ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO SCIENCES

(RSBSC)

DEPARTMENT OF MICROBIOLOGY

Learning Outcomes-based Curriculum Framework (LOCF) for

Undergraduate Programme in B.Sc Microbiology

COURSE STRUCTURE

&

SYLLABUS

W.E.F. AY 2022-23

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1. Preamble

Microbiology is the study of microorganisms or microbes such bacteria, viruses, fungi, algae, cyanobacteria, protozoa and prions. They are extremely important as their diverse activities range from causation of deadly diseases in humans, animals and plants to production of highly useful products like antibiotics, enzymes, alcohol, fermented foods, and recycling of dead and decaying organic matter in the nature. Thus the science of microbiology has an important role to play in health, agriculture, environment and industry. Several discoveries in the last two to three decades, which significantly impact this area, have put Microbiology on the centre stage of teaching, research and development all over the globe. The Choice Based Credit System (CBCS) curriculum for Microbiology at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the B.Sc. (Hons) program in Microbiology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. The curriculum was then developed in tune with the learning outcomes. It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Microbiology. Besides the contents of the curriculum, the teaching learning processes have also been designed to achieve these attributes. A variety of learning assessment tasks has been included in the curriculum. Besides assessing the knowledge/skills acquired by the students, these tasks would also help to supplement the teaching learning processes. There are core courses (CC) which encompass all important aspects of the discipline of Microbiology and are all compulsory courses. The choice based Discipline Specific Elective (DSE) courses are designed to enhance the expanse of the subject. DSE also give the students a chance to apply their knowledge of microbiology to study societal problems and suggest solutions in the form of small project under the mentorship of their teachers. These are also designed to expose the students to leaders / innovators in the areas related to microbiology for inspiration. The Generic Elective Courses (GEC) is designed to impart comprehensive understanding of Microbiology to students from other disciplines. The Microbiology students will have the choice to select courses from other disciplines depending on their interest and passion besides Microbiology. A number of Skill based Elective Courses (SEC), would give the students option to develop skills in areas which have direct relevance to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment-related job opportunities in Microbiology. The focus of the Ability Enhancement Compulsory Courses (AECC) which are 1 Credits each, is to develop communication skills and awareness about our environment. To comply with the education policy of Govt. of India namely access, equity and quality we have included Online Courses (OLC) which are available on NPTEL or SWAYAM portals under MOOCS programme being developed by MHRD to provide opportunity to the most disadvantaged students and to bridge the digital divide. The

online courses would also inculcate the habit of self-study at their own pace by the students and also acclimatize them to future technologies of learning processes.

2. Introduction:

In the increasingly globalized society, it is important that the younger generation especially the students are equipped with knowledge, skills, mindsets and behaviors which will enable them to perform their duties in a manner so that they become important contributors to the development of the society. This will also help them to fully utilize their educational training for earning a decent living so that the overall standard of their families and surroundings improve leading to development of welfare human societies. To achieve this goal, it is imperative that their educational training is improved such that it incorporates the use of newer technologies, use of newer assessment tools for mid-course corrections to make sure that they become competitive individuals to shoulder newer social responsibilities and are capable of undertaking novel innovations in their areas of expertise. In the face of the developing knowledge society, students will be well aware about the resources of self-development using on-line resources of learning which is going to be a major component of learning in the future. The learning will also be a continuous process so that the students are able to re-skill themselves so as to make themselves relevant to the changing needs of the society

3. Nature and extent of the B.Sc. Programme in microbiology:

Sl. No.	Year	MandatoryCredits to be secured for the Award
1.	After successful completion of 1stYear	48
2.	After successful completion of 1st and 2nd Years	96
3.	After successful completion of 1st, 2nd and 3rd Years	148

The undergraduate programme in Microbiology is the first level of college or university degree in the country as in several other parts of the world. A student pursuing 4 years undergraduate programme with research in a specific discipline shall be awarded an appropriate Degree in that discipline on completion of 8th Semester if he/she secures180 Credits. Similarly, for certificate, diploma and degree, a student needs to fulfil the associated credits.

After obtaining this degree, a microbiologist will enter into the job market or opt for undertaking further higher studies in the subject. After graduation the students may join

industry, academia, public health and play their role as microbiologists in a useful manner contributing their role in the development of the welfare society. Thus the LOCF curriculum developed has a very wide range covering all aspects of Microbiology with reasonable depth of knowledge and skills so to as to diversify them in various specialties of the subject and play their role professionally as expected of them. The current LOCF in Microbiology has been designed in keeping all these important points in mind.

4. Aims of Bachelor's degree programme in Microbiology:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide ranging contexts which involve the use of knowledge and skills of Microbiology. Their understanding, knowledge and skills in Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

5. Graduate Attributes in Microbiology:

GA1 Disciplinary knowledge and Understanding: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of BSc (Hons) Programme in Microbiology. It will provide the basic and advance knowledge in microbiology ,Along with the core papers, The AssamRoyal Global University gives much more emphasis on broader coverage of generic electives. A student of BSc in Microbiology Programme can choose any discipline from a wide range of basket as his/her generic electives, which facilitate the student in better understanding of the core courses**.** Moreover, a wide range of Skilled based papers are designed to improve the skill of the students.

GA 2 Practical Skills: The students of microbiology will have the opportunity to learn about the microbial world around them with the help of hands-on practical classes on microbe isolation, characterization etc. and its application. The Microbiology lab is well equipped with modern instruments to conducts experiments.

GA 3 Communication Skills: Ability to express thoughts and ideas effectively in writing and orally is very essential for a student. **The Assam Royal Global University** at Undergraduate and PG level has made ***Communicative English*** compulsory for all students in all semesters. A student at UG level will study six papers of Communicative English as **Ability Enhancement Compulsory Courses (AECC)** with a view to improve communication skills of the students.

GA 4 Critical thinking: A student will be capable of using analytic thought to a body of knowledge and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence. Faculty members organize Group Discussion, Power Point presentation, Debate, Quiz, seminars, lecture series etc regularly to develop this quality among the students.

GA 5 Problem solving: The course is designed to develop capacity to extrapolate from what a student has learned and apply their competencies to solve different kinds of non-familiar problems, and apply one's learning to real life situations.

