B.Sc., MICROBIOLOGY

SYLLABUS

(2020 -21 Onwards)

MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI – 12
TAMILNADU ,INDIA

B.Sc.MICROBIOLOGY
(FOR AFFILIATED COLLEGES)

CURRICULUM

(Effective from the academic year 2020-2021 onwards)

MANONMANIAM SUNDARANAR UNIVERSITY

ABHISHEKAPATTI, TIRUNELVELI– 627 012, TAMILNADU,INIDA

B.Sc. MICROBIOLOGY (CBCS PATTERN)

FOR AFFILIATED COLLEGES

(EFFECTIVE FROM THE ACADEMIC YEAR 2020-2021 ONWARDS)

REGULATIONS OF SYLLABUS

PROPOSAL FOR B.Sc., MICROBIOLOGY PROGRAMME

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 oppurtunities 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 subject or a subject from general stream papers (Biotechnology, Biochemistry, Microbiology) or vocational stream papers (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 50% 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	Upto 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 = $\frac{\sum(\text{Gradepoints} \times \text{Credits})}{\sum \text{Credits}}$

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.

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 2020-2021)

Semester- Wise Credit Distribution for B.Sc., Microbiology 2020- 21

Semester	Part	Sub No.	Subject Status	Subject Title	Contact Hrs/ Week	L Hrs./week	T Hrs./week	P Hrs./week	C Credits
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(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	2	0	0	2	2
	III	21	Allied– III	Molecular Biology	4	3	1	0	3
	III	22	Allied practical - III	Lab in Molecular Biology	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	Microbial Genetics	4	4	0	0	4
	III	29	Major practical - IV	Lab in Microbial Genetics	2	0	0	2	2
	III	30	Allied-IV	Genetic Engineering	4	3	1	0	3
	III	31	Allied practical - IV	Lab in Genetic Engineering	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	Agricultural Microbiology	6	4	2	0	4
	III	37	Core-VI Major	Industrial Microbiology and Bioprocess Technology	6	4	2	0	4
	III	38	Elective	A1. Virology or A2. Pharmaceutical Microbiology	5	3	2	0	3
	III	39	Elective	B1. Bioinformatics or B2. Advanced Biotechnology	5	3	2	0	3
	III	40	Major Practical - V	Lab in Agricultural Microbiology	3	0	0	3	2
	III	41	Major practical- VI	Lab in Industrial Microbiology and Bioprocess Technology	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	20
VI	III	43	Core - VII Major	Food and Dairy Microbiology	5	4	1	0	4
	III	44	Core - VIII Major	Medical and Diagnostic Microbiology	5	4	1	0	4
	III	45	Core - IX Major	Environmental Microbiology	5	4	1	0	4
	III	46	Elective	A. Biostatistics or B. Clinical Research and Drug Discovery	4	3	1	0	3
	III	47	Major practical - VII	Lab in Food and Dairy Microbiology	2	0	0	2	2
	III	48	Major practical - VIII	Lab in Medical and Diagnostic Microbiology	2	0	0	2	2
	III	49	Major practical - IX	Lab in Environmental Microbiology	2	0	0	2	2
	III	50	Project	Project	5	0	0	5	4
				SUB TOTAL	30	15	4	11	25

SEMESTER- III

MAJOR III : FUNDAMENTALS OF IMMUNOLOGY

Course Objectives

The course aims:

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

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 - Invivo 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.

Text books 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

Course Outcomes

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

CO 1.Explain the haematopioesis process and the development of stem cells to functional Immune cells.

CO 2.Determine the structure and function of different types of immune cells like polymorphonuclear leukocytes, Killer cells, Natural Killer cells, Dendritic cells, Bcells, Tcells.

CO 3.Understand the Structure, Types and Functions of Immunoglobins, Structure of Antigen.

CO 4. Master the serological techniques and its applications in Disease diagnosis.

CO 5. Elaborate the MHC, Transplantation Immunology, Auto immune diseases and Hypersensitivity associated diseases.

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	**13 hrs**
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	**14 hrs**
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	**11 hrs**
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	**12 hrs**
	Total hours for Units I to V	**60 hrs**

ALLIED III – MOLECULAR BIOLOGY

Course Objectives

The course aims

1. To impart information on the historical developments of molecular biology and molecules of life
2. To make the students aware of the concepts and mechanism of DNA replication process
3. To teach the students, the mechanisms of transcription and translation process in prokaryotes and eukaryotes.
4. To give an in-depth knowledge on DNA repair mechanisms.
5. To enhance student's interest on Regulation of gene expression.

UNIT I –

Basic Concepts inMolecular Biology – Introduction – Scope – Applications –. Nucleus: Nucleus structure, Chromatin and Chromosomes, allele, loci, gene. Nucleic acids as genetic material – Brief history, DNA (Watson and Crick model) and RNA structure. Properties of nucleic acids. Central Dogma of Molecular Biology.

UNIT –II

DNA Replication – Types – Experiments of Messelson and Stahl – Models of replication – Semi conservative, Unidirectional, Bidirectional, Rolling circle mechanism. Okazaki fragments. Prokaryotic and Eukaryotic replication. Enzymes involved in replication.

UNIT – III

DNA Damage and repair – Types of DNA damage, mechanism of repair (methyl directed, excision, recombinational, SOS).Genetic Recombination – Generalized and Site- specific.

UNIT IV

Genetic Code – Characteristic Features, RNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes. Post transcriptional and Post translational mechanisms.

UNIT V

Regulation of gene expression – Positive and negative control – Operon concept – Trp operon – Lac operon – Ara operon - Control. Catabolic repression.

Text books Recommended

1. Freidfelder. D and Malcinski. G.M., 1993, Essentials of molecular biology, II Ed, Jones Bartlett Publishers Inc, London.
2. Molecular biology of gene, 4th ed, 1987, J.D. Watson et al. The Benjamin/Cummings publ. California.
3. Gene VIII. 2002, Benjamin Lewis, OUP UK.
4. Maniatis et al, 2000, Molecular cloning: a laboratory manual, Cold Spring, Harlor laboratory press, NY.
5. R. A. Meyers, 1995, Molecular biology and biotechnology – A comprehensive desk reference. VCH publishers, NY
6. Cell and molecular biology 1996, Gerald Karp, John Wiley NY.

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

Course Outcomes

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

CO 1Explain the historical developments of molecular biology and molecules of life

CO 2 Elaborate the concepts and mechanism of DNA replication process

CO 3 Understand the mechanisms of transcription and translation process in prokaryotes and eukaryotes.

CO 4 Determine the DNA repair mechanisms.

CO 5 Explain the Regulation of gene expression.

