K-3,K-4
CO 3	Be an expert in knowing the fungal, viral and protozoan pathogens	K-1,K-2,K-3,K-4

Unit - I:
History of biotechnology
History of biotechnology - selection of Industrial microorganisms - Media and strain improvement.

Unit –II: Fermentation process
Fermentation process - standard fermented - Types of fermentation (Batch, Continuous and fed batch) - media used.

Unit - III:
Industrial Production
Industrial production of enzymes (Amylase) Beverages - wine, beer, Antibiotics (Penicillin)

Unit – IV:
Vaccination
Vaccine production and Therapeutic agents - Attenuated and live - Engineered organisms.

Unit –V:

Agriculture and Environmental microbes
Role of microbes in agriculture and environment - GMO's.

TextbooksRecommended

1. Gupta P.K. (1996). Elements of Biotechnology. Rastogi and Co., Meerut. India
2. MukheshPasupuleti (2006). Molecular Biotechnology. MJP Publishers. Chennai.
3. Dubey. R-C (1996). A Textbook of Biotechnology. S.Chand and Co. Ltd., New Delhi

Web resources:

1. https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/
2. http://www.whatisbiotechnology.org/index.php/science/summary/rdna

Course Outcomes
By the completion of the course the students will be able to..

Course Outcomes		Cognitive level
CO1	Understand the history, components, techniques and applications of biotechnology in microbial Fermentation Process.	K-2,K-3,K-4
CO2	Produce various fermented products and Vaccines.	K-2,K-3,K-4,K-6
CO3	Understand the role of microbes in Agriculture and Environment.	K-2,K-3,K-5,K-6

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule.

Unit	Topics covered	Hours
I	1.1 History of biotechnology	2
	1.2 Selection of Industrial microorganisms	2
	1.3 Media and strain improvement	2
	Total Hours	**6 hrs**
II	2.1 Fermentation process	2
	2.2 Types of fermentation (Batch, Continuous and fed batch)	2
	2.3 Media used in Fermentation process	2
	Total hours	**6hrs**
III	3.1 Industrial production of enzymes (Amylase)	2
	3.2 Beverages - wine, beer	2
	3.3 Antibiotics (Penicillin)	2
	Total hours	**6hrs**
IV	4.1 Vaccination - Vaccine production	2
	4.2 Production of Therapeutic agents Attenuated and live	2
	4.3 Engineered organisms in Vaccine production	2
	Total hours	**7 hrs**
V	5.1 Role of microbes in agriculture	2
	5.2 Role of microbes in Environment	2
	5.3 Genetically Modified Organisms (GMO)	2
	Total hours	**6hrs**
	Total hours for Units I to V	**30hrs**

SEMESTER V

CORE MAJOR V-ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY

Course Objectives
The course aims

1. To impart in-depth information on methods of ecology, Aero microbiology and Aquatic microbiology
2. To make the students understand the Waste management methods
3. To give an overview on Xenobiotic biodegradation, Bioleaching
4. To make the students to know about Biological Nitrogen Fixation and various techniques involved in biofertilizers andBiopesticideproduction
5. To introduce the cause of plant pathogenic diseases.

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

Course Outcomes		Cognitive level
CO1	Discuss on the microbes in different natural environments and Aero microbiology.	K-1,K-2,K-3
CO2	Analyse the importance of Waste management	K-3,K-4,K-5
CO3	Explain the different aspects of Xenobiotics and Biodegradation	K-1,K-2,K-3
CO4	Elaborate on Soil Microbiology and Microbial Interactions	K-1,K-2,K-3
CO5	Evaluate the production of biofertilizers and Biopesticides	K-3,K-4,K-5

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Unit –I : Aero and Aquatic Microbiology

Methods in Ecology, Aero Microbiology - Aerosol - droplet nuclei - air pollution - sources (Microbiological) - Air quality analysis, air sampling devices - air borne pathogens.Aquatic Microbiology: Fresh water – Ponds, Lakes, Streams. Marine habitats – Estuaries, Mangroves, Deepsea.Zonation – Upwelling – Eutrophication – Food chain. Potability of water – Microbial assessment of water quality, BiologicalIndicators- Brief account of water – borne diseases. Water Purification –Steps involved.

Unit –II, Waste Management

Types of Wastes – Characterization of solid and liquid wastes. Solid waste treatment– Saccharification – Gasification –Composting, Utilization of solid wastes – Food (SCP,

mushroom, yeast); Fuel (Ethanol, Methane, Hydrogen); Fertilizers (composting).Liquid waste treatment. BOD and COD, Treatment methods– Primary –Secondary (Anaerobic – Methanogenesis; Aerobic- Trickling filters, Activated sludge – Oxidation pond –Tertiary treatment. Utilization of liquid wastes – Food (SCP, Yeast) – Fuel (methane), Fertilizers (Cyanobacteria).

Unit –III:Xenobiotics and Environment

Xenobiotics degradation (Haloalkyl Propellants, Alkyl Benzyl Solfonates).Degradation of pesticides (DDT and Propanil).Bioremediation of contaminated soils and marine oil pollutants.types of bio- transformations. Influence ofecological factors on the effects of toxicity, Global Toxicity testing, Bioassay – Definition, purpose and Importance of Bioassay estimation of LC50.Biosensor, Definition- Components, Advantages and limitations, biocatalyst based, ion-affinity based and microorganism-based biosensors; Applications of biosensors in environmental monitoring.Bioleaching and Biomagnification.

Unit –IV: Soil and Plant Microbiology

Historical development of soil microbiology, Physical, Chemical and Biological Properties of Soil, Soil Horizon- various types of soil microbes and their importance.Factors influencing the soil microbial population.Biogeochemical cycle - Carbon, Nitrogen, Phosphorous and Sulphur.
Microbial interactions –Positive and Negative Interactions, Interaction of microbes with plants: Rhizosphere, Phyllosphere, Mycorrhizae.Concept of plant diseases - Definition of disease cycle and pathogenicity, Symptoms associated with microbial plant diseases. Stages in development of a disease - infection - invasion, colonization- White rust of crucifers *(Albugo)* - Late blight of potato *(Phytophthorainfestans)* Ergot of rye *(Clavicepspurpurea)* Black stem rust of wheat – *Pucciniagraministritici,* Citrus Canker (*Xanthomonascitri).*

Unit- V

Agriculture Microbiology-Biological nitrogen fixation - Nitrogen fixers - types - Rhizobium, Symbiotic and non-symbiotic nitrogen fixation. Root nodule formation. Structure of nodule& biochemistry of Nitrogen fixation, Nitrogenase, Nitrogen fixation inCyanobacteria,Biofertilizers and Biopesticides - Classification, Mass cultivation, Preparation and field application - Rhizobium, Azotobacter, Azospirillum, Phosphate solubilizers, VAM, Azolla. Biopesticides: classification, mode of action - Bacterial insecticides (Bacillus thuringiensis) and Viral insecticides (NPV) and Trichodermaviride.PGPR.

Textbook Recommended

1. SubbaRao NS (2004). Soil Microbiology. Fourth edition, Oxford and BH Publishing Co., New Delhi.
2. Mishra RR (2004). Soil Microbiology. First edition, CBS Publishers and distributors, New Delhi.

3. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India. Fourth edition, PHI Learning (P) Ltd., New Delhi.
4. Prescott LM Harley JP and klein DA (2013) Microbiology Mccrawttill, New York
5. Salle A.J (1996) Fundamental Principles of Bacteriology
6. R.C Dubey and Mahewari – 2014 A Text Book of Microbiology – Chand and Co New Delhi
7. Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning (P) Ltd., New Delhi.
8. Robert, L Tate (1995). Soil Microbiology. First edition, John Wiley and Sons, Inc. New York.
9. Sharma, P.D. (2001), Plant Pathology. First Edition. Rastogi Publications.
10. Atlas, R.M. and Bartha, R (1992). Microbial Ecology, Fundamental and Application, 3'd Edition, Bengamin and Cummings.
11. Hans G. Schlegel.(l993).General Microbiology. 7th edition. Cambridge University press.
12. Alexander, A.M. (1987). Introduction to Soil Microbiology. S'h Edition, John Wiley and Sons
13. Environmental Toxicology set of 3 volumes- Peter Gomes
14. Aquatic Environment and Toxicology-Pawan Kumar Bhart
15. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian
16. Atlas R.M and Bartha M (2003) Microbial ecology - Fundamentals and applications
17. Waste Water Microbiology by D.H. Bergey. 2nd Edition.Medtech, India. 2019.
18. Prescott's Microbiology by J. M. Willey, L. Sherwood, and C. Woolverton. 10th edition. McGraw Hill Higher Education, USA. 2017.
19. Brock Biology of Microorganisms by M.T. Madigan and J.M. Martinko. 15th edition. Prentice Hall International Inc., USA. 2017.
20. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA. 2011.
21. Advances in Applied Bioremediation edited by A. Singh, R.C. Kuhad and O. P. Ward. Springer-Verlag, Germany. 2009

Web Resources

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

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Concepts of Microbial ecology: Relationship between microorganism and different environments land, water and air.	2
	1.2 Microorganisms in Aquatic habitats	2
	1.3 Microbiology of water	2
	1.4 Water borne diseases	2
	1.5 Water purification methods	2
	Total Hours	**10 hrs**
II	2.1 Types of wastes- characterization of solid and liquid wastes	2
	2.2 Solid waste treatment methods	2
	2.3 Utilization of solid wastes	2
	2.4 Liquid waste treatment methods- Primary	1
	2.5Secondary (anaerobic – methanogenesis; aerobic- tricking activated sludge – oxidation pond – tertiary treatment.	1
	2.6 Utilisation of liquid wastes	2
	2.7 Ferlizers and Fuels from liquid wastes	2
	Total hours	**12hrs**
III	3.1 Xenobiotics degradation (Haloalkyl Propellants, Alkyl Benzyl Solfonates).. .	1
	3.2 Degradation of pesticides (DDT and Propanil). Bioremediation of contaminated soils and marine oil pollutants.	2
	3.3 Influence ofecological factors on the effects of toxicity, Global Toxicity testing, Bioassay – Definition, purpose and Importance of Bioassay estimation of LC50. Biosensor,	3