GA 6 Analytical reasoning: Microbiology is a subject of experimentation, reasoning and evidenced based learning. This enhances a student's ability to evaluate the reliability and relevance of evidence and can identify logical flaws in the arguments of others. Moreover, the students can analyse and synthesise data from a variety of sources and can draw valid conclusions and support them with evidence.

GA 7 Research-related skills: Microbiology is research-based subject with plenty of hands-on and practical opportunities. Students will be asked to prepare project report regularly which brings about the sense of inquiry and capability for asking relevant/appropriate questions. They can also develop the ability to recognise cause-and-effect relationships and can draw conclusions from data.

GA 8 Cooperation/Teamwork: Will be capable of working effectively in diverse teams in both class room and field-based situations.

GA 9 Information/digitalliteracy: Will also be capable of using computers in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources and use appropriate software for analysis of data.

GA 10 Moral and ethical awareness/reasoning: Capable of conducting their work with honesty and precision thus avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues.

GA 11 Lifelong learning: Capable of self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/re-skilling.

6. Qualification Descriptors:

The following will serve as the important qualification descriptors for a UG degree in Microbiology: 1. Knowledge of the diverse places where microbiology is involved. 2. Understanding of diverse Microbiological processes. 3. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. 4. Moderately advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnostics etc. 5. Generation of new knowledge through small research projects 6. Ability to participate in team work through small microbiology projects. 7. Ability to present and articulate their knowledge of Microbiology. 8. Knowledge of recent developments in the area of Microbiology. 9. Analysis

of data collected through study and small projects. 10. Ability to innovate so as to generate new knowledge. 11. Awareness how some microbiology leads may be developed into enterprise. 12. Awareness of requirements for fruition of a microbiology-related enterprise.

PROGRAM OUTCOME:

On Successful completion of this program the graduates shall have:

PO 1: Disciplinary knowledge

Ability to apply the fundamental knowledge of Microbes, the role of microbes, and Microbial techniques in the area of Microbiology.

PO 2: Communication Skills

Ability to communicate effectively.

PO 3:Critical thinking and problem-solving

Ability to conduct experiments, and analyze and interpret the results.

PO 4: Analytical reasoning

An ability to identify, formulate and solve problems in the area of Microbiology.

PO 5: Research Skill

An ability to use the techniques, skills, and modern professional tools necessary for professional practice and research.

PO 6:Team Work and time management

Ability to function in a multidisciplinary team.

PO 7: Scientific reasoning

An ability to learn a system with its component, or process to meet the desired need within realistic constraints.

PO 8: Self Direct learning

A knowledge of contemporary issues in the area of Microbiology

PO 9: Digital Literacy

An ability to use the techniques, skills, and modern professional tools necessary for professional practice and research.

PO 10:Moral and Ethical values

An understanding of professional and ethical responsibilities

PO 11:Leadership qualities

An ability to apply the relevant knowledge and managerial skills to manage the project of multidisciplinary nature.

PO 12:Life long learning

A recognition of the need for and an ability to engage in lifelong learning in the area of Microbiology.

6. Programme Specific Outcomes (PSOs) of B.Sc Microbiology course:

A candidate who is conferred degree in microbiology will develop following competencies during the programme of the study:

PO 1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

PO 2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.

PO 3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.

PO 4. Developed a broader perspective of the discipline of Microbiology to enable students to identify challenging societal problems and plan professional career to develop innovative solutions for such problems.

Programme Structure

B.Sc. in Microbiology

1st semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	MIB152C101	Fundamentals of Microbiology	4	0	0	4	4
2	MIB152C102	Biochemistry	4	0	0	4	4
3	MIB152C113	Practical I	0	0	8	4	8
	Skill Enhancement Elective Courses (SEC)						
4	MIB152S111	Microbial Quality Control in Water and Food	1	0	2	2	3
Value Addition Course							
5	MIB152V101	Will select one course from a basket of courses	1	0	2	2	3
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A101	Communicative English-I	1	0	0	1	1
7	BHS982A104	Behavioural Science-I	1	0	0	1	1
Generic Elective							
8	MIB152G101	Introduction and scope of microbiology	3	0	0	3	3
9	MIB152G102	Introductory Virology	3	0	0	3	3
		Total Credit	**18**	**0**	**6**	**24**	**30**
2nd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							

1	MIB152C201	Cell Biology	4	0	0	4	4
2	MIB152C202	Bacteriology	4	0	0	4	4
3	MIB152C213	Practical-II	0	0	8	4	8
	Skill Enhancement Elective Courses (SEC)						
4	MIB152S201	Fermentation Technology and Application	1	0	2	2	3
Value Addition Course							
5	MIB152V201	Will select one course from a basket of courses	1	0	2	2	3
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A201	Communicative English-II	1	0	0	1	1
7	BHS982A201	Behavioural Science-II	1	0	0	1	1
Generic Elective							
8	MIB152G201	Microbial disease and its diagnosis	3	0	0	3	3
9	MIB152G202	Microbes in sustainable agriculture and development	3	0	0	3	3
		Total Credit	**18**	**0**	**6**	**24**	**30**

3rd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	MIB152C301	Microbial Genetics	4	0	0	4	4
2	MIB152C312	Practical III	0	0	8	4	8
Discipline Specific Elective (DSE)							
3	MIB152D301	Phycology, Mycology and Virology	4	0	0	4	4
Internship							
4	MIB152I301	4 weeks internship after 2nd sem exam	0	0	8	4	8
Ability Enhancement Compulsory Courses (AECC)							
5	CEN982A301	Communicative English-III	1	0	0	1	1
6	BHS982A301	ILD	1	0	0	1	1
Generic Elective							
7	MIB152G301	Plant pathology and plant microbe interaction	3	0	0	3	3
8	MIB152G302	Industrial and Food Microbiology	3	0	0	3	3
		Total Credit	**16**	**0**	**16**	**24**	**32**
4th semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**