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Basic Concepts in Molecular Biology – Introduction – Scope – Applications	1
	1.2 Nucleus: Nucleus, chromatin and chromosomes, allele, loci, gene.	2
	1.3 Nucleic acids as genetic material – DNA (Watson and Crick model)	2
	1.4 RNA structure and Types	1
	1.5 Properties of nucleic acids.	1
	1.6 Central dogma of Molecular Biology	1
	Total Hours	**8 hrs**
II	2.1 DNA replication – Types – Experiments of Messelson and Stahl	2
	2.2 Models of replication – Semi conservative, unidirectional, bidirectional, rolling circle mechanism.	2
	2.3 Okazaki fragments. Prokaryotic replication	2
	2.4 Eukaryotic replication.	2
	2.5Enzymes involved in replication.	1
	Total hours	**9 hrs**
III	3.1 DNA damage - Types of DNA damage	2
	3.2 Mechanism of repair (methyl directed, excision, recombinational, SOS).	3
	3.3 Genetic Recombination – Generalized and Site- specific.	3
	Total hours	**8 hrs**

IV	4.1Genetic code – Characteristic Features,	2
	4.2 Transcription and Translation in Prokaryotes	4
	4.3 Transcription and Translation in Eukaryotes.	4
	4.4 Post transcriptional and Post translational mechanisms – Prokaryotes	1
	4.5 Post transcriptional and Post translational mechanisms – Eukaryotes	1
	Total hours	**12 hrs**
V	5.1 Regulation of gene expression – Positive and negative control	3
	5.2 Operon concept – Lac operon	2
	5.3 Trp operon and Ara operon - Control. Catabolic repression.	3
	Total hours	**8 hrs**
	Total hours for Units I to V	**45hrs**

SKILL BASED I

A - MEDICAL LAB TECHNOLOGY

Course Objectives

The course aims

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.

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 - Quality control 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 urine CSF - 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

Course Outcomes

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

CO1: Discuss the method of Collection of clinical specimens
CO2: Outline the methods in urine examination
CO3: Explain total and differential blood count.
CO4: Delineate the histo pathological sample preparation and Serological examination.
CO5: Expertise in clinical pathological techniques and routine sample examination.

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	**14 hrs**
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	**14 hrs**
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.

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.

Text books recommended

Text book of Clinical Biochemistry – Carl A. Bordis and Edward R. Ashwood

Text book of Medical Biochemistry – Dr. M.N. Chatterjee and Rane Shinde

Clinical Chemistry in diagnosis and treatment – Philip D. Mayne

Clinical chemistry – William Hoffman

Clinical Biochemistry with clinical correlation – Devin, Wiley

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

Course Outcomes:

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

CO 1 Explain the concepts and physical aspects in Clinical biochemistry.

CO 2 Prepare to use diagnosing instruments.

CO 3 Familiarise with the technique of collection of clinical specimens
CO 4 Perform respective laboratory tests for organ function
CO 5 Acquire knowledge on metabolic disorders and Clinical Enzymology.

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 incipidus – 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 haemophilia.	4
	Total hours	**10 hrs**

IV	4.1 ClinicOrgan function test: Lipid and lipoproteins: Classifications, composition, mode of action – Cholesterol. Factors affecting blood cholesterol level.	4
	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	**16 hrs**
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	**12 hrs**
	Total hours for Units I to V	**60 hrs**

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

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 .

Text books 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

Course Outcomes

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

CO 1 Understand about the history, scope, basics and components of microbiology to explore more about microbial world.
CO 2 Explain microscopy and microbial growth
CO 3 Demonstrate various microbial techniques involved.
CO 4 Acquire an overall knowledge on Microbial nutrition.

CO 5.Understand the concept of growth of microorganisms and growth curve.

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	**6 hrs**
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	**6 hrs**
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	**6 hrs**
V	5.1 Microbial - Cell structures	2
	5.2 Microbial Nutrition	2
	5.3 Growth curve	2
	Total hours	**6 hrs**
	Total hours for Units I to V	**30 hrs**

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

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.

Text books 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

Course Outcomes:

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

CO 1 Explain the important microbes in food
CO 2 Understand the principles of food spoilage .
CO 3 Acquire knowledge on preservation of foods.
CO 4 Understand the causative agents of Food Borne diseases

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	**6 hrs**
II	2.1 Principles of food preservation– Asepsis	2
	2.2 Removal of microorganisms	2
	2.3 Anaerobic methods of preservation	2
	Total hours	**6 hrs**
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	**6 hrs**
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	**6 hrs**
	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 prepation.
4. To Perform and Familiarise with Serological test like Widal, Immunodiffussion and ELISA tests.

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)

Text Books 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.

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

CO 1Perform the Collection of blood and Blood grouping tests
CO 2 Expertise in determining the Total and Differential count from Blood sample.
CO 3 Acquire skill in Antigen and Polyclonal Antibody preparation.
CO 4 Perform Serological tests like Widal, Immunodiffussion and ELISA.

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

ALLIED PRACTICAL III – LAB IN MOLECULAR BIOLOGY

Course Objectives
The course aims

1. To learn the methods in DNA and RNA and Plasmid isolation from plant and microbial sources.
2. To practice the technique of Agarose gel Electrophoresis.
3. To impart practical knowledge in demonstrating RFLP and RAPD mapping and Southern blotting technique.

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. Elution of DNA from agarose gel electrophoresis
8. Gel documentation & photography (Demonstration)
9. RFLP and RAPD mapping (Demonstration)
10. Southern blotting technique (Demonstration)

Text books Recommended

1. Molecular Biology by D. Clark, N. Pazdernik and M. McGehee. 3rd edition. Academic Cell, USA. 2018. 2
2. Lewin's Genes XII by J. Krebs, E. Goldstein and S. Kilpatrick. 12th edition. Jones and Bartlett Learning, USA. 2017.
3. Becker's World of the Cell by J .Hardin and G.P. Bertoni. 9th edition. Pearson, USA. 2015.
4. 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.
5. Cell and Molecular Biology: Concepts and Experiments by G. Karp. 7th edition. Wiley and Sons, UK. 2013.
6. Maniatis et al, 2000, Molecular cloning: a laboratory manual, Cold Spring, Harlor laboratory press, NY.

Course Outcomes

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

CO 1 Acquire the skill in DNA isolation from plant and microbial sources
CO 2 Acquire the skill in RNA isolation from Yeast
CO 3 Acquire the skill in Plasmid isolation
CO 4Perform the technique of Agarose gel Electrophoresis.
CO 5Demonstrating RFLP and RAPD mapping and Southern blotting technique.

Lecture Schedule

Practical	Topics covered	Hours
1	DNA isolation - from Plant cell & Microbes	4
2	Isolation of RNA from Yeast	4
3	Plasmid DNA isolation	4
4	Agarose gel electrophoresis	4
5	Digestion of plasmid DNA with restriction digestion (Demonstration)	2
6	Ligation of DNA fragment (Demonstration)	2
7	Elution of DNA from agarose gel electrophoresis	2
8	Gel documentation & photography (Demonstration)	2
9	RFLP and RAPD mapping (Demonstration)	3
10	Southern blotting technique (Demonstration)	3
	TOTAL 30 hours	

SEMESTER IV

MAJOR –IV – 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 microbial genetics
2. To impart information on the structure and organization of Genetic material in microbes.
3. To make the student knowledgeable on concepts and mechanism of DNA replication process
4. To expose the students on the plasmids and their applications
5. To give an in-depth knowledge on Viral Genetics
6. To enhance student's interest on Mutation genetics and Gene transfer mechanism in microbes

Unit – I

Structure and organization of Microbial Genome- Bacterial Nucleoid and Ribosome, Bacterial Chromosome-Organization and function of bacterial genome (E.coli),DNA as Genetic material – (Griffith Experiment, Hershey Chase Experiment) Circular and linear DNA,Supercoiling- Enzymes involved- RNA as the genetic material, Replication of RNA - Reverse transcriptase.