	3.4. Applications of biosensors in environmental monitoring.	4
	3.5 Bioleaching and biomagnifications	3
	Total hours	**13hrs**
IV	4.1 Soil microbiology- Microbes insoil	4
	4.2. Microbial Interactions	4
	Microbial diseases in plants	3
	Total hours	**11hrs**
V	5.1 Biological nitrogen fixation - Nitrogen fixers - types - Rhizobium,	2
	5.2 Symbiotic and non-symbiotic nitrogen fixation. Root nodule formation. Structure of nodule& biochemistry of Nitrogen fixation,	2
	5.3 Nitrogenase, Nitrogen fixation inCyanobacteria,Biofertilizers and Biopesticides - Classification, Mass cultivation, Preparation and field application - Rhizobium, Azotobacter, Azospirillum, Phosphate solubilizers, VAM, Azolla. Biopesticides:	3
	5.4. Classification, Mass cultivation, Preparation and field application - Rhizobium, Azotobacter, Azospirillum, Phosphate solubilizers,	3
	5.5 Phosphatesolubilizers, VAM, Azolla	2
	5.6 Bacterial insecticides (Bacillus thuringiensis) and Viral insecticides (NPV) and Trichodermaviride.PGPR.	2
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

Web Resources

1.https://microbewiki.kenyon.edu/index.php
2.https://www.elsevier.com/books/advances-in-agricultural-microbiology/subba-rao/
3.https://en.wikipedia.org/wiki/Agricultural_microbiology
4.https://www.microbe.net/resources/microbiology-web-resources

Course Outcomes

By the completion of the course the students will be able to

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

Course Outcomes		Cognitive level
CO1	Understand the microbes in air and water and their role.	K-2,K-3,K-4
CO2	Study the different types of waste management strategies.	K-1,K-2,K-3,
CO3	Learn Various types of xenobiotics and biodegradation.	K-3,K-4,K-5
CO4	Discuss the mechanism of Microbial interactions, Biological Nitrogen Fixation and production of Biofertilizers and Biopesticides	K-2,K-3,K-4
CO5	Understand the Plant diseases and the causative agents.	K-2,K-3,K-4

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

SEMESTER V

CORE- MAJOR VI – VIROLOGY
Course Objectives:

The course aim:

1. To acquaint students with the structure of viruses of plants, animals, and bacteria, their genome organization, and replication strategies within the host cell.
2. To learn how virus, evolve, spread and cause disease, and prevention and control methods for the same.
3. To describe themethods of diagnosing and detecting viruses

Course Outcomes:
By the completion of the course the student will be able to

Course Outcomes		Cognitive level
CO1	Describe the nature, properties and structure of viruses and will also gain knowledge of taxonomy of different groups of viruses.	K-2,K-3,K-4
CO2	Familiarise with diversity and multiplication of lytic and lysogenic bacteriophages.	K-1,K-3,K-4
CO3	Describe different ways of viral transmission, and prominent and unusual genomic features of different viruses with their significance.	K-1,K-2,K-3
CO4	Understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses.	K-2,K-3,K-4
CO5	Acquire knowledge about strategies to prevent viral infections: interferons, vaccines and antiviral compounds	K-2,K-3,K-4,K-5

Unit- I
General properties – Structural Characteristics of viruses- Cultivation Methods - Isolation and identification of viruses - Electron Microscopic Techniques for the detection of Viruses.Viral diagnosis techniques –Immunological, Cytopathic effect, Molecular diagnostic methods.

Unit-II
Classification - Classification of Animal viruses. Classification of plant viruses.Classification of bacteriophages.

Unit – III
Plant Viruses, common Plant viral diseases: TMV, Bunchy top of banana, satellite virus, Viroid – Double standed DNA virus – Assay methods. Bacterial Viruses – structure of bacteriophage, The Lytic life cycle (T-Even coliphages) – Lysogenic life cycle (T4, Phage Lambda).Isolation of coliphages.

Unit – IV

Animal viruses: Morphology, Pathogenesis and Laboratory diagnosis of Prions, Rhabdo virus, Foot and Mouth Disease. Human Viruses – Influenza, HIV, Hepatitis Viruses, Corona virus.

Unit – V

Virus: Assay - Purification and characterization of viruses, separation and characterization of viral components and quantification of viruses. Viral Vaccines.Prevention and treatment of viral diseases.Antiviral agents.

TextbooksRecommended

1. Alan J.Cann. (1997). Principels of Molecular virology.(2nd edition).Academic press, California.
2. Ann GiudiciFettner.(1990).The Science of Viruses.Quill, William Marrow, New York.
3. DimmockN.J.Primrose S.B.(1994). Introduction to Modern Virology. IV edition. Blackwell scientific Publications, Oxford.
4. James, C. Cappuccino. (1996). Microbiology. The Benjamin/Cummings Pub. Co. California. 5. Morag, C. Timbury (1994). Medical Virology. X edition. Churchill Livingston.
5. Nicklin, J. Greame-Cook and Killington, R. (2003). Instant Notes in Microbiology.(2nd edition).Viva Books private limited, New Delhi.
6. Robert I. Krasner. (2002). The Microbial challenge: Human Microbe Interactions, American society for Microbiology, Washington.
7. Roger Hull.2002.Mathews' Plant Virology.(4thEdition).Academic press-A Harcourt Science and technology company, New York.
8. Topley&Wilson's(1990). Principles of Bacteriology, Virology and Immunity. VIII editionVol.IV Virology, Edward Arnold, London.

Web Resources

1.https://open.oregonstate.education/generalmicrobiology/chapter/introduction-to-viruses/

2.https://www.biologydiscussion.com/viruses/animal-viruses/classification-of-animal-viruses-microbiology/65830

3 https://www.apsnet.org/edcenter/disandpath/viral/introduction/Pages/PlantViruses.aspx

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 General properties – Structural Characteristics	2
	1.2 Cultivation Methods - Isolation and identification of viruses	2
	1.3 Electron Microscopic Techniques for the detection of Viruses	2
	1.4 Viral diagnosis techniques –Immunological, cytopathic effect,molecular diagnostic methods	2
	Total Hours	**10 hrs**
II	2.1 Classification of Animal viruses.	4
	2.2 Classification of plant viruses.	3
	2.3 Classificaion of bacteriophages.	3
	Total hours	**10 hrs**
III	3.1 Plant Viruses, common plant viral diseases: TMV, Bunchy top of banana, satellite virus,	3
	3.2 Viroid – Double standed DNA virus – Assay methods.	3
	3.3 Bacterial Viruses – structure of bacteriophage, The Lytic life cycle (T-Even coliphages) – Lysogenic life cycle (T4, Phage Lambda).	3
	3.4 Isolation of coliphages.	2
	Total hours	**11hrs**
	4.1 Animal viruses: morphology, pathogenesis and laboratory diagnosis of prions,	2
	4.2 Morphology, pathogenesis and laboratory diagnosis of Rhabdo virus, Foot and Mouth Disease.	5
	4.3 Morphology, pathogenesis and laboratory diagnosis of Human Viruses – Influenza, HIV, Hepatitis Viruses, Corona virus.	6

IV	**Total hours**	**13hrs**
V	5.1 Virus: Assay, purification and characterization	5
	5.2 Separation and characterization of viral components	4
	5.3 Quantification of viruses. Viral Vaccines. Prevention and treatment of viral diseases. Antiviral agents	6
	Total hours	**15hrs**
	Total hours for Units I to V	**60hrs**

CORE –MAJORVII- MEDICAL AND DIAGNOSTIC MICROBIOLOGY

Course Objectives
The course aims

1. To introduce the basic concepts of Normal Flora of Human body and sources of infections
2. To provide basic knowledge on clinical pathogenicity of bacterial infections and their lab diagnosis and treatment
3. To impart basic knowledge on viral diseases, epidemiology and virulence factors associated with the pathogen.
4. To give an insight on different fungal and Protozoan diseases
5 To provide outline on diagnostic procedures in Microbiology laboratory

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

Course Outcomes		Cognitive level
CO1	Demonstrate the basic concepts of Normal Flora of Human body and sources of infections	K-2,K-3,K-4
CO2	Elaborate the clinical pathogenicity of bacterial infections and their lab diagnosis and treatment	K-3,K-4,K-5
CO3	Demonstrate the pathogenicity of viral pathogens, epidemiology and virulence factors associated with the pathogen.	K-2,K-3,K-4
CO4	Familiarise with the different fungal and Protozoan diseases	K-1,K-2,K-3
CO5	Expertise on diagnostic procedures in Microbiology laboratory	K-2,K-3,K-4

Unit - I
Sources of infection - Normal microbial flora of the human body - Sources of infection Mode of transmission: Direct - person to person and animal to person - In direct: Air and other modes (Food, water and insects) - Koch's postulates - control measures - Virulence factors of microbes - invasiveness and pathogenicity - Nonspecific resistant factors.

Unit - II
Clinical Symptoms Bacterial infections- Clinical Symptoms - Epidemiology, Pathogenesis, Laboratory diagnosis, Prevention and treatment of the following bacterial infections - Streptococcal infections - Meningitis - Tuberculosis - Leprosy: Gastrointestinal disorders - Typhoid, Cholera, Bacillary dysentery: Sexually transmitted disease - Syphilis and Gonorrhea: Anaerobic wound infection (Tetanus and gas gangrene)

Unit - III

Clinical Symptoms of Viral infections - Clinical Symptoms - Epidemiology, Pathogenesis, laboratory diagnosis, Prevention and treatment of the following viral infections - Respiratory infections (Common cold, influenzas, Measles, Mumps and Rubella) - Immunodeficiency disease (AIDS, Cytomegalovirus) and Herpes simplex virus.

Unit - IV

Clinical Symptoms of Fungal and Protozoan infections -Clinical Symptoms - Epidemiology, pathogenesis, laboratory, prevention and treatment of the following fungal and protozoan infections - systemic mycoses – subcutaneous mycoses, protozoan: Amoebiasis, Malaria, Leishmaniasis - Nosocomial infections.