Core Subjects							
1	MIB152C401	Molecular Biology	4	0	0	4	4
2	MIB152C412	Practical-IV	0	0	8	4	8
Discipline Specific Elective (DSE)							
3	MIB152D401	Microbial Physiology & Metabolism	4	0	0	4	4
	Skill Enhancement Elective Courses (SEC)						
4	MIB152S401	Mushroom Cultivation and Processing	0	0	4	2	4
Value Addition Course							
5	MIB152V401	Will select one course from a basket of courses	2	0	0	2	3
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A401	Communicative English-IV	1	0	0	1	1
7	BHS982A401	Functional Language	1	0	0	1	1
Generic Elective							
8	MIB152G401	Biosafety and Intellectual property rights	3	0	0	3	3
9	MIB152G402	Microbial Biotechnology	3	0	0	3	3
		Total Credit	**18**	**0**	**12**	**24**	**31**
5th semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	MIB152C501	Immunology	4	0	0	4	4
2	MIB152C512	Practical V	0	0	8	4	8
Discipline Specific Elective (DSE)(Select any two)							
3	MIB152D501	Instrumentation and Biotechniques	3	1	0	4	4
4	MIB152D502	Medical Microbiology	3	1	0	4	4
5	MIB152D503	Environmental and Agricultural Microbiology	3	1	0	4	4
Value Addition Course							
5	MIB152V501	Will select one course from a basket of courses	2	0	0	2	2
Internship							
6	MIB152I501	6 weeks internship after 4thsem exam/Project work	0	0	12	6	12
Ability Enhancement Compulsory Courses (AECC)							
7	CEN982A501	Communicative English-V	1	0	0	1	1
8		Env Studies & Sustainable Development	1	0	0	1	1
		Total Credit	**16**	**0**	**20**	**26**	**37**
6TH semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	MIB152C601	Genetic engineering	4	0	0	4	4
2	MIB152C412	Practical-VI	0	0	8	4	8

Discipline Specific Elective (DSE) (Select any three)							
3	MIB152D601	Industrial Microbiology	3	1	0	4	4
4	MIB152D602	Food Microbiology	3	1	0	4	4
5	MIB152D603	Inheritance Biology	3	1	0	4	4
	MIB152D604	Pharmaceutical Microbiology	3	1	0	4	4
	MIB152D605	Microbes in Sustainable Agriculture and Development	3	1	0	4	4
	MIB152D606	IPR and Bioethics	3	1	0	4	4
	Skill Enhancement Elective Courses (SEC)						
6	MIB152S601	Microbes study in soil and water bodies	0	0	4	2	4
Value Addition Course							
7	MIB152V601	Will select one course from a basket of courses	2	0	0	2	2
Ability Enhancement Compulsory Courses (AECC)							
8	CEN982A601	Communicative English-VI	1	0	0	1	1
9	BHS982A401	Human Value and Gender sensitization	1	0	0	1	1
		Total Credit	**20**	**0**	**12**	**26**	**32**

SYLLABUS (1ST SEMESTER)

Paper I: Fundamentals of Microbiology		**Subject code: MIB152C101**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course is designed with the objective to provide basic information about the history of microbiological development, Classification of the living system, and basic instruments used for the observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization techniques and distribution of microbes in different environments along with their application in industries.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the contribution made by prominent scientists in this field along with identifying different systems of classifying living organisms.	**BT 1**
CO 2	**Understand** the basic tool and techniques use for the microorganism growth and indetification..	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and its potential application	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	**Introduction to Microbial World** Development of microbiology as a discipline. Spontaneous generation *vs*. Biogenesis; Microbes in nature; Role of microbes in the fields of agriculture & environment, industry, medicine, astrobiology. History of microbiological development with special reference to the works of: Anton von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming and Elie Metchnikoff	**12**

II.	Binomial Nomenclature. Whittaker's five kingdom and Carl Woese's three domain concept of classification and their utility. Basics of Bergeys manual of systematic bacteriology. General characteristics of acellulars (Viruses, Viroids, Virusoid and Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on their distribution and occurrence, morphology, mode of reproduction and economic importance.	**12**
III.	Principle and application of light (bright and dark field), phase contrast, fluorescent, electron microscope, staining and fixation in microbiology. Sterilization: Physical and chemical methods of sterilization; mode of action of chemotherapeutic agents. Culture media: classification and importance; pure culture methods, preservation of pure cultures. .	**12**
IV	Microorganisms of Soil: Diversity of soil microflora and factors affecting their distribution. Brief account of microbial interactions in soil- symbiosis, mutualism, commensalism, competition and synergism and parasitism. Microbes in the Rhizosphere and their importance. Microorganisms of Water, Microorganisms of Air, Source and distribution of airborne and waterborne microorganisms. Microbes in the phyllosphere and their importance. Microbial Application in Industry: Food preservation (chemical and physical) methods, Microbial deterioration of food products. Fermented food products. Application of bacteria, yeast and molds in food industry.	**12**
TOTAL		**48**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology.* 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
4 Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.

References:

1. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.
2. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
3. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
4. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.

Paper II: Biochemistry		Subject code: MIB152C102
L-T-P-C-4-0-0-4	Credit units: 4	Scheme of evaluation: (T)

Course Objective:

This course is designed with the objective to provide students about the fundamental properties of different biomolecules: amino acids, proteins etc. and to enable students to understand the basic pathways involved in the biological systems. The course will also provide a foundation for the course on microbial physiology and metabolism.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** various biomolecules which are required for the development and functioning of a bacterial cell along.	**BT 1**
CO 2	**Understand** metabolism of carbohydrates, different pathways involved and the role of enzymes in such pathways.	**BT 2**
CO 3	**Apply** the knowledge in making buffers, study enzyme kinetics and calculate Vmax, Km, Kcat values.	**BT 3**
CO 4	**Analyze** problem associated with cell function and its pathway	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Major elements of life and their primary characteristics, atomic and chemical bonds, Cell dimension, turbidity measurements, Henderson-Hasselbach equation. Modern concepts of acids and bases. Ionization of acids; Dissociation of water, ionic product of water; Hydrogen in concentration-pH, determination of pH, dissociation of weak acids.	**12**

II.	**Classification and structure of Amino acids.** Amino acids as zwitterions in aqueous solutions, dihedral angle, titration of amino acids, separation of amino acids, standard and non-standard amino acid, classification of amino acid, ketogenic and glucogenic amino acid, Amino acid sequencing techniques.	**12**
III.	Introduction, Classification, and functions of proteins; Primary, Secondary, Tertiary and Quaternary structural organization of proteins, protein synthesis, characteristics of a dipeptide, Ramachandran plot. Carbohydrate metabolism- Glycolysis, Kreb's Cycle, Oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glyoxylate cycle. Structure of mitochondria, ETS pathway, sites of ATP production, inhibitors of electron transport chain.	**12**
IV	Photosynthesis, Structure of photosynthetic apparatus, light and dark reactions, C_3, C_4 and CAM pathway. Structure, properties, classification and function of Lipids. Fatty acid oxidation, biosynthesis of saturated and unsaturated fatty acids. Ketone bodies, oxidation of unsaturated and odd chain fatty acids.	**12**
	TOTAL	**48**