Unit – II

Plasmids and application- Bacterial plasmids – structure and properties of plasmids -Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, Plasmid replication - Transposons and IS(Insertion Sequence) elements - structure, types and properties.

Unit – III:

Viral Genetics - Viral Genome Organisation - Virus Replication RNA Viruses: General strategies, replication of plus stranded RNA virus (polio), negative strand RNA viruses (Influenza). Retroviruses (HIV). DNA viruses- Replication of double stranded DNA viruses (Pox), ssDNA Virus (AAV). Bacteriophage (T_4) - Lytic cycle and lysogenic cycle, Phage Genome – Structure and Genetics.

Unit –IV :

Types of mutation and its application - Mutations – Spontaneous and Induced, Base pair changes, Frame shift, Deletion, Insertion, Tandem duplications, Transitions, Transversions - Genotyphic and phenotypic mutants - Reversion and suppression - Ames test

Unit –V :

Gene transfer Mechanisms- Conjugation (cell transmissible plasmids, F factor and Hfr strains) - Transformation (Natural transformation, competence, DNA uptake, role of natural transformation artificially induced competence and electroporation). Transduction (Generalized and specialized transduction) – Genetic Recombination -Requirements molecular basis and genetic analysis of recombination in bacteria)

Text books 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

Course Outcomes

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

CO 1 Acquire interest in research in the area of life science by teaching with essentials of microbial genetics

CO 2 Understand the structure and organization of Genetic material in microbes.

CO 3 Familiarise on the concepts and mechanism of DNA replication process

CO 4 Expertise on the concepts of plasmids and their applications

CO 5 Update the knowledge on Viral Genetics, Mutation and Gene transfer mechanism in microbes

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Structure and organization of Bacterial Nucleoid and Ribosome	2
	1.2 Bacterial Chromosome- Organization and function of bacterial genome (E.coli)	2
	1.3 DNA as Genetic material, Circular and linear DNA	2
	1.4 Supercoiling- Enzymes involved	1
	1.5 RNA as the genetic material, Replication of RNA - Reverse transcriptase	2
	Total Hours	**9 hrs**
II	2.1 Bacterial plasmids – structure and properties of plasmids	2
	2.2 Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid	3
	2.3 linear plasmids, - Plasmid replication	3
	2.4 Transposons and its elements - structure, types and properties	2
	Total hours	**10 hrs**
III	3.1 Viral Genome Organisation - Virus Replication	2
	3.2 RNA Viruses: General strategies, replication of plus stranded RNA virus (polio), negative strand RNA viruses (Influenza)	3
	3.3 Retroviruses (HIV)	3
	3.4 DNA viruses- Replication of double stranded DNA viruses (Pox), ssDNA Virus (AAV)	3
	3.5 Bacteriophage (T_4) - Lytic cycle and lysogenic cycle, Phage Genome – Structure and Genetics	4
	Total hours	**15 hrs**

IV	4.1 Mutations – Spontaneous and Induced, base pair changes, frame shift, deletion, insertion, tandem duplications, transitions transversions	5
	4.2 Genotyphic and phenotypic mutants	2
	4.3 Reversion and suppression	3
	4.4 Ames test	2
	Total hours	**12 hrs**
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	**14 hrs**
	Total hours for Units I to V	**60 hrs**

ALLIED –IV -GENETIC ENGINEERING

Course Objectives:

The course aims:

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

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. Characteristics of an ideal vector, cloning vectors ,choice of vectors for E. coli, fungi, higher plants and mammalian cells.

Unit – II

Restriction enzymes - Eco RI, Hind III, Sma, Hae III and BamHI - Types and sources - Recognition sequences and utilities, Adapter and Linker, cohesive and blunt ends - enzymes involved in genetic engineering.

Unit - III

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 –IV

Gene Transfer- Methods of gene transfer- Electroporation, transduction, and liposome mediated gene transfer. Direct transfer of DNA- Microinjection, particle bombardment. Screening of recombinants- Insertional inactivation and complementation, blue-white screening, immunodetection and radioactive probes.

Unit –V

Gene Mapping and Gene Amplification - Techniques of Restriction mapping - Construction of chimaeric DNA - cloning in bacteria - Molecular probes - Blotting techniques (southern, Western, Northern) Techniques – C DNA library, Gene amplification - Basic PCR and its modifications- Applications of PCR in biotechnology and genetic engineering - DNA finger printing, Micro array - protein engineering.

Text books recommended

1. Brown, T.A (1999) Gene cloning. (3rd Edition) chapman and Hall publication
2. Old RW and primrose, 1995 principles of Gene manipulation, 5th edition, Blackwell scientific publication FRG
3. T.A. Brown 1995, 3rd edition, An introduction to Gene cloning
4. Glick B.R and Pasternak JJ 1994 Molecular Biotechnology, Principles and Application of recombinant DNA, ASM press Washington

Web resources:

a. https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/
b. https://www.rpi.edu/dept/chem-eng/Biotech-environ/Projects00/rdna/rdna.html
c. http://www.whatisbiotechnology.org/index.php/science/summary/rdna
d. https://www2.le.ac.uk/projects/vgec/highereducation/topics/recombinanttechniques

ehttp://biology.kenyon.edu/courses/biol114/Chap08/Chapter_08a.html

Course Outcomes

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

CO 1 Create the desire of carrying out research in biotechnology
CO 2 Demonstrate various techniques and enzymes used in recombinant DNA construction.
CO 3 Work on Cloning vectors and Gene libraries
CO 4 Familiarise with Gene transfer techniques.
CO 5 Understand the processes involved in Gene mapping and Gene amplification

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 History and scope of genetic engineering - Definition - concepts - Principles and Application of rDNA technology	2
	1.2 Isolation & purification of DNA from cells	1
	1.3 DNA ligases, DNA modifying enzymes	1
	1.4 Eukaryotic and Prokaryotic hosts for cloning. Characteristics of an ideal vector	2
	1.5 Cloning vectors, choice of vectors for E. coli, fungi, higher plants and mammalian cells	2
	Total Hours	**8 hrs**
II	2.1 Restriction enzymes, Types and sources Eco RI, Hind III, Sma, Hae III and BamHI -	3
	2.2 Recognition sequences and utilities	2
	2.3 Enzymes involved in genetic engineering	2
	Total hours	**7 hrs**
III	3.1 Plasmid based vectors - Natural (pSC 101, pSF 2124, pMBI),	2
	3.2 Artificial - pBR 322 and pUC construction	2
	3.3 Phage based vectors - Lamda phage vectors and its derivatives	3
	3.4 Hybrid vectors - phagemid, phasmid and cosmid, BAC and YAC	2
	Total hours	**9 hrs**
IV	4.1 Gene Transfer- Methods of gene transfer- Electroporation, transduction, and liposome mediated gene transfer.	3
	4.2 Direct transfer of DNA- Microinjection, particle bombardment.	2
	4.3 Screening of recombinants- Insertional inactivation and complementation, blue-white screening.	3
	4.4 Immunodetection and radioactive probes.	3
	Total hours	**11 hrs**

V	5.1 Gene Mapping and GeneAmplificationTechniques of restriction mapping	2
	5.2 - Construction of chimaeric DNA - cloning in bacteria	2
	5.3 Molecular probes - Blotting techniques (southern, Western, Northern) Techniques – C DNA library,	2
	5.4 Gene amplification - Basic PCR and its modifications- Applications of PCR in biotechnology and genetic engineering.	2
	5.5 DNA finger printing, Micro array - protein engineering.	2
	Total hours	**10 hrs**
	Total hours for Units I to V	**45 hrs**

MAJOR PRACTICAL-IV
LAB IN MICROBIAL GENETICS

Course Objectives

The course aims

1. To learn the techniques of Isolating the Spontaneous mutants,
2. To Practise the concept of UV mutagenesis, Chemical Mutagenesis.
3. To impart knowledge on the process of Conjugation, Transformation and Transduction 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.