Unit - V

Diagnostic Microbiology - General safety measures used in Microbiology laboratory, Sterilization and disinfection, Biomedical waste management in a Medical Microbiology laboratory: Types of the waste generated, Segregation, Treatment, Disposal,Antimicrobial Chemotherapies and their targets, Drug resistance, drug-bacteria relationship, clinical implications, and prevention. Collection of samples, culture, identification, rapid diagnosis of bacteria, immunologic or molecular diagnostic tests.Vaccination.VaccineTypes, Preparation-Immunization schedule.

Textbooks Recommended

1. Ananthanaryanan R and Panikar J (200) Textbook of Microbiology, Orient Longmans
2. Rajan (2007) Medical Microbiology MJP Publisher, Chennai
3. Kani L Mukherjee, Medical Lab technology Hill Publishing Co., Ltd., New Delhi Vol I-III

Web Resources

1. https://clinlab.ucsf.edu/
2. https://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html
3. http://www.hematologyatlas.com/principalpage.htm
4. https://www.bloodline.net/
5. http://www.protocol-online.org/prot/Histology/index.html
6. https://www.microbe.net/resources/microbiology/web-resources
   https://www.omicsonline.org/medicalmicrobiology-diagnosis.php

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Normal microbial flora of the human body	2
	1.2 Sources of infection	2
	1.3 Mode of transmission: Direct - person to person and animal to person - In direct: Air and other modes (Food, water and insects)	3
	1.4 Koch's postulates - control measures	1
	1.5Virulence factors of microbes - invasiveness and pathogenicity - Nonspecific resistant factors	2
	Total Hours	**10 hrs**
II	2.1 Clinical Symptoms - Epidemiology, Pathogenesis, Laboratory diagnosis, Prevention and treatment of the following bacterial infections - Streptococcal infections	2
	2.2 Meningitis - Tuberculosis - Leprosy	3
	2.3 Gastrointestinal disorders - Typhoid, Cholera, Bacillary dysentery	3
	2.4 Sexually transmitted disease - Syphilis and Gonorrhea	2
	2.5 Anaerobic wound infection (Tetanus and gas gangrene)	3
	Total hours	**13hrs**
III	3.1 Clinical Symptoms - Epidemiology, Pathogenesis, laboratory diagnosis, Prevention and treatment of the following viral infections - Respiratory infections (Common cold, influenzas, Measles, Mumps and Rubella)	6
	3.2 Immunodeficiency disease (AIDS, Cytomegalovirus) and Herpes simplex virus	6
	Total hours	**12hrs**

IV	4.1 Clinical Symptoms - Epidemiology, pathogenesis, laboratory, prevention and treatment of the following fungal - Systemic mycoses – subcutaneous mycoses	3
	4.2 Protozoan infections - Amoebiasis, Malaria, Leishmaniasis	4
	4.3 Nosocomial infections.	2
	Total hours	**9hrs**
V	5.1 Diagnostic Microbiology - General safety measures used in Microbiology laboratory	1
	5.2Sterilization and disinfection, Biomedical waste management in a Medical Microbiology laboratory	3
	5.3 Types of the waste generated, Segregation, Treatment, Disposal,	2
	5.4 Antimicrobial Chemotherapies and their targets, Drug resistance, drug-bacteria relationship, clinical implications, and prevention.	2
	5.5 Collection of samples, culture, identification,	3
	5.6 Rapid diagnosis of bacteria, immunologic or molecular diagnostic tests.	3
	5.7 Vaccination - Vaccine Types, Preparation-Immunization schedule.	2
	Total hours	**16hrs**
	Total hours for Units I to V	**60hrs**

MAJOR ELECTIVE I - A1: BIOINFORMATICS

Course Objectives
The course aims

1. To study on basics of Relational data base and modes of data transfer.
2. To gain knowledge on Biological Data bases.
3. To impart information on Sequence Alignment technique
4. To know the Diversity of Genomes.
5. To learn the application of Protein structure modelling.

CourseOutcomes
By the completion of the course, students should be able to:

Course Outcomes		Cognitive level
CO1	Evaluate Relational Data Bases	K-4,K-5,K-6
CO2	Apply the tools used in Biological databases	K-3,K-4,K-5
CO3	Demonstrate the use of Sequence Alignment Techniques	K-3,K-4,K-5
CO4	Acquire knowledge on Diversity of Genomes.	K-1,K-2,K-3
CO5	Familiarize with the different methods of Protein Structure Modelling	K-2,K-3,K-4,

Unit –I
Data Analysis - RDBMS - Definition of relational database - Mode of data transfer (FTP, TCP), advantage of encrypted data transfer.

Unit –II
Biological databases - Biological database - nucleic acid, genome, protein sequence and structure, gene expression databases, database of metabolic pathway, Mode of data storage - File - formats - FASTA, Gene bank and Uniprot, Data submission and retrieval form NCBI, DDBJ, Uniprot, PDB.

Unit –III
Sequence alignment -Local and Global sequence alignment, pairwise and multiple sequence alignment, scoring an alignment, scoring matrices, PAM and BLOSUM Series of matrices - Types of Phylogenic trees - Different approaches of phylogenetic tree construction – UPGMA.

Unit –IV
Diversity of Genomes - Diversity of Genomes: Viral, prokaryotic and eukaryotic genomes - transcriptome - proteome, 2-D gel electrophoresis, MALDI - TOF Spectrometry, Major features of completed genomes:*E. coli, S. cerevisiae***,** Arabidopsis, Human.

Unit –V

Protein Structure- Hierarchy of protein structure - primary, secondary and tertiary structures, modeling, structural classes, Motifs, Folds and Domains, Protein structure prediction -Research in bioinformatics: - Comparative analysis, Homology Modeling and Drug discovery and design Insilcomethod.

TextbooksRecommended

1. Saxena Sanjay (2003) A first course in computers, Vikas Publishing house
2. Pradeep and SinhaPreeti (2007) Foundations of computing 4th edition BPB Publication
3. LeskM.A(2008) Introduction to Bioinformatics, Oxford Publication, 3rd International student edition.
4. Vittal R. Srinivas, " Bioinformatics : A Modern Approach" , 2005, ISBN : 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
5. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC., U.K.

Web resources:

1. https://www.bioinformatics.org
2. bioinformaticsonline.com
3 https://www.ncbi.nlm.nih.gov/

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Data Analysis - RDBMS - Definition of relational database	3
	1.2 Mode of data transfer (FTP, TCP)	3
	1.3 Advantage of encrypted data transfer	3
	Total Hours	**9hrs**
II	2.1 Biological database - Nucleic acid, Genome, Protein sequence and structure, Gene expression databases, database of metabolic pathway	4
	2.2 Mode of data storage - File - formats - FASTA, Gene bank and Uniprot,	4
	2.3 Data submission and retrieval form NCBI, DDBJ, Uniprot, PDB	4
	Total hours	**12hrs**
III	3.1 Local and Global sequence alignment	4
	3.2 Pairwise and multiple sequence alignment,	4
	3.3 Scoring an alignment, scoring matrices, PAM and BLOSUM Series of matrices	3
	3.4 Types of Phylogenic trees - Different approaches of phylogenetic tree construction – UPGMA	3
	Total hours	**14hrs**
IV	4.1 Diversity of Genomes: Viral, prokaryotic and eukaryotic genomes	3
	4.2 Transcriptome – proteome	2
	4.3 2-D gel electrophoresis, MALDI - TOF Spectrometry	3
	4.4 Major features of completed genomes:*E.coli, S. cerevisiae*, Arabidopsis, Human	3
IV	**Total hours**	**11hrs**
V	5.1 Protein Structure - Hierarchy of protein structure - primary, secondary and tertiary structures	3
	5.2 Modeling, structural classes, Motifs, Folds and Domains,	3
	5.3 Protein structure prediction	3
	5.4 Research in bioinformatics	2
	5.5 Homology Modeling and Drug discovery and design Insilco method	3
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

MAJOR ELECTIVE I-A2 – BIOSTATISTICS

Course Objectives
The Course aim:

1. To introduce the basic concepts of Biostatistics and kinds and functions of Biological data.
2. To familiarize with methods of collecting data, sampling, Tabulating and graphical representations of data.
3. To perform statistical analysis of data by using measures of central tendency
4. To provide basic knowledge in analysing data by Standard deviation.
5. To carryout Correlation and Regression analysis on biological data.

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

Course Outcomes		Cognitive level
CO1	Demonstrate basic concepts of Biostatistics and kinds and functions of Biological data.	K-2,K-3,K-4,K-5
CO2	Carryout the methods of collecting data, sampling, Tabulating and graphical representations of data.	K-1,K-2,K-3 K-4,K-5
CO3	Evaluate statistical analysis of data by using measures of central tendency	K-2,K-3,K-4
CO4	Analyse data by Standard deviation.	K-3,K-4,K-5
CO5	Perform Correlation and Regression analysis on biological data.	K-3,K-4,K-5

Unit – I
Introduction to Biostatistics – Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics.

Unit – II
Collection of data, sampling and sampling design, classification and tabulation, types of representations, graphic – bar diagrams, pie diagrams and curves

Unit – III
Measures of central tendency, mean, median, mode, geometric mean

Unit – IV

Measures of dispersion and variability, changes. Deviations –mean deviation, standard deviation, coefficient of variation, Standard error, Skewness – Karl Pearson's and Bowley's coefficient of Skewness, Kurtosis.

Unit -V

Correlation Analysis – Scatter diagram – Karl Pearson's Correlation Coefficient, Regression analysis –Test of significance – ANOVA (one way).