Text books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
3. Harper, 1999. Biochemistry, McGraw Hill, NewYork
4. Lodish, H.T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. 2004. Molecular Cell Biology, Scientific American Books, Inc. Newyork

References:

1. Berg, J. M., Tymoczko, J. L. and Stryer.(2006). *Biochemistry*, 6th Edition, W.H Freeman and Co.
2. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York

Paper III: Practical I		**Subject code: MIB152C113**
L-T-P-C-0-0-8-4	**Credit units: 4**	**Scheme of evaluation: (P)**

Course Objective:

This course is design with the introduction of basic instruments used in microbiological study and preparation of media use for growing different microbes. This course also cover different technique involve in the isolation and study of microbes from different samples. Further this course also introduces the qualitative and quantitative analysis of important biomolecules from the samples.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** Biosafety protocol and other laboratory ethics	**BT 1**
CO 2	**Understand** the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light	**BT 2**
CO 3	**Apply** the knowledge of practical to study microorganism in surrounding environment	**BT 3**
CO 4	**Analyze** problem associated with microbes and its impact	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Microbiological laboratory standards and safety protocols. 2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory. 3. Preparation of common microbial media (PDA, LB, LBA, NA) & sterilization techniques	**24**
II.	4. Isolation and characterization of microorganisms from soil, water and air and motility tests. 5. Isolation of pure cultures of bacteria by streaking method and staining process. 6. Bacterial growth study and plotting of the bacterial curve. 7. Study of the protozoans (*Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium)* using permanent mounts/photographs.	**24**
III.	8. Preparation of Stock Solution, Normal, Molar and Millimolar solutions.	**24**

	9. Tests of carbohydrates, proteins and amino acids- both quantitative and qualitative. 10. TLC / Paper chromatographic separation of plant pigments and amino acids.	
IV	11. Study of the following genera through temporary and permanent slides: *Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia*and *Nostoc* 12. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*	**24**
TOTAL		**96**

Recommended Texts:

1. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA.987pp.

2. Black, J.G. 2008. Microbiology principles and explorations. 7th edition. John Wiley and Sons Inc., New Jersey. 846pp.

3. Dubey, R.C. and Maheshwari, D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & Company Ltd

SEC-I: Microbial Quality Control in water and food		**Subject code: MIB152S111**
L-T-P-C-0-0-4-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objective:

This course is design with an objective to provide an overview to students about different methods and techniques and practical aspect of microbiological safety in water and food industries. The course will also provide a basic understanding about industries oriented microbiological work.

Course Outcome: On completion of the course the students will be expected to
Course Outcomes

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

SI No	Course Outcome	Blooms Taxonomy Level
CO 1	**Remember** different aspect of food safety and method used in industry.	BT 1
CO 2	**Understand about the** practical aspects of microbiological safety	BT 2
CO 3	**Apply** various detection methodologies and use of different microbiological media in food industries.	BT 3
CO 4	**Analyze** problems associated with drinking water and food industries	BT 4

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. To understand Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets 2. To Discard biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	12
II.	1. Determination of microorganism in Food / water Samples: Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical test 2. Sterility testing for pharmaceutical products, Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk	12
III.	1. Detection of specific microorganisms - on XLD agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar, Enrichment culture technique.	12
	2. Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water	12
TOTAL		48

Reference Books :

1. Quality Control in the Food Industry V1, S Herschdoerfer,ISBN: 9780323152068,: Academic Press, 1967

2. Principles of Sensory Evaluation of Food- 1965 MA Amerine, RM ,Pangborn and EB Roessler, Elsevier.
3. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
4. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
5. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
6. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

GE 1 Paper : Introduction and Scope of Microbiology **Subject code: MIB152G101**

L-T-P-C-3-0-0-3 **Credit units: 3** **Scheme of evaluation: (T)**

Course Objective:

This course is design with an objective to provide the basic information about the history of microbiological development, Classification of living system and basic instruments used for observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization technique and distribution of microbes in different environment along with their application in industries.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the development of the microbiology and the contribution made by prominent scientists in this fields	**BT 1**
CO 2	**Understand** microbe diversity, distribution s and their economic importance	**BT 2**
CO 3	**Apply** the knowledge to Illustrate the characteristics of different types of microorganisms	**BT 3**
CO 4	**Analyze** their interaction with other organisms and surrounding environment	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Introduction to Microbial World** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenne	**9**
II.	General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa),Sterilization: Physical and chemical methods of sterilization; mode of action of chemotherapeutic agents.	**9**
III.	Principle and application of light (bright and dark field), phase contrast, fluorescent, electron microscope, staining and fixation in microbiology. Culture media: classification and importance; pure culture methods, preservation of pure cultures	**9**
IV	Microorganisms of Soil: Diversity of soil microflora and factors affecting their distribution. Brief account of microbial interactions in soil- symbiosis, mutualism, commensalism, competition and synergism and parasitism. Microbes in the Rhizosphere and their importance. Microorganisms of Water, Microorganisms of Air, Source and distribution of airborne and waterborne microorganisms. Microbes in the phyllosphere and their importance. Microbial Application in Industry: Food preservation (chemical and physical) methods, Microbial deterioration of food products. Fermented food products. Application of bacteria, yeast and molds in food industry.	**9**
	TOTAL	**36**

Textbooks:

4. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
5. Sharma PD. (2005). *Microbiology.* 4th edition (reprint). Rastogi Publication, Meerut.

6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
5 Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.

References:

5. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.
6. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
7. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
8. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.

GE 2 Paper: Introductory Virology **Subject code: MIB152G102**

L-T-P-C-3-0-0-3 **Credit units: 3** **Scheme of evaluation: (T)**

Course Objective:

This course will give an overview of medically important viruses and their genome organization, replication strategies within the host cell. The course is also design to provide information about different transmission mode and prevention strategies to control of viral diseases. Common human viral infection will be the main focus of this course giving emphasis on virus - host interaction in understanding the diversity of viruses and viral diseases.