Experiments

1. Isolation of spontaneous mutants
2. UV-mutagenesis - survival studies
3. Chemical mutagenesis - NTG
4. Conjugation in bacteria (Interrupted & Uninterrupted) – (Demonstration)
5. Transformation in *E.coli (*Demonstration*)*
6. Transduction of *E.coli* (Demonstration)
7. Isolation of Plasmid DNA by Agarose gel electrophoresis.
8. Quantification of DNA by Diphenylamine method
9. Demonstration of antibiotic resistant mutant
10. Quantification of Protein by Bradford method.

Text Books 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

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

CO 1 Master the techniques of Isolating the Spontaneous mutants,

CO 2 Learn and Practise the concept of UV mutagenesis, Chemical Mutagenesis.

CO 3 Understand the process of Conjugation, Transformation and Transduction in E.coli

CO 4 Master the techniques of Isolation of Plasmid DNA by Agarose gel Electrophoresis.

CO 5 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.

Lecture Schedule

Practical	Topics covered	Hours
1	Isolation of spontaneous mutants	3
2	UV-mutagenesis - survival studies	4
3	Chemical mutagenesis – NTG	4
4	Conjugation in bacteria (Interrupted & Uninterrupted) – (Demonstration)	3
5	Transformation in *E.coli*(Demonstration)	3
6	Transduction of *E.coli* (Demonstration)	3
7	Isolation of Plasmid DNA by Agarose gel electrophoresis.	3
8	Quantification of DNA by Diphenylamine method	3
9	Demonstration of antibiotic resistant mutant	2
10	Quantification of Protein by Bradford method.	2
	TOTAL 30 hours	

ALLIED PRACTICAL – IV
LAB IN GENETIC ENGINEERING

Course Objectives:
The course aims

1. To expose students to exhibit passion over teaching, research and jobs in Biotech industries.
2. To improve their experimental skills, reliability and effectiveness needed for effective research and employment.
3. To impart the skill in isolating and separating DNA from Bacteria.
4. To quantify RNA and Protein.
5. To demonstrate Blotting techniques and PCR amplification

Experiments

1. Isolation of Chromosomal DNA from Bacteria.
2. Separation of protein by SDS- PAGE.
3. Quantification of Protein by Lowry's Method.
4. Isolation of RNA from bacteria.
5. Quantification of RNA.
6. Western blotting technique (Demonstration)
7. Northern blotting technique (Demonstration)
8. Polymerase chain reaction (Demonstration)

Text Books 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.

Course Outcomes
By completing the course the students will be able to

CO 1 Carryout research and jobs in Biotech industries.
CO 2 Improve their experimental skills needed for effective research and employment.
CO 3 Develop the skill in isolating and separating DNA from Bacteria.
CO 4 Quantify RNA and Protein.
CO 5 Demonstrate Blotting techniques and PCR amplification

Lecture Schedule

Practical	Topics covered	Hours
1	Isolation of Chromosomal DNA from Bacteria.	5
2	Separation of protein by SDS- PAGE.	4
3	Quantification of Protein by Lowry's Method.	4
4	Isolation of RNA from bacteria.	4
5	Quantification of RNA.	4
6	Western blotting technique (Demonstration)	3
7	Northern blotting technique (Demonstration)	3
8	Polymerase chain reaction (Demonstration)	3
	TOTAL 30 hours	

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 nano satructures and Applications in Biology.
3. To learn the basics of Nano microbiology.
4. To gain a indepth knowledge on Extraction and applications od Nano technology.

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.

Text books 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

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

Course Outcomes

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

CO 1 Understand the methods and application of modern Nanobiomolecules and their contribution in the various fields of biotechnology and healthcare.
CO 2 Explain the Protein based nano satructures and its Applications in Biology.
CO 3 Elaborate the basic concepts in the field of Nano microbiology.
CO 4 Be the expert in the field of Extraction and applications of Nanomaterials from different sources.
CO 5. Understand and update the applications of Nanotechnology.

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 nanosystem. 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 (buckyballs, nanotubes, graphene)	4
	2.3 Metal based nano materials (nanogold, nanosilver and metal oxides)	4
	2.4 Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics.	2
	Total hours	**13 hrs**

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 Characterisation 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	**15 hrs**
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 Nanomechanics and Nanocomputing, DNA Nanotubes	3
	4.4 Applications in Biology, Quantum dots for cell labeling and study of Apotopsis,	4
	4.5 Nanopore sequencing, Nano motors from DNA	2
	Total hours	**12 hrs**
V	5.1 Nano biotechnology -Application of Nanoparticles - Introduction to bio sensors and tissue engineering	3
	5.2 - Targetted 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
	5.5 Bio nanotechnology in medical diagnostics and Therapeutics.	2
	Total hours	**11 hrs**
	Total hours for Units I to V	**60 hrs**

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

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 *Agaricus campestris*, *Agaricus bisporus*, and *Volvariella volvaciae*, Preparation of compost, filling tray beds, spawning, maintain optimal temperature, casing, watering, harvesting, storage.

Unit – IV:

History of Patening - 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.

Text books 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.R Aneja, 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/

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

CO 1 Be an expert in the basic concepts of Entrepreneur development
CO 2 Understand the contributions of Government and financial institutions in entrepreneurial development.
CO 3 Create interst in the production of fermented food and beverages.
CO 4 Undertakemushroom cultivation as a start-up option.
CO 5 Understand the concepts of IPR and Patent process

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	**11 hrs**
III	3.1 Mushroom cultivation – edible and poisonous mushroom	4
	3.2 Cultivation of *Agaricus campestris*, *Agaricus bisporus*, and *Volvariella volvaciae*,	4
	3.3 Steps Involved - Preparation of compost, filling tray beds, spawning, maintain optimal temperature, casing, watering, harvesting, storage	4
	Total hours	**12 hrs**
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	**13 hrs**
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	**14 hrs**
	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 pathogenecity.

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 .

Text Books 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://clinlab.ucsf.edu/

Course Outcomes

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

CO 1 Understand diverse microbial pathogens and its effect and managerial strategies.

CO 2 Be an expert in understanding the common bacterial pathogens and their pathogenecity.

CO 3 Be an expert in knowing the fungal, viral and protozoan pathogens

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	**6 hrs**
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	**6 hrs**
IV	4.1 Viral pathogen - Pox virus	1
	4.2 Viral pathogen Mumps virus	1
	4.3 Viral pathogen Rabies	2
	4.4 Viral pathogen HIV	2
	Total hours	**6 hrs**

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	**6 hrs**
	Total hours for Units I to V	**30 hrs**

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 indepth knowledge in microbial Fermentation Process
3. To impart an interest to produce various fermented products and Vaccines.

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 .