TextbooksRecommended

1. Statistical Methods by S.P. Gupta – Sultan Chand & Sons
2. An introduction to Biostatistics by SundarRao and Richard J, PHI publications
3. Fundamentals of Biostatistics by Veer BalaRastogi
4. Statistics by R.S. N. Pillai and Bhagavathi, S. Chand & Sons
5. Biostatistics by P.N. Arora and P.K. Malhan, HPH Publications 6. Biostatistics by Gurumani.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Introduction to biostatistics – Definition	2
	1.2 Statistical methods, biological measurement	3
	1.3 Kinds of biological data	3
	1.4 Functions of statistics and limitation of statistics.	2
	Total Hours	**10 hrs**
II	2.1 Collection of data, sampling and sampling design	3
	2.2 Classification and tabulation	3
	2.3 Types of representations, graphic – bar diagrams, pie diagrams and curves	5
	Total hours	**11hrs**
III	3.1 Measures of central tendency –Basic Introduction	2
	3.2 Mean, Median, Mode	5
	3.3 Geometric Mean	5
	Total hours	**12hrs**
IV	4.1 Measures of dispersion and variability - Basic Concepts	2
	4.2. Deviations –mean deviation, standard deviation	3
	4.3 Coefficient of variation, Standard error	3
	4.4 Skewness – Karl Pearson's and Bowley's coefficient of Skewness,	3
	4.5 Kurtosis	2
	Total hours	**13hrs**
V	5.1 Correlation Analysis – Scatter diagram	3
	5.2 Karl Pearson's Correlation Coefficient	3
	5.3 Regression analysis	4
	5.4 Test of significance – ANOVA (one way).	4
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

MAJOR ELECTIVE I – A3 -PHARMACEUTICAL MICROBIOLOGY

Course Objectives
The Course aims to:

1. To introduce the basic concepts of Pharmaceutical product quality and its spoilage.
2. To gain an in depth knowledge on Mechanism of action of antimicrobial agents
3. To impart basic knowledge on Sterilisation process in Pharmaceutical industry.
4. To give an insight on Sterility testing of Pharmaceutical products.
5. To provide outline on the production of vaccines.

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

Course Outcomes		Cognitive level
CO1	Acquire knowledge on basic concepts of Pharmaceutical product quality and its spoilage.	K-2,K-3,K-4
CO2	Demonstrate the Mechanism of action of antimicrobial agents.	K-2,K-3,K-4
CO3	Explain the Sterilization process in Pharmaceutical industry.	K-1,K-2,K-3
CO4	Demonstrate the Sterility testing of Pharmaceutical products.	K-2,K-3,K-4
CO5	Familiarize the process of production of Vaccines.	K-1,K-2,K-3

6.

UNIT I
Introduction- Ecology of microorganisms and Pharmaceutical products – air, water, raw materials, packaging, buildings, equipment's, cleaning equipment and utensils. Microbial spoilage – factors, source and control, extent, medicament– borne infection, preservation and quality assurance.

UNIT II
Disinfectants- Factors in choice of antimicrobial agent, types of disinfectants, disinfectant policies. Mechanism of action of antimicrobial chemical disinfectants, sensitivity and resistance.

UNIT III
Sterilization Procedures- Heat, gaseous, radiation, filtration, new sterilization methods. Sterility testing methods – specific inactivation, dilution, and membrane filtration.Growth of animal cells in culture, general procedure for cell culture, Primary, established and trans-formedcellcultures. Application of cell cultures in pharmaceutical industry and research.

UNIT IV

Antimicrobial agents: Types of antibiotics, Synthetic microbial agents - mechanism of action and its clinical uses. Evaluation of liquid disinfectants- Phenol coefficient tests, capacity use dilution test. Disinfectant efficacy tests.Production of Penicillin, Streptomycin.Sterility testing of pharmaceutical products - Injectables - IV fluids - Pyrogen testing. Endotoxin test - LAL test, Microbial limit test.

UNIT V

Vaccines- Productionof vaccines, - BCG and Typhoid.Production of Toxoid - Tetanus, and Diphtheria.Pharmacopoeia and types.Preparation of Antisera and their standardization.in – vivo diagnostics, immune sera and human immunoglobulins with quality control. Production of pharmaceuticals by microbes – dextran's, Vitamins, Human Insulin.

TextbooksReccomended

1. Russell and Ayliffe, G.A.J Principles and practice of Disinfection, preservation and sterilization; Oxford Univeresity Press. 1982.
2. Gregory P.H.; Microbiology of the Atmosphere; Leonard Hill. 2 nd ed., 2000.
3. Murray. S. Cooper, Quality Control in Pharmaceutical Industry, Vol 2; Academic press, New York. 2001.
4. S.P.Vyas, V.K. Dixit, Pharmaceutical Biotechnology; CBS publishers and Distributors, New Delhi. 2004.
5. Rajesh Bhatia, RatanlalIhhpunjani, Quality assurance in Microbiology; CBS publishers and distributors, New Delhi. 2005.

Web Resources

1. https://www.pharmaresearchlibrary.com/wp-content/uploads/2013/03/Pharmaceutical-Microbiology.pdf

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Introduction- Ecology of microorganisms and pharmaceutical products	2
	1.2 Air, water, raw materials, packaging, buildings, equipment's, cleaning equipment and utensils.	3
	1.3 Microbial spoilage – factors, source and control	2
	1.4 Preservation and quality assurance	3
	Total Hours	**10 hrs**
II	2.1 Disinfectants- Factors in choice of antimicrobial agent, types of disinfectants, disinfectant policies.	5
	2.2 Mechanism of action of antimicrobial chemical disinfectants, sensitivity and resistance.	5
	Total hours	**10 hrs**
III	3.1 Sterilization procedures- Heat, gaseous, radiation, filtration, new sterilization methods.	3
	3.2 Sterility testing methods – specific inactivation, dilution, and membrane filtration.	3
	3.3 Growth of animal cells in culture, general procedure for cell culture, Primary, established and trans-formed cell cultures.	3
	3.4 Application of cell cultures in pharmaceutical industry and research.	3
	Total hours	**12hrs**
IV	4.1 Antimicrobial agents: Types of antibiotics, Synthetic microbial agents - mechanism of action and its clinical uses.	4
	4.2 Evaluation of liquid disinfectants- Phenol coefficient tests, capacity use dilution test. Disinfectant efficacy tests.	4
	4.3 Production of Penicillin, Streptomycin. Sterility testing of pharmaceutical products - Injectables - IV fluids	4
	4.4 Pyrogen testing. Endotoxin test - LAL test, Microbial limit test	2
	Total hours	**14hrs**
V	5.1 Vaccines- Production of vaccines, - BCG and Typhoid.	3
	5.2 Production of Toxoid - Tetanus, and Diphtheria.	3
	5.3 Pharmacopoeia and types.	2
	5.4Preparation of Antisera and their standardization. in – vivo diagnostics, immune sera and human immunoglobulins with quality control.	3

	5.5Production of pharmaceuticals by microbes – Dextran's, Vitamins, Human Insulin.	3
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

MAJOR PRACTICALS – V
LAB IN ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Course Objectives

The Course aims:

1. To make the students familiar with the isolation of microbes from soil
2. To Practise the isolation of nitrogen fixers from soil and other sources.
3. To understand the VAM infection in plant roots by microscopic techniques.
4. To find out the presence of different types of nutrients in soil
5. To visually study the production of biofertilizers through Industrial visit.

Course Outcomes

By the completion of the course the students will be able to

Course Outcomes		Cognitive level
CO1	Familiarise with the isolation of microbes from soil	K-2,K-3,K-4
CO2	Expertise in isolation of nitrogen fixers from soil and other sources.	K-3,K-4,K-5
CO3	Understand the VAM infection in plant roots by microscopic techniques.	K-2,K-3,K-4
CO4	Find out the presence of different types of nutrients in soil	K-2,K-3,K-4,K-5
CO5	Study the production of biofertilizers through Industrial visit.	K-1,K-2,K-3

Experiments

1. Isolation of bacteria from soil
2. Isolation of fungi from soil
3. Isolation of actinomycetes from soil
4. Testing antagonistic activity of soil microbes
5. Isolation of microbes from rhizosphere.
6. Isolation of Rhizobium from Root nodules
7. Isolation of Azotobacter
8. Microscopic examination of VAM
9. Isolation of Phosphobacteria from soil
10. Determination of BOD
11. Determination of COD
12. Microbial degradation of cellulose
13. Most probable number test (MPN)
14. Microbial examination of water quality by Standard Plate Count Method
15. Isolation of Microbes from Air.
16. Visit to a water testing or any lab with importance to Environmental microbiology and write a report or Visit to a biofertilizer Production unit and write a report based on the visit

Textbooks Recommended

1. J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York.
2. M. Kannan 1996, Laboratory Manual in General Microbiology
3. P. Gunasekaran - Laboratory Manual in Microbiology
4. Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental procedures in Life Sciences - Ajantha book house, Chennai.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Lecture Schedule

Practical	Topics covered	Hours
1	Isolation of bacteria from soil	2
2	Isolation of fungi from soil	2
3	Isolation of actinomycetes from soil	3
4	Testing antagonistic activity of soil microbes	5
5	Isolation of microbes from rhizosphere.	3
6	Isolation of Rhizobium fro Root nodules	3
7	Isolation of Azotobacter	3
8	Microscopic examination of VAM	1
9	Isolation of Phosphobacteria form soil	2

10 11	Determination of BOD Determination of COD.	2 3
12	Microbial degradation of Cellulose	3
13	Most probable number test (MPN)	3
14	Microbial examination of water quality by Standard Plate Count Method	4
15	Visit to a water testing or any lab with importance to Environmental microbiology and write a report or Visit to a biofertilizer Production unit and write a report based on the visit	6
	TOTAL- 45 hours	

MAJOR PRACTICALS VI
LAB IN VIROLOGY AND MEDICAL AND DIAGNOSTIC MICROBIOLOGY

Course Objectives
The course aim:

1. To understand the methods of isolating Bacteriophage
2. To study the cultivation of viruses
3. To test the cytopathic effects of virus
4. To study DNA and RNA viruses
5. To conduct serological test for typhoid and HIV
6. To visually understand the setup of a Clinical laboratory by visiting

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

Course Outcomes		Cognitive level
CO1	Conduct the isolation of bacteriophages	K-2,K-3,K-4,K-5
CO2	Evaluate the cultivation of viruses	K-3,K-4,K-5
CO3	Demonstrate the techniques to cultivation of viruses	K-2,K-3,K-4