Course Outcome: On completion of the course the students will be expected to

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the origin, structure, medically important viruses and their genome organization, replication strategies within the host cell	**BT 1**
CO 2	**Understand** the infectious nature and their role in causing diseases.	**BT 2**
CO 3	**Apply** the knowledge to understant different viral strategies to evade host immune and cellular factors	**BT 3**
CO 4	**Analyze** the knowledge to develope different preventive measures to against viral diseases and develope vaccine and other antiviral drugs	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**General Characteristics of Viruses** Nature and general properties of viruses, concept of viroids, virusoids/satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses	**9**
II.	**Viral nucleic acids Replication and maturation** . Salient features of viral Nucleic acid, Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses, Assembly, maturation and release of virions	**9**
III.	**Bacteriophages and medically important virus** Bcteriophage(lytic and lysogenic life cycle), clinically important viruses - Rota virus, Corona virus(***SARS***-CoV2***)***, Hepadnavirus(Hepatitis B, C & D), Human Papilloma virus(HPV), Ebolla virus, Human immunodeficiency virus (HIV).	**9**
IV.	**Viral Transmission, Prevention & control of viral diseases** Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination; Applications of Virus (Phage therapy).	**9**
TOTAL		**36**

Text books

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition
BlackwellPublishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology.3rd edition.Prentice Hall publication, New Jersey.

5. Wagner EK, Hewlett MJ. (2004). Basic Virology.2nd edition.Blackwell Publishing.

Reference Books:

1. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
2. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
3. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
4. Versteeg J. (1985). A Color Atlas of Virology.Wolfe Medical Publication.

SYLLABUS (2 nd SEMESTER)

Paper II: Cell Biology		**Subject code: MIB152C201**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course is designed with an objective to provide the basic features of living cells particularly emphasizing more on the prokaryotic cells and detail information about the cell components along with their role in maintaining the cells.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various components of the cell and their function.	**BT 1**
CO 2	**Understand** the function of the cells and their roles.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and archaea.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Introduction to cell** Cell theory, Structural organization of prokaryotic cell, eukaryotic cells and their function. Comparative characters of prokaryotes and eukaryotes.Plasma membrane **:**Structural organization of cell membrane, plasma membrane and their function. Mechanism of transport across the plasma membrane, Sodium Potassium pump, Glucose transport, transport of ions in neuron.	**12**
II.	**Cell organelles; structure & function** Endoplasmic reticulum, golgi complex, lysosome, peroxisome, ribosomes and vacuoles, mitochondria; role of mitochondria in oxidative reactions and electron transport chain. Chloroplast and its role in photosynthesis..	**12**
III.	**Nucleus** Nucleus- Structure, organization and function, Nuclear envelope, role of nuclear pore in transport across the envelope, nucleoplasm and nucleolus, Chromatin structure and organization.	**12**
IV	**Cytoskeleton, Cell cycle & cell division** Microtubule and microfilaments: Intermediate filaments and Extracellular matrix. Cell cycle and its phases, Cell divisions (mitosis & Meosis) and Cell death, Cell cycle- control and regulation and cancer.	**12**
TOTAL		**48**

Textbooks:

1. Bruce Albert*set al*. *Molecular Biology of cell*. Garland Publications
2. Daniel. *Molecular Cell Biology*. Sceintific American Books.
3. Jack D. Bruke. *Cell Biology*. The William Twilkins Company.
4. Old and Primrose. *Principles of Gene Manipulations*. Black Well Scientific Publications.
5. Ambrose and Dorouthy M Hasty. *Cell Biology*. ELBS Publications.
6. Sharp. *Fundamentals of Cytology*. McGraw Hill Company.

Reference Books:

1. Wilson and Marrision. *Cytology*. Reinform Publications
2. Smith. *Molecular Biology*. Faber and Faber Publications
3. EDP Roberties and EMF Roberties. *Cell and Molecular Biology*. Sauder College.

4. Gardener EJ, Simmons MJ and Snustad DP. *Principles of Genetics*. John Wiley and Sons Publications.

Paper II: Bacteriology		**Subject code: MIB152C202**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course is design with an objective to provide the basic features of bacteria and their growth and adaptation. The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate between	**BT 1**
CO 2	**Understand** the nutritional requirements of bacteria and various media used for growth and development.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the bacterial potential for human well fare	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	**Cell organization** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall; Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms; Effect of antibiotics and enzymes on the cell wall.	**12**

	Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.	
II.	**Important archaeal and eubacterial groups** Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota and Euryarchaeota [Methanogens, thermophiles and Halophiles] Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: (a) Gram Negative: Non proteobacteria: General characteristics with suitable examples.Alpha-,Beta-, Gamma- Delta- and Zeta proteobacteria: General characteristics with suitable examples. (b) Gram Positive: Low (Firmicutes) and High (Actinobacteria) G+C: General characteristics with suitable examples. (c) Cyanobacteria: An Introduction.	**12**
III.	**Growth and nutrition** Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action	**12**
IV	**Reproduction in Bacteria** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate **Bacterial Systematics** Aim and principles of classification, systematics and taxonomy, Concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria	**12**
TOTAL		**48**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology.*4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). *Jawetz, Melnick and Adelberg's Medical Microbiology*. 24th edition. McGraw Hill Publication.
6. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
7. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th ed. Pearson/Benjamin Cummings.