Text books Recommended

1. Gupta P.K. (1996). Elements of Biotechnology. Rastogi and Co., Meerut. India
2. Mukhesh Pasupuleti (2006). Molecular Biotechnology. MJP Publishers. Chennai.
3. Dubey. R-C (1996). A Text Book 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

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Course Outcomes

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

CO 1 Update the history, components, techniques and applications of biotechnology in microbial Fermentation Process.

CO 2 Produce various fermented products and Vaccines.

CO 3 Understand the role of microbes in Agriculture and Environment.

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	**6 hrs**
III	3.1 Industrial production of enzymes (Amylase)	2
	3.2 Beverages - wine, beer	2
	3.3 Antibiotics (Penicillin)	2
	Total hours	**6 hrs**
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	**1 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	**6 hrs**
	Total hours for Units I to V	**30 hrs**

SEMESTER V

CORE MAJOR V-AGRICULTURE MICROBIOLOGY

Course Objectives

The course aims

1. To impart in-depth information on soil microbes and agriculture
2. To make the students understand the role of Microbial Interactions on plants
3. To give an overview on Biological Nitrogen fixation
4. To make the students to know about various techniques involved in biofertilizers and Biopesticide production
5. To introduce the cause of plant pathogenic disesases.

Unit –I

Soil Microbiology -Historical development of soil microbiology, Physical , Chemical and Biological Properties of Soil, Soil Horizon- various types of soil microbes and their importance. Organic matter – sources and decomposition. Soil enzymes and soil sickness .Factors influencing the soil microbial population. Biogeochemical cycle - Carbon, Nitrogen, Phosphorous and Sulphur.

Unit – II

Methods in Ecology, Microbial interactions - Commensalism, Synergism, Mutualism, Amensalism, Competition, Parasitism and Predation. Interaction of microbes with plants: Rhizosphere, Phyllosphere, Mycorrhizae.Rumen flora.Insect symbiosis.

Unit –III–

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 m Cyanobacteria, Heterocyst.Frankia.

Unit- IV

Biofertilizers and Biopesticides - Classification, Mass cultivation, Preparation and field application - Rhizobium, Azotobacter, Azospirillum, Phosphate solubilizers, Potash mobilizers (Frateuria aurentia), VAM, Azolla. Liquid biofertilizer.Biopesticides: classification, mode of action - Bacterial insecticides (Bacillus thuringiensis) and Viral insecticides (NPV) and Trichoderma viride.PGPR.

Unit- V

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- Concepts of constitutive defence mechanisms in plants, White rust of crucifers *(Albugo candida)* - Late blight of potato *(Phytophthora infestans)* Ergot of rye *(Claviceps purpurea)* Black stem rust of wheat – *Puccinia graminis tritici,* Citrus Canker (*Xanthomonas citri).*

Text book Recommended

1. SubbaRao NS (2004). Soil Microbiology. Fourth edition, Oxford and BH Publishing Co.Pvt. Ltd., 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.

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:

CO 1. Understand the properties of soil, Soil Microorganisms.

CO 2. Study the different types of Microbial Interactions.

CO 3. Learn Various types of Biofertilizers and their preparation.

CO 4. Discuss the mechanism of Biological Nitrogen Fixation.

CO 5.Understand the Plant diseases and the causative agents.

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Historical development of soil microbiology, Physical , Chemical and Biological Properties of Soil	2
	1.2 Soil Horizon- various types of soil microbes and their importance.	1
	1.3 Organic matter – sources and decomposition. Soil enzymes and soil sickness.	2
	1.4 Factors influencing the soil microbial population.	1
	1.5 Biogeochemical cycle - Carbon, Nitrogen, Phosphorous and Sulphur	4
	Total Hours	**10 hrs**
II	2.1 Methods in Ecology	2
	2.2 Microbial interactions - Commensalism, Synergism, Mutualism	3
	2.3 Amensalism, Competition, Parasitism and Predation.	2
	2.4 Interaction of microbes with plants: Rhizosphere, Phyllosphere, Mycorrhizae.	3
	2.5 Rumen flora.	2
	2.6 Microbe Insect symbiosis	2
	Total hours	**14 hrs**
III	3.1 Biological nitrogen fixation - Introduction	1
	3.2 Nitrogen fixers - types - Rhizobium, Symbiotic and non symbiotic nitrogen fixation.	5
	3.3 Root nodule formation. Structure of nodule & biochemistry of Nitrogen fixation, Nitrogenase	4
	3.4 Nitrogen fixation in Cyanobacteria, Heterocyst.Frankia	3
	Total hours	**13 hrs**

IV	4.1 Biofertilizers - classification,	2
	4.2 Mass cultivation and field application - Rhizobium, Azotobacter, Azospirillum, Phosphate solubilizers, potash mobilizers (Frateuria aurentia)	4
	4.3 VAM and Azolla.	16
	4.4 Liquid biofertilizer	2
	4.5 Biopesticides: classification, mode of action - Bacterial insecticides (Bacillus thuringiensis)	4
	4.6 Viral insecticides (NPV) , Fungal Insecticides Trichoderma viride.	2
	4.7 Plant Growth Promoting Rhizobacteria (PGPR)	2
	Total hours	**10 hrs**
V	5.1 Concept of plant disease - definitions of disease cycle and pathogenicity	3
	5.2 Symptoms associated with microbial plant diseases.	3
	5.3Stages in development of a disease - infection - invasion, colonization	
	5.4 Concepts of constitutive defence mechanisms in plants	3
	5.5 White rust of crucifers *(Albugo candida)* - Late blight of potato *(Phytophthora infestans)* Ergot of rye *(Claviceps purpurea)* Black stem rust of wheat – *Puccinia graminis tritici*	4
	5.6 Citrus Canker (*Xanthomonas citri)*	
	Total hours	**13 hrs**
	Total hours for Units I to V	**60 hrs**

SEMESTER V

CORE- MAJOR VI – 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

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, homogenisers, 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) , Acohol (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.

Text books 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:

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

Course Outcomes

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

CO 1. Explain the types of fermentation process

CO 2. Understand the design , Types and operation of fermenters in various industries.

CO 3. Formulate the media for fermentation process

CO 4 Perform the methods of Production, harvesting and product recovery in industrial fermentations

CO 5 Work out the Production of various commercial fermented products.

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
	2.2 Solid 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	**13 hrs**
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 inoculums for yeast, bacteria, mycelia and fungal processes.	4
	3.4 Sterilization methods	2
	Total hours	**12 hrs**

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

MAJOR ELECTIVE I: A1 –VIROLOGY

Course Objectives:

The course aims :

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

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. Classificaion 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.

Text books Recommended

1. Alan J.Cann. (1997). Principels of Molecular virology.(2nd edition).Academic press, California.
2. Ann Giudici Fettner.(1990).The Science of Viruses.Quill, William Marrow, New York.
3. Dimmock N.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 edi
9. tion Vol.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

Course Outcomes:

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

CO1: Describe the nature, properties and structure of viruses and will also gain knowledge of taxonomy of different groups of viruses.

CO2: Familiarise with diversity and multiplication of lytic and lysogenic bacteriophages.

CO3: Describe different ways of viral transmission, and prominent and unusual genomic features of different viruses with their significance.

CO4: Understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses.

CO 5: Acquire knowledge about strategies to prevent viral infections: interferons, vaccines and antiviral compounds

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	**11 hrs**
IV	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
	Total hours	**13 hrs**
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	**15 hrs**
	Total hours for Units I to V	**60hrs**

MAJOR ELECTIVE I - A2 -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.