Experiments

1. Isolation on Bacteriophage from Sewage
2. Demonstration of cultivation of viruses by chick embryonated egg.
3. Study of selected bacterial viruses – T4 phage, T7, M13 Phage
4. Study of selected Plant viruses-TMV, CaMV
5. Study of selected Animal Viruses- HIV, Influenza, HSV, HBV, Rabies
6. Study of cytopathic effects of viruses using photographs.
7. Performing local lesion technique for assaying plant viruses
8. Isolation of normal flora from mouth
9. Isolation of bacteria from pus
10. Isolation of bacteria from urine
11. Isolation of normal bacteria from blood
12. Antibiotic susceptibility testing by Disc diffusion method
13. Fungi - slide culture techniques
14. Parasite - Iodine wet mount
15. Giemsa staining
16. Leishman staining
17. Widal test - Slide and tube test
18. ELISA technique – Demonstration
19. Visit to a Clinical lab and write a report based on the visit conducted

TextbooksRecommended

1. James, C. Cappuccino. (1996). Microbiology. The Benjamin/Cummings Pub. Co. California.
2. Morag, C. Timbury (1994). Medical Virology. X edition. Churchill Livingston
3. Topley&Wilson's(1990). Principles of Bacteriology, Virology and Immunity. VIII edition Vol.IV Virology, Edward Arnold, London.
4. J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York
5. M. Kannan 1996, Laboratory Manual in General Microbiology
6. P. Gunasekaran - Laboratory Manual in Microbiology
7. Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental procedures in Life Sciences - Ajantha book house, Chennai
8. Dr.S.M.Reddy and Dr.S.Ram Reddy - Microbiology A laboratory manual - BSC Publishers and Distributors – Hyderabad

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Practical	Topics covered	Hours
1.	Isolation on Bacteriophage from Sewage	3
2.	Demonstration of cultivation of viruses by chick embryonated egg.	2
3.	Study of selected bacterial viruses – T4 phage, T7, M13 Phage	3
4.	Study of selected Plant viruses-TMV, CaMV	2
5.	Study of selected Animal Viruses- HIV, Influenza, HSV, HBV, Rabies	3
6.	Study of cytopathic effects of viruses using photographs.	2
7.	Performing local lesion technique for assaying plant viruses	3
8.	Isolation of normal flora from mouth	2
9.	Isolation of bacteria from pus	2
10.	Isolation of bacteria from urine	3
11.	Isolation of normal bacteria from blood	2
12.	Antibiotic susceptibility testing by Disc diffusion method	2
13.	Fungi - slide culture techniques	2
14.	Parasite - iodine wet mount	2
15.	Giemsa staining	2
16.	Leishman staining	3
17.	Widal test - Slide and tube test	2
18.	ELISA technique – Demonstration	3
19.	Visit to a Clinical lab and write a report based on the visit conducted	2
	Total	**45hrs**

SEMESTER VI

CORE -MAJORVIII-FOOD AND DAIRY MICROBIOLOGY

Course Objectives:
The course aims

1. To introduce the microbes important in food microbiology and food safety standards
2. To give an overview on Principles of Preservation of different types of food.
3. To highlight the process of spoilage of different foods and methods to preserve.
4. To create awareness among the students about food borne diseases.
5. To impart knowledge on quality and safety of dairy foods and bacteriological tests for milk.

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Explain how food acts as a substrate for microbes and Food safety standards.	K-2,K-3,K-4
CO2	Demonstrate various methods of Food preservation strategies.	K-2,K-3,K-4
CO3	Elaborate the mechanism of different food spoilages	K-2,K-4,K-5
CO4	Aware of food borne microorganisms and the disease caused by them	K-2,K-3,K-4
CO5	Familiarize with the methods of preparing different dairy products.	K-1,K-2,K-3

Unit –I
Food as a substrate for microorganisms, - Microorganisms important in food microbiology - Mold, Bacteria and Yeast – Food quality control measures.Quality assurance of food products. Food safety standards -HACCP, FDA, WHO, FSSAI, lSI, EPA.

Unit – II
General Principles of food Preservation - High temperature, Low temperature - Drying - Food additives - Sanitation - Hazard analysis, Critical control point - personal hygiene - oriental fermented food (Piden, Minchin, Fermented Coffee, Soy sauce).

Unit –III
Contamination of food and Food Poisoning- Spoilage and preservation of - cereals and cereal products - vegetable and fruit - meat and meat product.Food poisoning - Food borne infections -

Bacterial (Staphylococcus, Clostridium, Salmonella) - Fungal (Mycotoxins - Aflatoxin, Patulin, ochratoxin) - Viral (Hepatitis) - Rickettsia – Trichinosis.

Unit –IV

Dairy Microbiology - Sources of microorganisms in milk, Dairy products - Curd - Butter milk - cheese - Yogurt - Acidophilus milk - Kefir - Koumiss - sour cream. Spoilage and Preservation of milk and milk products.Milk borne bacterial disease (Diptheria, Q fever, Tuberculosis, Mastitis) Viral - Foot and mouth disease, Fungal - Microsporum, Aspergillosis.

Unit –V

Bacteriological tests for milk - Phosphatase milk - Standard plate count - Direct microscopic count (DMC) - Burri smear - (clot - on - boiling) - Alizarin alcohol test - shake culture method - Rejection or platform testing - Detection of *Staphylococcus aureus* in milk

Textbooks recommended

1. Parihar and parihar - Dairy Microbiology (2011 Agrobios (india)
2. Adams M.R and Moss M.O (1995) Food Microbiology
3. Frazier W.C and westhoff D.C (2014) Food microbiology Tata MC Craw Hill Publishing co Ltd
4. Jay J.M (1987) Modern food Microbiology
5. Sivashankar B - Moss (2011). Food Processing and Preservation. Eighth edition, PHI Learning P.Ltd., New Delhi.
6. Vijaya Ramesh K (2007). Food Microbiology. First edition, MJP Publishers, Chennai.
7. BanwartGJ (2004). Basic Food Microbiology. Second edition, CBS Publishers and Distributors, New Delhi.
8. James M Jay (2003). Modern Food Microbiology. Fourth edition, CBS Publishers, New Delhi
9. Roday, S. (1998). Food Hygiene and Sanitation. Tata Mcgraw Hill Publications.

Web Resources

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

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Foodas a substrate for microorganisms, - Microorganisms important in food microbiology - Mold, Bacteria and Yeast	3
	1.2 Food quality control measures. Quality assurance of food products.	3
	1.3 Food safety standards -HACCP, FDA, WHO, FSSAI, lSI, EPA	4
	Total Hours	**10 hrs**
II	2.1Preservation of food - General Principles of food Preservation - High temperature, Low temperature	3
	2.2 Preservation methods -Drying, Food additives	3
	2.3 Sanitation - Hazard analysis, Critical control point - personal hygiene.	3
	2.4 Oriental fermented food (Piden, Minchin, Fermented coffee, Soy sauce	2
	Total hours	**11hrs**
III	3.1 Contamination of food and Food Poisoning-Spoilage and preservation of - Cereals and cereal products - Vegetable and fruits	3
	3.2 Meat and meat products.	1
	3.3 Food poisoning - Food borne infections - Bacterial (Staphylococcus, Clostridium, Salmonella)	3
	3.4 Fungal (Mycotoxins - Aflatoxin, Patulin, ochratoxin)	2
	3.5 Viral (Hepatitis) - Rickettsia – Trichinosis	3
	Total hours	**12hrs**

IV	4.1 Dairy Microbiology - Sources of microorganisms in milk, Dairy products - Curd - Butter milk - cheese - Yogurt - Acidophilus milk -	3
	4.2 Kefir - Koumiss - sour cream.	1
	4.3 Spoilage and Preservation of milk and milk products.	3
	4.4 Milk borne bacterial disease (Diptheria, Q fever, Tuberculosis, Mastitis)	2
	4.5 Viral - Foot and mouth disease	1
	4.6 Fungal - Microsporum, Aspergillosis	3
	Total hours	**13hrs**
V	5.1 Bacteriological tests for milk - Phosphatase milk - Standard plate count - Direct microscopic count (DMC) - Burri smear - (clot - on - boiling)	6
	5.2 Alizarin alcohol test - shake culture method - Rejection or platform testing	4
	5.3 Detection of *Staphylococcus aureus* in milk	4
	Total hours	**14hrs**
	Total hours for Units I to V	**60hrs**

CORE MAJOR IX –INDUSTRIAL MICROBIOLOGY AND BIOPROCESS TECHNOLOGY

Course Objectives

The course aims

1. To know Industrial Fermentation process.
2. To make the students able to understand the structure and design of Bioreactors.
3. To know the media and industrial important microorganisms
4. To create a comprehensive knowledge on Downstream Processing Techniques.
5. To understand the Production methods of various fermented commercial products

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Explain the types of fermentation process	K-2,K-3,K-4
CO2	Understand the design, Types and operation of fermenters in various industries.	K-2,K-3,K-4,K-5,K-6
CO3	Formulate the media for fermentation process	K3,K-4,K-5,K-6
CO4	Perform the methods of Production, harvesting and product recovery in industrial fermentations	K-3,K-4,K-5
CO5	Work out the Production of various commercial fermented products.	K-3,K-4,K-5

Unit –I:

Development of Industrial Microbiology- Brief history and developments in Industrial Microbiology - Types of fermentation process - solid state and liquid state (Stationary and submerged) fermentations - batch, fed batch and continuous fermentations. Sources of industrially important microbes and methods for their isolation, Preservation and maintenance of industrial strains - Strain improvement.

Unit – II

Bioreactor : Introduction to bioreactor, Batch and fed batch reactor, continuous reactor, solid state and submerged, aerobic and anaerobic fermentation, mixed microbial population, immobilization of cells and co immobilization, immobilized reactor, Design of bioreactor: construction of material, Basic components – Agitator, aerator, valves, seals, stirrer, glands, measurement and control of parameters, control pathway, Types of Bioreactors- Air lift, stirred tank, tower, fluidized bed, packed bed, pulsed filed.

Unit – III

Introduction of Bioprocess- Media design and usage in fermentation, Types of media, composition of media – carbon sources, nitrogen sources, vitamins, mineral, inducer, precursors and inhibitors. Microbial growth- Inoculums development: Development of inoculums for yeast, bacteria, mycelia and fungal processes. Sterilization methods

Unit –IV

Microbial growth kinetics: Factors affecting microbial growth, fermentation kinetics- Downstream processing: Biomass removal, separation of microbial cells and solid matters, centrifugation, sedimentation, flocculation, microfiltration, Disintegration of microorganism : Sonification, homogenizers, enzymatic lysis, membrane based purification, ultrafiltration, reverse osmosis, dialysis, Chromatography: size, charge, shape, hydrophobic interaction, Drying :spray driers, drum driers, freeze dries.