UNIT I

Introduction- Ecology of microorganisms and Pharmaceutical products – air, water, raw materials, packaging, buildings, equipments, 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 – Dextrans, Vitamins, Human Insulin.

Text books Recommended

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, Ratanlal Ihhpunjani, 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

Course Outcomes

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

CO 1 Acquire knowledge on basic concepts of Pharmaceutical product quality and its spoilage.

CO 2 Demonstrate the Mechanism of action of antimicrobial agents .

CO 3 Explain the Sterilisation process in Pharmaceutical industry.

CO 4 Demonstrate the Sterility testing of Pharmaceutical products.

CO 5 Familiarise the process of production of Vaccines.

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, equipments, 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	**12 hrs**
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	**14 hrs**

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
	5.4 Preparation of Antisera and their standardization. in – vivo diagnostics, immune sera and human immunoglobulins with quality control.	3
	5.5 Production of pharmaceuticals by microbes – Dextrans, Vitamins, Human Insulin.	3
	Total hours	**14 hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR ELECTIVE II - B1: 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.

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 insilico method .

Text books Reccomended

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/

CourseOutcomes

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

CO1: Evaluate RelatioanalData Bases
CO2: Apply the toolsused in Biological databases
CO3: Demonstrate the use of Sequence Alignment Techniques
CO4: Acquire knowledge on Diversity of Genomes.
CO5: Familiar with the different methods of Protein Structure Modelling

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	**12 hrs**
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	**14 hrs**
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
	Total hours	**11 hrs**
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 insilico method	3
	Total hours	**14 hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR ELECTIVE –II - B2- ADVANCED BIOTECHNOLOGY.

Course Objectives

The course aims

1. To introduce the basic concepts of Genetic Anlaysis and Gene Sequencing
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.

Unit I

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 II

Plant tissue culture – Concept of totipotency – Principle - Sterilization techniques – Media preparation – Types of media – MS media, Plant growth regulators.

Callus culture – Suspension culture - Organogenesis. Plant micro propagation, Single cell culture, Virus elimination and Shoot tip cultures. Horticulture – Haploid plant production – Virus free plants Embryo culture - Isolation, culture and fusion of plant protoplasts. Somaclonal variation, Somatic embryogenesis.Cryopreservation and germ plasm conservation.

Unit III

Plant genome organization, Gene silencing in crop plants, Production of therapeutic antibodies and vaccines in plants – Agrobacterium tumefaciens and Rhizogenes transformation – Secondary metabolites – Types and uses - Invitro productions. Genetic engineering of crop plant for insect resistance (Bt –cotton), fungus resistance, virus resistance, drought, cold and saline resistance. Improvements of crop yield, quality and nutritions - Transgenic plants - Ti plasmid - virus, herbicide resistant plants:

Unit –IV

Genetic engineering in animals-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.

Unit V

Mapping of Human genome, Role of RFLP, DNA fingerprinting and PCR in forensic science, Targeted Genome Editing: ZFNs, TALENs, CRISPRs -- Gene Targeting: Knock-ins & Knock-outs -- DNA Finger Printing gene therapy types and their applications.

Text books Recommended

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

Course Outcomes

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

CO 1 Work on basic concepts of Genetic Anlaysis and Gene Sequencing
CO 2 Gain expertise on Plant tissue culture techniques
CO 3 Improve their knowledge on Plant Biotechnology.
CO 4 Carry out research on Transgenic animals
CO 5 Explain Gene mapping.

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Genome – overview of genome, sequence of genome acquisition and analysis – homologies – SNPs – Genetic analysis	3
	1.2 Linkage mapping, High Resolution Chromosome mapping and analysis	2
	1.3 Physical mapping, YAC, Hybrid mapping, strategies	2
	1.4 Sequence Specific Tags (SST), Sequence Tagged Sites (STS), ISH, FISH, RFLP, RAPD.	2
	1.5 DNA sequencing – methods, Maxam and Gilbert method, ladder, Fluorescent, Shot gun methods	3
	Total Hours	**12hrs**
II	2.1 Plant tissue culture – Concept of totipotency – Principle	2
	2.2 Sterilization techniques – Media preparation – Types of media – MS media, Plant growth regulators.	2
	2.3 Callus culture – Suspension culture - Organogenesis. Plant micro propagation, Single cell culture, Virus elimination and Shoot tip cultures.	2
	2.4 Horticulture – Haploid plant production – Virus free plants Embryo culture	2
	2.5 Isolation, culture and fusion of plant protoplasts. Somaclonal variation	2
	2.6 Somatic embryogenesis	2
	2.7 Cryopreservation and germplasm conservation.	2
	Total hours	**14 hrs**
III	3.1 Plant genome organization, Gene silencing in crop plants, Production of therapeutic antibodies and vaccines in plants	2
	3.2 Agrobacterium tumefaciens and Rhizogenes transformation	2
	3.3 Secondary metabolites – Types and uses - Invitro productions.	2
	3.4 Genetic engineering of crop plant for insect resistance (Bt – cotton), fungus resistance, virus resistance, drought, cold and saline resistance. Improvements of crop yield, quality and nutritions -	2
	3.5 Transgenic plants - Ti plasmid - virus, herbicide resistant plants	2
	Total hours	**10 hrs**

IV	4.1 Genetic engineering in animals-transformation of animal cells, cloning vectors and expression vectors and animal viral vectors.	3
	4.2 Transgenic animals improving important genes, production of recombinant proteins, immunotoxins, vaccines, hybridoma technology,	4
	4.3 Molecular and cellular biology of fertilization	4
	4.4 Hybridoma technology and monoclonal antibodies	2
	Total hours	**13hrs**
V	5.1 Mapping of human genome	2
	5.2 Role of RFLP, DNA fingerprinting and PCR in forensic science	2
	5.3 Targeted Genome Editing: ZFNs, TALENs	2
	5.4 CRISPRs - Gene Targeting: Knock-ins & Knock-outs -- DNA Finger Printing	3
	5.5 Gene therapy types and their applications	2
	Total hours	**11 hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR PRACTICALS – V
LAB IN AGRICULTURE MICROBIOLOGY

Course Objectives

The Course aims:

1. To make the students familiar with the isolation of microbes from soil
2. ToPractise 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.

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 fro Root nodules
7. Isolation of Azotobacter
8. Microscopic examination of VAM
9. Isolation of Phosphobacteria from soil
10. Estimation of soil pH
11. Estimation of soil Nitrate
12. Estimation of soil Sulphate
13. Estimation of soil Phosphorus
14. Visit to a biofertilizer production unit and write a report based on the visit.

Text books 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.

Course Outcomes

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

CO 1Familiar with the isolation of microbes from soil

CO 2 Expertise in isolation of nitrogen fixers from soil and other sources.

CO 3Understand the VAM infection in plant roots by microscopic techniques.

CO 4 Find out the presence of different types of nutrients in soil

CO 5 Study the production of biofertilizers through Industrial visit.

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	2
4	Testing antagonistic activity of soil microbes	3
5	Isolation of microbes from rhizosphere.	2
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	Estimation of soil Ph	1
11	Estimation of soil Nitrate	1
12	Estimation of soil Sulphate	1
13	Estimation of soil Phosphorus	1
14	Visit to a biofertilizer production unit and write a report based on the visit	6
	TOTAL 30 hours	

MAJOR PRACTICALS VI – LAB IN INDUSTRIAL MICROBIOLOGY AND BIOPROCESS TECHNOLOGY

Course Objectives

The course aims :

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 lyophilisation process for preserving the cultures.

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)

Text books Reccomended

- 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.

Course Outcomes

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

CO 1 .Demonstrate fermentation from yeast
CO 2. Demonstrate Protoplast fusion technique.
CO 3. Expertise in isolating, cultivating and preserving industrially important microorganisms
CO 4. Produce antibiotics, Vitamins and Glutamic acid using microbes.
CO 5. Demonstrate the lyophilisation process for preserving the cultures

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	

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. .

Unit –I

Food as a substrate for micro organisms, - 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 Coffe, 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

Text books 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

Course Outcomes

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

CO 1. Explain how food acts as a substrate for microbes and Food safety standards.

CO 2. Demonstrate various methods of Food preservation strategies.

CO 3 Elaborate the mechanism of different food spoilages

CO 4. Aware of food borne microorganisms and the disease caused by them

CO 5. Familiarise with the methods of preparing different dairy products.

Lecture Schedule

Unit	Topics covered	Hours
I	1.1 Food as a substrate for micro organisms, - 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	2.1 Preservation of food - General Principles of food Preservation 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	**11 hrs**
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	**12 hrs**
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	**13 hrs**

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

MAJOR IX -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 pathogenecity 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

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 - Non specific 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 Symtoms - Epidemiology, Pathogenesis, laboratory diagnosis, Prevention and treatment of the following viral infections - Respiratory infections (Common cold, infiuenza, 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 .Vaccine Types, Preparation-Immunization schedule.

Text books 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://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
7. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php

Course Outcomes

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

CO 1 Demonstrate the basic concepts of Normal Flora of Human body and sources of infections

CO 2 Elaborate the clinical pathogenecity of bacterial infections and their lab diagnosis and treatment

CO 3 Demonstrate the pathogenecity of viral pathogens, epidemiology and virulence factors associated with the pathogen.

CO 4 Familiarise with the different fungal and Protozoan diseases

CO 5 Expertise ondiagnostic procedures in Microbiology laboratory

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
	1.5 Virulence 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	**13 hrs**
III	3.1 Clinical Symtoms - Epidemiology, Pathogenesis, laboratory diagnosis, Prevention and treatment of the following viral infections - Respiratory infections (Common cold, infiuenza, Measles, Mumps and Rubella)	6
	3.2 Immunodeficiency disease (AIDS, Cytomegalovirus) and Herpes simplex virus	6
	Total hours	**12 hrs**
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	**9 hrs**
V	5.1 Diagnostic Microbiology - General safety measures used in Microbiology laboratory	1
	5.2 Sterilization 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	**16 hrs**
	Total hours for Units I to V	**60 hrs**

CORE MAJOR X - ENVIRONMENTAL MICROBIOLOGY

Course Objectives

The course aims

1. To understand the basic concepts of microbial ecology in natural environments.
2. To enhance the knowledge on Aero and Aquatic microbiology
3. To critically analyse the role of microbes in treatment of wastes/sewage
4. To impart information on microbial bioremediation
5. To study the concepts of bio safety and environmental monitoring

Unit- I

Concepts in Microbial Ecology: Relationship between microorganism and different environments land, water and air. Aeromicrobiology -Microbiology of air - Enumeration of bacteria from air - Air sampling devices - Air sanitation -Assessment of air quality, Air borne diseases.

Unit- II

Types of Aquatic ecosystems: Fresh water – Ponds, Lakes, Streams. Marine habitats – Estuaries, Mangroves, Deepsea. Zonations – Upwelling – Eutrophication – Food chain. Potability of water – Microbial assessment of water quality, Biological Indicators- Brief account of water – borne diseases. Water Purification –Steps involved.

Unit- III

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. Treatment methods – Primary –Secondary (Anaerobic – Methanogenesis; Aerobic- Trickling filters, Activated sludge – Oxidation pond –Ttertiary treatment. Utilization of liquid wastes – Food (SCP, Yeast) – Fuel (methane), Fertilizers (Cyanobacteria).

Unit IV

Biodeterioration: Deterioration of Paper, Leather, Wood, Textiles, Metal corrosion, Mode of deterioration, Organisms involved, its disadvantages and Mode of prevention. Bioremediation of contaminated soils and marine oil pollutants. Degradation of pesticides (DDT and Propanil).

Unit- V

Bio-transformation,**Bio-accumulation and Bio-magnification**: Principles, receptor sites absorption and storage of xenobiotics, types of bio- transformations. Influence of ecological 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.

Text books Recomended

1. Environmental Toxicology set of 3 volumes- Peter Gomes
2. Aquatic Environment and Toxicology-Pawan Kumar Bhart
3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian
4. Atlas R.M and Bartha M (2003) Microbial ecology - Fundamentals and applications
5. Waste Water Microbiology by D.H. Bergey. 2nd Edition. Medtech, India. 2019.
6. Prescott's Microbiology by J. M. Willey, L. Sherwood, and C. Woolverton. 10th edition. McGraw Hill Higher Education, USA. 2017.
7. Brock Biology of Microorganisms by M.T. Madigan and J.M. Martinko. 15th edition. Prentice Hall International Inc., USA. 2017.
8. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA. 2011.
9. 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

Course Outcomes

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

CO 1: Discuss on the microbes in different natural environments and Aeromicrobiology.

CO2:Analyse the importance of microbial analysis of drinking water and Aquatic microbiology.

CO3:Explain the different aspects of Solid waste management and sewage treatment Systems.

CO4:Elaborate on bioremediation and Biodegradation of Pesticides.

CO5:Evaluate the bioaccumulation of Xenobiotics and Environmental Monitoring Regulations.

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 Microorganism inhabiting extreme environments.	2
	1.3 Microbiology of air - Enumeration of bacteria from air - Air sampling devices	2
	1.4 Air sanitation -Assessment of air quality	2
	1.5 Air borne diseases.	2
	Total Hours	**10 hrs**
II	2.1 Types of Aquatic ecosystems: Fresh water – Ponds, Lakes, Streams.	2
	2.2 Marine habitats – Estuaries, Mangroves, Deepsea.	2
	2.3 Zonations – Upwelling – Eutrophication – Food chain.	2
	2.4 Potability of water – microbial assessment of water quality	1
	2.5 Biological Indicators	1
	2.6 Brief account of Water – Borne diseases.	2
	2.7 Water Purification	2
	Total hours	**12hrs**
III	3.1 Types of wastes – characterization of solid and liquid wastes.	1
	3.2 Solid waste treatment – saccharification – gasification – composting	2
	3.3 Utilization of solid wastes – food (SCP, mushroom, yeast); fuel (ethanol, methane, hydrogen); fertilizers (composting).	3
	3.4 Liquid waste treatment. Treatment methods – primary –secondary (anaerobic – methanogenesis; aerobic- tricking activated sludge – oxidation pond – tertiary treatment.	4
	3.5 Utilization of liquid wastes – food (SCP, Yeast) – fuel (methane), fertilizers (Cyanobacteria).	3
	Total hours	**13 hrs**

IV	4.1 Biodeterioration: Deterioration of paper, leather, wood, textiles, metal corrosion mode of deterioration, organisms involved, its disadvantages and mode of prevention	4
	4.2. Bioremediation of conta 4.3. minated soils and marine oil pollutants.	4
	4.3 Degradation of pesticides (DDT and Propanil).	3
	Total hours	**11 hrs**
V	5.1 Bio-transformation, bio-accumulation and bio-magnification: Principles, receptor sites, absorption and storage of xenobiotics	3
	5.2 Types of bio- transformations.	2
	5.3 Influence of ecological factors on the effects of toxicity,global. Toxicity testing	2
	5.4 Bioassay – Definition, purpose and Importance of Bioassay estimation of LC50.	3
	5.5 Biosensor, Definition- Components, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors	2
	5.6 Applications of biosensors in environmental monitoring	2
	Total hours	**14 hrs**
	Total hours for Units I to V	**60 hrs**

MAJOR ELECTIVE III-A – BIOSTATISTICS

Course Objectives

The Course aims :

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 tendancy
4. To provide basic knowledge in analyzing data by Standard deviation.
5. To carryout Correlation and Regression analysis on biological data.