Unit –V

Commercial Production -Microbial products in pharma, food and Agri, Production of Organic Acids(Citric acid, Vinegar), Alcohol (Ethanol), Vitamins (Vitamin B_2 and B12) Antibiotics (Penicillin - Streptomycin), Amino acid (Glutamic Acid) Enzymes (amylase, protease)Dextran and Xanthan,non-microbial products produced through microbes – Hormones – GH, IFN.

Textbooks recommended

1. Stanbury P.F.A. Whitakar and Hal S.J (1995) Principles of fermentation technology (2^{nd} Edition)
2. Casida, L.E.1989 - industrial Microbiology willey Eastern Limited New Delhi
3. Click, B.R., .Pasternak, J.J. (1994). Molecular Biotechnology – ASM Press.
4. Demain A.L. Solomon, N.A. (1986). Manual of Industrial Microbiology and Biotechnology. ASM Press
5. Prave, P. Faust, V, Sitting, W., Sukatsch, D.A. (1987). Fundamentals of Biotechnology. ASM Press.
6. Reed. G. (1982). Prescott and Dunn's Industrial Microbiology. Macmillian Publishers. Sikyta, B.(1983). Methods in Industrial Microbiology, Ellis Horwood limited.

Web resources:

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

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

K-5	Evaluate
K-6	Create

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Brief history and developments in Industrial Microbiology	1
	1.2 Types of fermentation process - solid state and liquid state (Stationary and submerged) fermentations	2
	1.3 Batch, fed batch and continuous fermentations.	2
	1.4 Sources of industrially important microbes and methods for their isolation, Preservation and maintenance of industrial strains -	2
	1.5 Strain improvement	2
	Total Hours	**9 hrs**
II	2.1 Bioreactor: Introduction to bioreactor, Batch and fed batch reactor, continuous reactor	2
	2.2Solid state and submerged, aerobic and anaerobic fermentation, Mixed microbial population	3
	2.3 Immobilization of cells and co immobilization, immobilized reactor	2
	2.4 Design of bioreactor: construction of material, Basic components – Agitator, aerator, valves, seals, stirrer, glands, measurement and control of parameters, control pathway,	3
	2.5 Types of Bioreactors- Air lift, stirred tank, tower, fluidized bed, packed bed, pulsed filed.	3
	Total hours	**13hrs**
III	3.1Introduction of bioprocess, Media design and usage in fermentation	3
	3.2 Types of media, composition of media – carbon sources, nitrogen sources, vitamins, mineral, inducer, precursors and inhibitors.	3
	3.3 Microbial growth- Inoculums development: Development of	4

	inoculums for yeast, bacteria, mycelia and fungal processes.	
	3.4 Sterilization methods	2
	Total hours	**12hrs**
IV	4.1 Microbial growth kinetics: Factors affecting microbial growth, fermentation kinetics	2
	4.2 Downstream processing: Biomass removal, separation of microbial cells and solid matters, centrifugation, sedimentation, flocculation, microfiltration	3
	4.3 Downstream Processing- Disintegration of microorganism: Sonification, bead mills, homogenizers, chemical lysis, enzymatic lysis, membrane based purification, ultrafiltration, reverse osmosis, dialysis	3
	4.4 Chromatography: size, charge, shape, hydrophobic interaction	2
	4.5 Drying: spray driers, drum driers, freeze drier	2
	Total hours	**12hrs**
V	5.1 Commercial Production -Microbial products in pharma, food and agriculture	1
	5.2 Production of Organic Acids (Citric acid, Vinegar)	2
	5.3 Alcohol (Ethanol), Vitamins (Vitamin B_2 and B12)	3
	5.4 Antibiotics (Penicillin - Streptomycin)	3
	5.5 Amino acids (Glutamic Acid	1
	5.6 Enzymes (amylase, protease)Dextran and Xanthan,	2
	5.7 Non-microbial products produced through microbes – Hormones – GH, IFN	2
	Total hours	**14hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR ELECTIVE I-A1
BIOTECHNOLOGY AND GENETIC ENGINEERING

Course Objectives
The course aims

1. To introduce the basic concepts of
2. To gain an in-depth knowledge on Plant tissue culture techniques
3. To impart basic knowledge on Plant Biotechnology.
4. To give an insight on Transgenic animals
5. To provide outline on Gene mapping.

6. To highlight the tools and applications of genetic engineering to inculcate the desire of research in biotechnology
7. To make the students knowledgeable on various techniques and enzymes used in recombinant DNA construction.
8. To give an outline on Cloning vectors and Gene libraries.
9. To provide an in-depth knowledge on Gene transfer techniques.
9. To highlight the processes involved in Gene mapping.
10. To expose the students on the methods of Gene amplification.

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

Course Outcomes		Cognitive level
CO1	Work on basic concepts of Genetic Analysis and Gene Sequencing	K-4,K-5,K-6
CO2	Gain expertise on Plant tissue culture techniques	K-3,K-4,K-5
CO3	Improve their knowledge on Plant Biotechnology.	K-2,K-3,K-4,K-5
CO4	Carry out research on Transgenic animals	K-3,K-4,K-5
CO5	Explain Gene mapping	K-1,K-2,K-3

Unit I

Genetic Engineering- Introduction - History and scope of genetic engineering - Definition - concepts - Principles and Application of rDNA technology - Isolation & purification of DNA from cells – DNA ligases, DNA modifying enzymes, Eukaryotic and Prokaryotic hosts for cloning. Restriction Enzymes - types and sources,

Unit II

Cloning Vectors - Plasmid based vectors - Natural (pSC 101, pSF 2124, pMBI), Artificial - pBR 322 and pUC construction: Phage based vectors - Lamda phage vectors and its derivatives: Hybrid vectors - phagemid, phasmid and cosmid, BAC and YAC.

Unit III

Genome – overview of genome, sequence of genome acquisition and analysis – homologies – SNPs – Genetic analysis, Linkage mapping, High Resolution Chromosome mapping and analysis – Physical mapping, YAC, Hybrid mapping, strategies, Sequence Specific Tags (SST), Sequence Tagged Sites (STS), ISH, FISH, RFLP, RAPD. DNA sequencing – methods, Maxam and Gilbert method, ladder, Fluorescent, Shot gun

Unit IV

Plant Biotechnology - Plant tissue culture – Concept of totipotency, Sterilization techniques – Media preparation – Types of media – MS media, Plant Growth regulators, Organogenesis.Plant micro propagation, Horticulture - Isolation, culture and fusion of plant protoplasts.Soma clonal variation, Somatic embryogenesis.Gene silencing in crop plants- Genetic engineering of crop plant for insect resistance (Bt –cotton), fungus resistance, virus resistance, drought, cold and saline resistance- Transgenic plants - Ti plasmid - herbicide resistant plants:

Unit -V

Animal Biotechnology -Transformation of animal cells, cloning vectors and expression vectors and animal viral vectors. Transgenic animals improving important genes, production of recombinant proteins, immunotoxins, vaccines, hybridoma technology, Molecular and cellular biology of fertilization,Hybridoma technology and monoclonal antibodies, Human Genome mapping, Targeted Genome Editing: ZFNs, TALENs, CRISPRs - DNA Finger Printing, gene therapy types and their applications

TextbooksRecommended

1. Principles of Gene Manipulation and Genomics(link is external) – 7th Edition – Sandy B. Primrose, Richard Twyman – Blackwell Publishing
2. Gene Cloning and DNA Analysis: An Introduction(link is external) - 6th Edition - T. A. Brown - John Wiley & Sons
3. An Introduction to Genetic Engineering(link is external) - 3rd Edition - Desmond S. T. Nicholl - Cambridge University Press
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (link is external)- 4th Edition - Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten - ASM Press
5. J. Hammond, P McGarvey and V. Yasibov (Eds). Plant Biotechnology Springer Verlag 2000.
6. T.J. Fu, G. Singh and W. R. Curtis (Eds). Plant Cell and Tissue culture for the production
7. H.S. Chawla: Biotechnology in crop improvement. International Book distributing company 1998.
8. R. J. Henry: Practical Application of Plant Molecular Biology. Chapman and hall. 1997.

9. P.K. Guptha. Elements of BiotechnologyRastogi and Co, Meerut, 1996.
10. U. Sathyanarayanan, Biotechnology, Books and allied (P) Ltd.2005
11. S.S. Bhojwani and M.K. Razdan, Tissue culture Theory and Practice, 2004.
12. Paul Christou and Harry Klee (2004) Hand book of Plant Biotechnology. Vol. I & II John Wiley & Sons

Web Resources

1. https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/
2. https://www.rpi.edu/dept/chem-eng/Biotech-environ/Projects00/rdna/rdna.html
3. http://www.whatisbiotechnology.org/index.php/science/summary/rdna
4. https://www2.le.ac.uk/projects/vgec/highereducation/topics/recombinanttechniques
5. http://biology.kenyon.edu/courses/biol114/Chap08/Chapter_08a.html

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 History and scope of genetic engineering - Definition - concepts - Principles and Application of rDNA technology -	3
	1.2 Principles and Application of rDNA technology	2
	1.3 - Isolation & purification of DNA from cells – DNA ligases,	2
	1.4 DNA modifying enzymes, Eukaryotic and Prokaryotic hosts for cloning	2
	1.5 Eukaryotic and Prokaryotic hosts for cloning. Restriction Enzymes - types and sources,	3
	Total Hours	**12hrs**
II	2.1 Plasmid based vectors -: Phage based vectors - Lamda phage vectors and its derivatives: Hybrid vectors - phagemid, phasmid and cosmid, BAC and YAC.	4
	2.2 Natural (pSC 101, pSF 2124, pMBI), Artificial - pBR 322 and pUC construction	2
	2.3 Phage based vectors - Lambda phage vectors and its derivatives:	2
	2.4 Horticulture – Haploid plant production – Virus free plants Embryo culture	2
	2.5 Hybrid vectors - phagemid, phasmid	2
	2.6 cosmid, BAC and YAC	2
	Total hours	**14hrs**
III	3.1Overview of genome, sequence of genome acquisition and analysis – homologies – SNPs – Genetic analysis, Linkage mapping, High Resolution Chromosome mapping and analysis	2
	3.2 Physical mapping, YAC, Hybrid mapping, strategies, Sequence Specific Tags (SST), Sequence Tagged Sites (STS),Agrobacterium tumefaciens and Rhizogenes transformation	2
	3.3 ISH, FISH, RFLP, RAPD.	2
	3.4 Genetic engineering of crop plant for insect resistance (Bt –cotton), fungus resistance, virus resistance, drought, cold and saline resistance.	2
	3.5 DNA sequencing – methods, Maxam and Gilbert method, ladder, Fluorescent, Shot gun	2
	Total hours	**10 hrs**

IV	4.1 Plant tissue culture – Concept of totipotency, Sterilization techniques – Media preparation – Types of media – MS media, Plant Growth regulators, (Bt –cotton), fungus resistance, virus resistance, drought, cold and saline resistance- Transgenic plants - Ti plasmid - herbicide resistant plants:	4
	4.2 Plant Growth regulators, Organogenesis. Plant micro propagation, Horticulture- Isolation, culture and fusion of plant protoplasts. Soma clonal variation, Somatic embryogenesis.	4
	4.3 Gene silencing in crop plants- Genetic engineering of crop plant for insect resistance.	3
	4.4fungus resistance, virus resistance, drought, cold and saline resistance- Transgenic plants - Ti plasmid - herbicide resistant plants:	2
	Total hours	**13hrs**
V	5.1 Transformation of animal cells, cloning vectors and expression vectors and animal viral vectors. Transgenic animals improving important genes, production of recombinant proteins, immunotoxins, vaccines, hybridoma technology,	4
	5.2 Molecular and cellular biology of fertilization,Hybridoma technology and monoclonal antibodies, Human Genome mapping,	2
	5.3 Targeted Genome Editing: ZFNs, TALENs, CRISPRs	2
	5.4 DNA Finger Printing,gene therapy types and their applications.Mapping of human genome.	3
	Total hours	**11hrs**
	Total hours for Units I to V	**60hrs**

MAJOR ELECTIVE I–B
CLINICAL RESEARCH AND DRUG DISCOVERY

Course Objectives
The Course Aim:

1. To understand the basic concepts of Pharmacology and Clinical Research.
2. To learn the steps involved in new drug discovery and Ethics in Clinical trials.
3. To enhance the basic knowledge in different phases of Clinical trials and Safety Monitoring.
4. To understand the basic concepts in Preclinical toxicology and methods in toxicology studies.
5. To provide a basic knowledge in data management in clinical trials

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

Course Outcomes		Cognitive level
CO1	Explain the basic concepts of Pharmacology and Clinical Research.	K-1,K-2,K-3,K-4
CO2	Evaluate the steps involved in new drug discovery and Ethics in Clinical trials.	K-3,K-4,K-5
CO3	Demonstrate the different phases of Clinical trials and Safety Monitoring.	K-2,K-3,K-4
CO4	Expertise in Preclinical toxicology and methods in toxicology studies.	K-2,K-3,K-4
CO5	Manage data in clinical trials	K-2, K-4,K-5,K-6

Unit I
Drug discovery and drug development –Introduction- Basic pharmacology and clinical research.Basic knowledge about receptors, drugs, pharmacodynamic, pharmacokinetics (ADME), Drug interactions, clinical research.Introduction toPharmacoeconomics.

Unit II
New drug discovery process –Steps involved in new drug discovery process, timelines for each steps, advantages and purpose of each steps, ethics in clinical research, unethical trials, Thalidomide tragedy.

Unit III
Clinical trials - phase I, II, III, IV trials, Post marketing surveillance- methods – Principles of sampling – inclusion and exclusion criteria – methods of allocation and randomization – Informed consent process (in brief) – Monitoring treatment outcome –Termination of trial – Safety monitoring in clinical trials.

Unit IV

Preclinical toxicology- General Principles, Systemic toxicology (single dose and repeated dose toxicity studies), Carcinogenicity, Mutagenicity, Teratogenicity, Reproductive toxicity, Local toxicity, Genotoxicity, Animal toxicity requirements.

Unit V

Basic terminology in clinical research - Types of clinical trials – single binding, double binding, randomized trials, cross over design and their examples, interventional study, ethical committee and its members, Institutional ethical committee/Independent ethical committee, Data management in clinical trials.

Textbooks Recommended

1. Basic and Clinical Pharmacology, Prentice Hall, International, katzung, B.G.
2. Clinical Pharmacology. Scientific book agency, Laurence, D.R and Bennet P.N.
3. Clinical Pharmacy and Therapeutics. Herfindal E.T., Hirschman J.L., Williams and Wilkins.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Drug discovery and drug development –Introduction- Basic pharmacology and clinical research.	4
	1.2 Basic knowledge about receptors, drugs, pharmacodynamic, pharmacokinetics (ADME), drug interactions,	4
	1.3 Clinical research.	2
	1.4 Introduction to pharmacoeconomics.	1
	Total Hours	**11hrs**
II	2.1 New drug discovery process	2
	2.2 Steps involved in new drug discovery process	3
	2.3 Timelines for each steps, advantages and purpose of each steps,	2
	2.4 Ethics in clinical research, unethical trials, Thalidomide tragedy.	3
	Total hours	**10 hrs**
III	3.1 Clinical trials - phase I, II, III, IV trials	2
	3.2 Post marketing surveillance	2
	3.3 Methods – Principles of sampling – inclusion and exclusion criteria	3
	3.4 Methods of allocation and randomization – informed consent process (in brief)	3
	3.5 Monitoring treatment outcome – termination of trial – safety monitoring in clinical trials	2
	Total hours	**12hrs**
IV	4.1 Preclinical toxicology: General principles, systemic toxicology (single dose and repeated dose toxicity studies)	4
	4.2. Carcinogenicity, mutagenicity, teratogenicity	4
	4.3 Reproductive toxicity, local toxicity, genotoxicity, animal toxicity requirements.	5
	Total hours	**13hrs**
V	5.1 Basic terminology in clinical research	2
	5.2 Types of clinical trials – single binding, double binding, randomized trials, cross over design and their examples, interventional study	4
	5.3 Ethical committee and its members, Institutional ethical committee	4
	5.4 Independent ethical committee	2
	5.5 Data management in clinical trials.	2
	Total hours	**14hrs**

	Total hours for Units I to V	**60hrs**

MAJOR PRACTICALS VIII - LAB IN FOOD AND DAIRY MICROBIOLOGY

Course Objectives
The Course aim:

1. To perform experiments to study the quality of milk and curd samples
2. To study the methods of isolating and identifying the microbes in different types of food.
3. To practice the production of Wine and Bread.
4. To conduct serological test for typhoid and HIV.
5. To visually understand the processes in food industry by conducting a visit.

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

Course Outcomes		Cognitive level
CO1	Find out the quality of Milk and curd samples.	K-3,K-4,K-5
CO2	Isolate and identify the microbial contamination in different types of foods	K-2,K-3,K-4
CO3	Demonstrate the production of Wine and Bread.	K-2,K-3,K-4
CO4	Expertise in food processing or milk processing techniques by visiting a industry	K-3,K-4,K-5
CO5	Develop the analytical skill to be a quality controller in food and dairy Industry	K-4,K-5,K-6

Experiments

1. Dye Reduction Test for milk – MBRT test
2. Determination of milk quality by Resazurin test
3. Evaluation of quality of curd by SPC.
4. Enumeration of bacteria in spoiled foods
5. Enumeration of microorganism from bread
6. Isolation and identification of microbes from fruits
7. Isolation and identification of microbes from vegetables
8. Determination of thermal death time

9. Determination of thermal death Point
10. Isolation of yeast from grapes
11. Wine production using yeast (Demonstration)
12. Isolation of *Salmonella* from poultry products
13. Bread preparation (Demonstration)
14. Visit to a Food processing laboratory or Food Quality control lab and write a report

TextbooksRecommended

1. J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York
2. M. Kannan 1996, Laboratory Manual in General Microbiology
3. P. Gunasekaran - Laboratory Manual in Microbiology
4. Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental procedures in Life Sciences - Ajantha book house, chennai
5. Dr.S.M.Reddy and Dr.S.Ram Reddy - Microbiology A laboratory manual - BSC Publishers and Distributors – Hyderabad

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Practical	Topics covered	Hours
1	Dye Reduction Tests for milk – MBRT test.	2
2	Evaluation of quality of curd by SPC.	2
3	Enumeration of bacteria in spoiled foods	2
4	Enumeration of microorganism from bread	2
5	Isolation and identification of microbes from fruits	2
6	Isolation and identification of microbes from vegetable	2
7	Isolation of microorganisms from grains	2
8	Determination of thermal death time	2
9	Determination of thermal death Point	2
10	Isolation of yeast from grapes	2
11	Wine production using yeast (Demonstration)	2
12	Isolation of *Salmonella* from poultry products	2
13	Bread preparation (Demonstration)	2
14	Visit to a Food processing laboratory or Food Quality control lab and write a report	4
	TOTAL 30 hours	

MAJOR PRACTICAL -IX

LAB IN INDUSTRIAL MICROBIOLOGY AND BIOPROCESS TECHNOLOGY

Course Objectives

The course aim:

1.To perform experiments to demonstrate fermentation from yeast
2. To Practise Protoplast fusion technique.
3. To isolate, cultivate and preserve industrially important microorganisms
4. To produce antibiotics, Vitamins and Glutamic acid using microbes.
5. To demonstrate the lyophilization process for preserving the cultures.