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).

Text books Recommended

1. Statistical Methods by S.P. Gupta – Sultan Chand & Sons
2. An introduction to Biostatistics by Sundar Rao and Richard J, PHI publications
3. Fundamentals of Biostatistics by Veer Bala Rastogi
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.

Course Outcomes

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

CO 1 Demonstrate basic concepts of Biostatistics and kinds and functions of Biological data.
CO 2 Carryout the methods of collecting data, sampling, Tabulating and graphical representations of data.
CO 3 Evaluate statistical analysis of data by using measures of central tendancy
CO 4 Analyze data by Standard deviation.
CO 5 Perform Correlation and Regression analysis on biological data.

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	**11 hrs**
III	3.1 Measures of central tendency –Basic Introduction	2
	3.2 Mean, Median, Mode	5
	3.3 Geometric Mean	5
	Total hours	**12 hrs**

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

MAJOR ELECTIVE III - B - CLINICAL RESEARCH AND DRUG DISCOVERY

Course Objectives
The Course Aims:

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

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 to Pharmacoeconomics.

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.

Text books Recomended

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.

Course Outcomes

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

CO 1 Explain the basic concepts of Pharmacology and Clinical Research.
CO 2 Evaluate the steps involved in new drug discovery and Ethics in Clinical trials.
CO 3 Demonstrate the different phases of Clinical trials and Safety Monitoring.
CO 4 Expertise in Preclinical toxicology and methods in toxicology studies.
CO 5 Manage data in clinical trials

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	**11 hrs**
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	**12 hrs**

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

MAJOR PRACTICALS VIII
LAB IN FOOD AND DAIRYMICROBIOLOGY

Course Objectives
The Course aims:

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.

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

Text Books 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

Course Outcomes

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

CO 1: Find out the quality of Milk and curd samples.

CO 2: Isolate and identify the microbial contamination in different types of foods

CO 3: Demonstrate the production of Wine and Bread.

CO 4: Expertise in food processing or milk processing techniques by visiting a industry

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	

PRACTICAL IX- LAB IN MEDICAL AND DIAGNOSTIC MICROBIOLOGY

Course Objectives
The Course aims:

1.To understand the microorganisms in different clinical specimen
2. To learn the Antimicrobial Succeptibility of different antibiotics.
3. To practice the identification of fungal and protozoan parasites by staining techniques
4. To conduct serological test for typhoid and HIV
5. To visually understand the set up of a Clinical laboratory by visiting

Experiments.

1. Isolation of normal flora from mouth
2. Isolation of bacteria from pus
3. Isolation of bacteria from urine
4. Isolation of normal bacteria from blood
5. Antibiotic susceptibility testing by Disc diffusion method
6. Fungi - slide culture techniques
7. Parasite - Iodine wet mount
8. Giemsa staining
9. Leishman staining
10. Widal test - Slide and tube test
11. ELISA technique – Demonstration
12. Visit to a Clinical lab and write a report based on the visit conducted

Text Books 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

Course Outcomes

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

CO 1: Isolate and study the microorganisms from clinical specimen

CO 2: Demonstrate the Antimicrobial Succeptibility testing

CO 3: Identify the fungi and protozoan parasites by staining techniques

CO 4: Perform serological test for typhoid and HIV

CO 5: Learn the aseptic conditions and laboratory protocols in a Clinical laboratory through the visit conducted.

Lecture Schedule

Practical	Topics covered	Hours
1	Isolation of normal flora from mouth	3
2	Isolation of bacteria from pus	3
3	Isolation of bacteria from urine	3
4	Isolation of normal bacteria from blood	3
5	Antibiotic susceptibility testing by Disc diffusion method	3
6	Fungi - slide culture techniques	2
7	Parasite - iodine wet mount	2
8	Giemsa staining	2
9	Leishman staining	2
10	Widal test - Slide and tube test	1
11	ELISA technique – Demonstration	1
12	Visit to a Clinical lab and write a report based on the visit conducted	5
	TOTAL 30 hours	

MAJOR PRACTICALS X
LAB IN ENVIRONMENTAL MICROBIOLOGY

Course Objectives
The course aims

1. To understand the methods of assessing the BOD and COD in water samples
2. To study microbial degradation of Cellulose.
3. To test the microbial quality of watersamples.
4. To impart skills for the testing of microbes in air.

Experiments

1. Determination of BOD
2. Determination of COD
3. Microbial degradation of cellulose
4. Most probable number test (MPN)
5. Membrane filter technique for the quality analysis of water
6. Microbial examination of water quality by Standard Plate Count Method
7. Microbial Examination of Marine water by Standard Plate count method
8. Isolation of Microbes from Air.
9. Visit to a water testing or any lab with importance to Environmental microbiology and write a report.

Text Books Recommended

1. Atlas RM and Bartha R. Microbial Ecology Fundamentals and Applications, 3rd Ed., Benjamin and Cummings .Pub.Co.NewYork.1993.
2. RajanS. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.2012.
3. Rajan.S and Selvi Christy R. Experimental Procedures in Life Sciences. Anajanaa Book House, Chennai Monica Cheesbrough. District Laboratory Practice in Tropical Countries - Part I and II, 2nd edition, Cambridge University Press, NewDelhi.2011.
4. Betty A Forbes, Daniel F Sahmand Alice S Weissfeld. Bailey and Scott's Diagnostic Microbiology, MosbyElsevier.12thEdition.2007.
5. JamesGCappuccinoandNatalieSherman.Microbiology-ALaboratoryManual(4thedition).TheBenjaminpublishingcompany,NewYork.1996

Course Outcomes

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

CO 1: Conduct experiments on microbial quality of water

CO 2: Evaluate air quality & microbial analysis

CO 3: Demonstrate microbiological assessment of marine and potable water samples

Lecture Schedule

Practical	Topics covered	Hours
1	Determination of BOD	3
2	Determination of COD	3
3	Microbial degradation of cellulose	4
4	Most probable number test (MPN)	3
5	Membrane filter technique for the quality analysis of water	3
6	Microbial examination of water quality by Standard Plate Count Method	3
7	Microbial Examination of Marine water by Standard Plate count method	3
8	Isolation of Microbes from Air.	3
9	Visit to a water testing or any lab with importance to Environmental microbiology and write a report.	5
	TOTAL 30 hours	

Students 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.