Course Outcomes

By the completion of the course the students will be able to

Course Outcomes		Cognitive level
CO1	Demonstrate fermentation from yeast	K-1,K-2,K-3
CO2	Demonstrate Protoplast fusion technique.	K-1,K-2,K-3
CO3	Expertise in isolating, cultivating and preserving industrially important microorganisms	K-2,K-3,K-4,K-5
CO4	Produce antibiotics, Vitamins and Glutamic acid using microbes.	K-3,K-4,K-5
CO5	Demonstrate the lyophilization process for preserving the cultures	K-2,K-3,K-4

Experiments

1. Demonstration of fermentation from yeast
2. Protoplast Fusion – Somatic hybridization (demonstration)
3. Isolation of industrially important microbes
4. Preservation of industrially important microbes (Demonstration)
5. Purification of protein by ammonium sulphate precipitation
6. Production of antibiotic from Microorganisms
7. Production of Vitamins using Microorganisms (demonstration)
8. Production of Glutamic acid using microorganisms (demonstration)
9. Lyophilization (demonstration)

Textbooks Recommended

- J.G. Cappuccino and N.Sherman 1996 Microbiology - A laboratory manual - Benjamin Cummins, New York
- M. Kannan 1996, Laboratory Manual in General Microbiology

- P. Gunasekaran - Laboratory Manual in Microbiology.
- Dr.S.Rajan and Mrs.R.Selvi Christy - Experimental Procedures in Life Sciences – Ajanthabook house, Chennai.

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

Strongly Correlated – 3; Moderately Correlated – 2; Weakly Correlated – 1; No Correlation – 0;

Lecture Schedule

Practical	Topics covered	Hours
1	Demonstration of fermentation from yeast	3
2	Protoplast Fusion – Somatic hybridization (demonstration)	3
3	Isolation of industrially important microbes	5
4	Preservation of industrially important microbes (Demonstration)	3
5	Purification of protein by ammonium sulphate precipitation	3
6	Production of antibiotic from Microorganisms	5
7	Production of Vitamins using Microorganisms (demonstration)	3
8	Production of Glutamic acid using microorganisms (demonstration)	3
9	Lyophilization (demonstration)	2
	TOTAL 30 hours	

Project

To address and assess the diverse problems associated with various fields relevant to microbes through the techniques learnt to design managerial measures for a healthy environment.

Students will gain exposure to work with microbes for the production of various metabolic products like Antibiotics, Enzymes and so on.

ALLIED FOR B.Sc., Zoology, B.Sc., Botany, B.Sc., Biotechnology, B.Sc., Nutrition and Dietetics, B.Sc., Bioinformatics, B.Sc., Biochemistry B.Sc., Chemistry and B.Sc., Physics

ALLIED COURSE- MICROBIOLOGY-I

COURSE OBJECTIVES

6. ***Understand and remember the historical aspects of Microbiology and Microorganisms and to analyses the roles of different technical outputs.***
7. ***. Explain and relate the commonly used microscopes used to visualize microorganisms.***
8. ***. Identify the different structural components of bacteria and to classify them based on that and relate their features of different microbial groups***
9. ***Understand the mechanism and types ofstaining techniques and transfer learnt techniques in needy places.***
10. ***Describe and classify the diverse kinds of sterilization and determine the suitability of techniques to value samples.***

COURSE OUTCOMES ***COGNITIVE LEVELS***

CO1:	Understand and remember the history of Microbiology.	*K-1, K-2, K-4 & K-5*
CO2:	Explain and relate the commonly used microscope.	*K-1, K-2 & K-3*
CO3:	Summarize the bacterial anatomy and characterize its morphological features.	*K-1, K-2, K-3 & K-5*
CO4:	Describe basic and specialized staining technique and indicate its importance.	*K-1, K-2, & K-4*

CO5:	Identify the diverse kinds of sterilization techniques to value samples.	*K-1, K-2, K-4 & K-5*

Unit-I

Introduction to Microbiology- History of Microbiology- Anton von Leeuwenhoek, Robert Koch, Louis Pasteur, Edward Jenner, Alexander Fleming.

Unit-II

Microscopy- Optical or Light microscope- Dark and Bright microscope- Phase contrast microscope- Florescent microscope and Electron microscope.

Unit-III

Morphology – Size of Bacteria- Shape of bacteria- Bacterial Anatomy- Cell wall, Cytoplasmic membrane, Cytoplasm, Mesosome, Intra-cytoplasmic inclusion, Nucleoid, Pili and Flagella- Types of flagella.

Unit-IV

Staining techniques- simple, differential - Gram's, Acid fast stain, Special stain- Negative – Albert stain and Spore stain.

Unit-V

Sterilization technique- Physical agents- Sunlight, Drying, Heat, Dry heat- Hot air oven, Moist heat- Autoclave – Filtration- Radiations.

REFERENCES

1. Ananthanarayanan and Paniker's –Text book of Microbiology- ninth edition, University press
2. Michael J Pelczar, Microbiology 5th edition McCraw Hill, Education
3. SARAS Microbiology, low price edition, SARAS publication

On completion of the course, students will be able to

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

ALLIED COURSE–MICROBIOLOGY PRACTICAL-I

COURSE OBJECTIVES:

1. *To make the students aware of basic laboratory rules and regulations and the fundamental instruments used in microbiology labs.*
2. *To perform microscopic staining and wet mount studies.*
3. *To carryout motility of microorganisms.*
4. *To understand the sterilization methods.*
5. *To employ the suitable technique to control microorganisms.*

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1.	*Make the students aware of basic laboratory rules and regulations and the fundamental instruments used in microbiology labs*	K-2, K-3,K-4
CO2.	*Identify and characterize microorganism using microscopic staining and wet mount studies.*	K-2, K-3,K-4, K-5
CO3.	*Apply the hanging drop method to observe motility.*	K-1, K-3,K-4, K-5
CO4.	*Analyze appropriate sterilization methods*	K-2, K-3,K-4, K-5
CO5	*Employ the microbial control measure*	K-2, K-3, K-4, K-5

1. Simple staining
2. Gram’s staining
3. Negative staining
4. Spore staining

5. Motility of bacteria- Hanging drop method
6. Light microscope (DEMO)
7. Hot Air Oven (DEMO)
8. Autoclave (DEMO)
9. Membrane filter (DEMO)
10. Control of microorganisms- UV Radiation (DEMO)

REFERENCES

1. BhartiArora. D.R.Arora, Practical Microbiology, CBS Publishers & Distributors
2. James G.Cappuccino, Natalie Sherman, Microbiology –A laboratory Manual- Seventh Edition- Published by Dorling Kindersley (India) .
3. Ananthanarayanan and Paniker's –Text book of Microbiology- ninth edition, University press

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

ALLIED COURSE– MICROBIOLOGY-II

COURSE OBJECTIVES

1. *Describe and classify the diverse kinds of sterilization and media and discover the suitability of techniques and media to value samples.*
2. *Employ microbial cultural methods and cultivation techniques.*
3. *Apply the techniques to detect microbial populations in water.*
4. *Analyse the air borne microbes and its measurements.*
5. *Examine the milk quality using common lab tests and detect milk borne diseases.*

COURSE OUTCOMES

CO1: Describe and classify the diverse kinds of media and suitability of media to value samples.
CO2: Recognize and correlate different types of microbial culture methods.
CO3: Recite the significance of water quality tests.
CO4: Memorize the distribution of air microbes and their isolation techniques
CO5:Analyse the bacteriological examination of milk quality tests

Unit-I

Culture media- types of media- Liquid-Solid-simple media- complex media- synthetic and defined media- special media- blood agar- LJ Media- MacConkey agar medium- Transport medium.

Unit-II

Culture methods- Aerobic culture method- streak culture – Lawn and carpet culture – stoke culture- stab culture- pour plate- liquid culture- anaerobic culture methods- McIntosh – Filder anaerobic jar- Robertson cooked meat medium.

Unit-III

Bacteriology of water- bacteriological examination- detection of coliform bacteria- presumptive method- MPN Technique- Eijkman test- Membrane filtration method, fecal *Streptococci*, *Clostridium species*.

Unit-IV

Bacteriology of Air- Airborne infection- droplets infection- microbial content of air- dust- droplets- droplet nuclei- measurement of air contamination- sedimentation or settle plate method.

Unit-V

Bacteriological examination of Milk- viable count- test for coliform bacilli- methylene blue reduction test- Phosphatase test- turbidity test- examination specific pathogens- tubercle bacilli- *Brucellasps.,*

REFERENCES

1. Ananthanarayanan and Paniker's –Text book of Microbiology- ninth edition, University press
2. Michael J Pelczar, Microbiology 5th edition McCraw Hill, Education .
3. SARAS Microbiology, low price edition, SARAS publication

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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

ALLIED COURSE– MICROBIOLOGY PRACTICAL- II

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

COURSE OBJECTIVES

1. *To develop microbial liquid culture media*
2. *To cultivate microorganisms using different techniques*
3. *To observe water quality using MPN technique.*
4. *To isolate air microorganisms.*
5. *To examine milk quality using different techniques.*

COURSE OUTCOMES (COs), On completion of the Practical's, Students will be able to

COURSE OUTCOMES		COGNITIVE LEVELS
CO1.	***To train students in microbial media preparation***	K-1,K-2,K-4,K-5,K-6
CO2..	***Cultivation and visualization of pure culture techniques microorganisms***	K-2,K-3,K-4&K-5
CO3.	***Quantification of microorganisms through MPN standards.***	K-2,K-3,K-4&K-5
CO4.	***Examination of air flora***	K-2,K-3,K-4,K-5,K-6
CO5:	***Quality standards for microorganisms in milk***	*K-2,K-3,K-4,K-5*

1. Preparation of liquid media (nutrient broth, peptone water)
2. Preparation of Solid media (agar plate, agar slant)
3. Pure culture technique

4. Streak plate technique
5. MPN Test
6. Settle plate method (detection of air contamination)
7. Total viable count of milk
8. Methylene blue reduction test of milk
9. Turbidity test for milk
10. Phosphatase test of milk

REFERENCES

1. BhartiArora. D.R.Arora, Practical Microbiology, CBS Publishers & Distributors
2. James G.Cappuccino, Natalie Sherman, Microbiology –A laboratory Manual-Seventh Edition- Published by Dorling Kindersley (India) .
3. Ananthanarayanan and Paniker's –Text book of Microbiology- ninth edition, University press

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

Mapping of Course Outcomes with Programme Outcomes and Programme Specific Outcomes

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

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