8. Tortora GJ, Funke BR and Case CL (2013). *Microbiology: An Introduction*. 11th edition. Pearson Education.

References:

1. Atlas RM. (1997).Principles of Microbiology.2nd edition.WM.T.Brown Publishers.
2. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht

3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

Paper III: Practical II		**Subject code: MIB152C213**
L-T-P-C-0-0-8-4	**Credit units: 4**	**Scheme of evaluation: (P)**

Course Objective:

This course is design to enable students to prepare different Medias for culturing bacteria and different techniques used for isolation of pure culture of bacteria. This course is also design to help students identify microbes based on different staining method and also learn basic structure of virus.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different staining techniques	**BT 1**
CO 2	**Understand** cell division through practical	**BT 2**
CO 3	**Apply** the knowledge of practical to study microorganism in surrounding environment	**BT 3**
CO 4	**Analyze** problems associated with microbes detection and growth in lab	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**

I.	1. To study staining techniques in Bacteria: Simple staining, Negative staining, Gram's staining, Acid fast staining, Capsule staining and Endospore staining 2. To study motility of bacteria by hanging drop method, swimming and twitching motility	**24**
II.	3. Isolation of pure cultures of bacteria by streaking method; Estimation of CFU count by spread plate method/pour plate method 4. Estimation of Coliform loads in drinking water	**24**
III.	5.Study of cytopathic effects of viruses using photographs 6.Assessment of microbiological quality of water	**24**
IV	7.Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips. 8. Study of meiosis in onion bud cell or grasshopper testis by temporary preparation /permanent slides. 8- isolation of DNA from blood cell. 9- Cytochemical staining of proteins by Bromophenol blue.	**24**
TOTAL		**96**

Books:

1-De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.

2. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.

3. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San fransisco.

SEC II: Fermentation technology and application		**Subject code: MIB152S201**
L-T-P-C-0-0-2-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objective: This course is design to enable students learn about fermentation process alongwith different fermented food items obtained from microbiological activities.. This course is also design to help students learn about different useful microbes that are use in fermentation process and also learn about the production of fermented food items

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** microorganisms in the preparation specific fermented food items and the preparation of inoculum.	**BT 1**
CO 2	**Understand** the general laboratory safety measures and maintain the same.	**BT 2**
CO 3	**Apply** the knowledge for the preparation of various chemicals.	**BT 3**
CO 4	**Analyze** the source of probiotic in fermented foods and their health benefits	**BT 4**

Detailed Syllabus:

Textbooks:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. Production of ethyl alcohol from fruit juice or sugar sources. 2. Estimation of protein in fermented food 3. To understand different Fermented Foods and its advantages and health benefits	**12**
II.	4. To study Milk Based Fermented Foods: Dahi, Yogurt: Preparation of inoculums, types of microorganisms and production process	**12**
III.	5. To study Grain Based Fermented Foods: Bread, Idli and Dosa: Microorganisms and production process	**12**
IV	6. To study vegetable Based Fermented Foods: Pickels, Saeurkraut: Microorganisms and production process	**12**
TOTAL		**48**

1.Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.

3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4.Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

GE3: Microbial diseases and its Diagnosis		**Subject code: MIB152G201**
L-T-P-C-3-0-0-3	**Credit units: 3**	**Scheme of evaluation: (T)**

Course Objective: This course is design to enable students to enable the students develop a proper understanding of different pathogenic microbes, their mode of transmission and life cycle of human and animal pathogen. This course is also design to help students learn the basic skills for diagnosis and identification of pathogenic microbes.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** pathogenic microbe and their features, life cycle as well as mode of transmission.	**BT 1**
CO 2	**Understand** the different symptoms associated with microbial diseases and their diagnosis	**BT 2**
CO 3	**Apply** the knowledge in the identification of different pathogenic microbes associated with human diseases.	**BT 3**
CO 4	**Analyze** and Develope strategies to tackle the spread of pathogenic microbes in both community and hospital setting	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Impotant Microbial Diseases** Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.	**12**

II	**Collection of Clinical Samples** Method of collecting clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	**12**
III	**Direct Microscopic Examination and Culture.** Examination of sample by staining-Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsastained thin blood film for malaria Preparation and use of culture media-Blood agar,Chocolate agar,Lowenstein-Jensen medium,MacConkey agar, Mannitol Salt Agar. Distinct colony properties of various bacterial pathogens.	**12**
IV	**Serological and Molecular Methods** Serological Methods-Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes, Automation in microbial diagnosis. Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.	**12**
Total		**48**

Suggested Reading

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnickand Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

GE 4 Paper: Microbes in sustainable agriculture and development		Subject code: MIB152G202
L-T-P-C-3-0-0-3	Credit units: 3	Scheme of evaluation: (T)

Course Objective:

This course is design with an objective to provide the basic information about the microbes present in the soil and their role in mineralization of different organic and inorganic compounds present in the soil. Further,this course is also design to provide information regarding different microbial pathogens that infect other living organisms and the use of microbes in the field of agriculture as biopesticides or biofertilizer etc. along with transgenic crops and their advantages.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the soil property and its profile and the types of microbes present in the soil	**BT 1**
CO 2	**Understand** the role of microbes in degrading or recycling different compounds present in the soil and the production of different gases.	**BT 2**
CO 3	**Apply** the knowledge to Identify different soil pathogens associated with plant diseases.	**BT 3**
CO 4	**Analyze** the knowledge in eradicating plant diseases using microbial agents and the application of both wild type and genetically modified microbes in the field of agriculture	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Microbial Activity in Soil and Green House Gases (Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control)	9
II.	Soil born pathogen, Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	9
III.	Biofertilization, Phytostimulation, Bioinsecticides (Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs)	9
IV	Secondary Agriculture Biotechnology (Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters). GM Crop-Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.	9
TOTAL		**36**

TEXTBOOKS:

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management.7th edition.Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009).Env.Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology.Blackwell Scientific Publication, Oxford, England.

Reference Books:

1.Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
2. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
3.Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. NewYork.
4.Reddy, S.M. *et. al.* (2002).Bioinoculants for Sustainable Agriculture and Forestry, Sci.Pubs.
5.Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic
Publishing GmbH KG

SYLLABUS (3rdSEMESTER)

Paper I: Microbial Genetics		**Subject code: MIB152C301**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T/P/TP)**

Course Objective:

The purpose of this course is to introduce the student to the advanced concepts of genetics micro-organism, Student will gain an understanding of molecular mechanisms of DNA transfer and mutation in prokaryotes and lower eukaryotes.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** the core concept of genetic material and its transmission	**BT 1**
CO 2	**Understand** the genome organization in bacteria and the mechanism of DNA transfer	**BT 2**
CO 3	**Apply** the concepts of genetic material transmission, and recombination as a molecular biology tool and explain various levels of gene regulation in prokaryotic system	**BT 3**
CO 4	**Analyze** the process of genetic information flow and its regulation to understand the evolution process and antibiotic resistance development.	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Genetic material**,** vertical and horizontal gene transfer**,** Mechanisms behind the information flow, central dogma of life, Brief survey of Mandelian Genetics, allels, law of dominance, independent assortment, linkage and crossing over, interaction of genes, Extrachromosomal inheritance: mitochondrial & chloroplast inheritance.	**12**
II	Bacterial chromosome and plasmids, types of plasmid, mega plasmid, organization of genome in prokaryotes, Meselson and stah experiment, exon and intron isolation of bacterial mutants, prototroph and auxotroph. Transformation, conjugation , one gene-one enzyme hypothesis.	**12**
III	Mutation, types, rates and agents that cause mutation, Molecular basis of mutation, Genome instability: chromosomal aberration; errors in DNA replication during cell division. Mutagenic agents, base analogs, Assay of mutagenic agents (Ames test). drug resistance or Antibiotic resistance in bacteria	**12**
IV	Genetics of Bacteriophages **-** General characteristics of the viral genome, T4 virulent Phage- Structure- life cycle. Lambda temperate phage- Structure – Transduction and its type. Decision-making mechanism for Lytic and lysogenic cycle, Lytic cycle, Lysogenic cycle Lysogenic repression.	**12**
Total		**48**

Text Books:

1. James D Watson *et al*. (2009). Molecular biology of the gene. 5th Edition, Pearson.
2. Karp, G. (2010);*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, . John Wiley &Sons.Inc.
3. Stanley R Maloy. Microbial Genetics. 5th Edition, Narosa publishing house.
4. Daniel J Fairbanks. Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796

References:

1. Peter J Russel. Genetics. Pearsons Education India, ISBN-10: 9332571627.
2. William Klug, Michael Cummings, Charlotte A Spencer, Michael A Palladino. Concept of Genetics, 10th edition, Pearsons.

Paper: Practical III		Subject code: MIB152C312
L-T-P-C-4-0-0-4	Credit units: 4	Scheme of evaluation: (T/P/TP)

Course Objective:

This course is design with an objective to provide students an idea about different experiments used in measuring the bacterial growth along with the effects of different factors on bacterial growth. The course also includes cell division study and different techniques involve in the study of soil microflora.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of buffers and calculate the same.	**BT 1**
CO 2	**Understand** isolation of plasmid and genomic DNA from bacteria	**BT 2**
CO 3	**Apply** the knowledge to screen antibiotic resistance bacteria	**BT 3**
CO 4	**Analyze** the role of different factors enhance the mutation and its impact	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1- Plasmid isolation from bacteria cell 2-Genomic DNA Isolation from bacterial cell 3-Transformation of DNA in E.coli cell	24
II.	4- Estimation of DNA by DPA method. 5-Replica plating technique 6-screening of antibiotic resistance bacterial against ampicillin and gentamycin	24
III.	7-Isolation and identification of Aspergillus, Penicillium, Fusarium, Alternaria from different sources 8-Isolation and identification of Nostoc, Anabaena, Oscillatoria, Microcystis.	24

IV	9-staining of fungal spores 10-study nutritional deficiency on fungal growth 11- Study of the methods of isolation and propagation of plant viruses 12- Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique	24
	TOTAL	96

Text Books:

5. James D Watson *et al*. (2009). Molecular biology of the gene. 5th Edition, Pearson.
6. Karp, G. (2010);*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, . John Wiley &Sons.Inc.
7. Stanley R Maloy. Microbial Genetics. 5th Edition, Narosa publishing house.
8. Daniel J Fairbanks. Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796

References:

3. Peter J Russel. Genetics. Pearsons Education India, ISBN-10: 9332571627.
4. William Klug, Michael Cummings, Charlotte A Spencer, Michael A Palladino. Concept of Genetics, 10th edition, Pearsons.

Paper : Phycology , Mycology and virology **Subject code: MIB152D301**

L-T-P-C-4-0-0-4 **Credit units: 4** **Scheme of evaluation: (T)**

Course Objective:

This course is design to make students learn about thecharacteristic features of algae, fungi and their classification. The course also includes the application of algae and fungi in different areas.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Remember** the cell structure, life cycles and economic importance of algae and fungi.	**BT 1**
CO 2	**Understand** the role of fungi and algae are used as biofertilizers in agriculture and as biopesticides	**BT 2**
CO 3	**Apply** the knowledge to Identify different soil pathogens associated with plant diseases.	**BT 3**
CO 4	**Analyze** the knowledge to identify potential algae and fungi in solving environmental issues as well as agriculture related problems	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Phycology:** Characteristic features and classification of Algae Study of the following classes with reference to genera listed below (occurrence, thallus organization and life cycles): a) Chlorophyceae: *Volvox, Coleochaete* b) Charophyceae: *Chara* c) Bacillariophyceae: General features with reference to pinnate and centric diatoms, d) Xanthophyceae: *Vaucheria*. e) Phaeophyceae: *Ectocarpus* *f) Rhodophyceae: Polysiphonia* *g) Cyanophyceae: Nostoc*	**12**
II.	**Mycology**: Characteristic features and classification of fungi Study of the following classes with reference to the genera listed below (occurrence, somatic structure and life cycles): a) Cellular slime molds - *Dictyostelium* b) True slime molds (Myxomycetes) - *Physarum* c) Oomycetes - *Saprolegnia, Phytophthora* d) Chytridiomycetes - *Neocallimastix* e) Zygomycetes – *Mucor* f) Ascomycetes - *Saccharomyces, Penicillium, Neurospora* g) Basidiomycetes - *Agaricus* h) Deuteromycetes - *Candida, Alternaria*	**12**
III.	Lichens: Types, thallus structure and importance. Applications of algae in agriculture, environment, industry and food, Economic importance of fungi with reference to agriculture, environment (biodeterioration), industry(pharmaceutical and food); Mycotoxins	**12**
IV	Introduction's of viruses, discovery of viruses, Biological status (nature) and general properties of viruses; Theories of viral origin. Forms and structure of viruses, capsid symmetry, enveloped and non enveloped viruses. General concept	

	of viroids, virusoids/satellite viruses and prions. Viral taxonomy: classification and nomenclature of different groups of viruses. Isolation, purification and cultivation of viruses. Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes.	**12**
TOTAL		**48**

Text Books:

1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group,New York

2. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.

3.Raham LE, Graham JM and Wilcox LW. (2009). Algae.2nd edition. Benjamin Cumming, New York.

4.Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition BlackwellPublishing Ltd.

5. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

6.Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC

References:

1.Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.

2. Webster J. (1980). Introduction to Fungi.2nd edition. Cambridge University Press

3.Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.

4.Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

SYLLABUS (3rd SEMESTER)

Paper: Plant Pathology and Plant microbe interaction Subject code: MIB152G301

L-T-P-C-4-0-0-4 **Credit units: 4** **Scheme of evaluation:(T)**

Course Objective:

The course is developed with the following objectives: To enable the students develop a proper understanding about the interaction taking place among the microorganism along

with anotherorganism. This course also includes the microbes present in the soil environment and their impacts on different plants. Further this course also includesabout the plant pathogens and the social impact of plant diseases.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the plant immune system along with the causation of diseases in plants by different types of microorganisms namely bacterial, fungal and viral	**BT 1**
CO 2	**Understand** plant diseases, their etiology, salient characteristics and control measures.	**BT 2**
CO 3	**Apply** the knowledge to Identify different soil pathogens associated with plant diseases.	**BT 3**
CO 4	**Analyze** the diseased plant samples in the laboratory and are able to identify the salient features of the disease-causing microbe and the lesions produced on the plant parts.	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Introduction to Plant-Microbial interactions:** Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: Symbiotic and non-symbiotic interactions;	**12**
II	**Concept of interactions:**Rhizosphere; Non – rhizosphere; R : S ratio; Rhizosphere effect; Phyllosphere effect; Spermosphere effect; Plant growth promoting rhizobacteria; epiphytic and endophyticmicrobiomes and their significance; bioactive compound from endophytic fungi.	**12**
III	**Microbial Interactions and Plant Health:**Basal Resistance or PAMP-Triggered Immunity (PTI); Pathogen-Induced Resistance or Effector-TriggeredImmunity (ETI); Effectors; Resistance Proteins; Avr/R Protein Interaction;Indirect Interaction: Guard Hypothesis	**12**

IV	**Microbesas Plant Pathogens**: Concept of plant disease-definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	**12**
Total		**48**

Textbooks:

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,

2. Singh RS. (1998). Plant Diseases Management.7th edition.Oxford& IBH, New Delhi.

3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 8th edition. McGraw Hill Higher Education.

4. Pelczar MJ, Chan ECS and Krieg NR. (2010). Microbiology. 8th edition. McGraw Hill Book Company.

Reference books:

1. Singh DP, Singh HB, Prabha R (2017). Plant-Microbe Interactions in Agro-Ecological Perspectives. Vol. 1. Springer.
2. Boland GJ and Kuykendall LD (1998). Plant-microbe Interactions and Biological Control Books in Soils, Plants, and the Environment. CRC Press.

Paper I: Industrial and Food Microbiology **Subject code: MIB152G302**

L-T-P-C-3-0-0-3 **Credit units: 3** **Scheme of evaluation: (T)**

Course Objective:

This course is design with an objective to allow students learn about large number of substrate that are used for the industrial fermentation processes and understanding of different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentations and their processes parameters. Further students will acquire a detailed knowledge of number of products which are produced by industrial fermentation processes.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the important microbes use in the fermentative production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry.	**BT 1**
CO 2	**Understand** various physical parameters which affect production of industrial products by the microorganisms and the safety aspects of the production and use of these products	**BT 2**
CO 3	**Apply** the knowledge to Identify different food born microorganism and develope food preservation techniques.	**BT 3**
CO 4	**Analyze** the practical knowledge to Develope laboratory skills in the production of alcohol and enzymes by fermentative process using bacteria/yeast; skills for laboratory testing and quality control of food.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Introduction to industrial microbiology** Brief history and developments in industrial microbiology, Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains.	**12**
II.	**Types of fermentation processes** - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration	**12**
III.	**Food Microbiology:** Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors; chemical preservation and food additives, Contamination and Spoilage of food products.	**12**

IV	**Food-borne infections and intoxications–** bacterial: *Bacillus, Clostridium, Escherichia, Shigella,* and non-bacterial intoxication, food borne outbreaks– laboratory testing procedures, preventive measures, GMP and Hazard Analysis and CriticalControl Point. Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.	**12**
	TOTAL	**48**

Facilitating the achievement of Course Learning Outcomes

Reference Books:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology.1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction.1st edition. Wiley – Blackwell
4.Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology.1st edition. W.H. Freeman and Company
5.Casida LE. (1991). Industrial Microbiology.1st edition.Wiley Eastern Limited.

Suggested Readings:

1.Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
2. Stanbury PF, Whitaker A and Hall SJ.(2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

SYLLABUS (4th SEMESTER)

Paper I: Molecular Biology		**Subject code: MIB152C401**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T/P/TP)**

Course Objective:

The purpose of this course is to introduce the student to the advanced concepts in molecularbiology. Student will gain an understanding of molecular mechanisms of DNA replication,

DNArepair,transcription, translation, and gene regulation in prokaryotic and eukaryotic organisms. Thestudent will study the techniques and experiments used to understand these mechanisms.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of gene, genome and nucleic acids.	**BT 1**
CO 2	**Understand** the structure of DNA and RNA, organization of eukaryotic genome	**BT 2**
CO 3	**Apply** the concepts of DNA repair mechanisms, and recombination as a molecular biology tool and explain various levels of gene regulation in both prokaryotic and eukaryotic organisms.	**BT 3**
CO 4	**Analyze** post-transcriptional processes, RNA editing, RNAi and miRNA along with translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Basic concepts of Genetic Information** Nucleic acids as genetic information carriers, experimental evidences. Primary structure of nucleic acids and their properties. Highly repetitive, moderately repetitive and unique DNA sequences, Classes of RNA, secondary and tertiary structure. Secondary structures of nucleic acids, anti-parallel strands, base composition, base equivalence, base pairing and base stacking, types of DNA, structural characteristics, chirality and cot curve.	12
II.	**DNA Replication and Transcription** DNA replication in prokaryotes: Conservative, semiconservative and dispersive types, DNA polymerases, enzymes and protein factors involved in replication. Mechanism of	12

	replication in eukaryotes, inhibitors of replication. Transcription in prokaryotes and eukaryotes, RNA polymerases; promoters, differences in transcription termination,	
III.	**Translation and Regulation of Gene Expression** Translation, post translational modifications. Genetic code: Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis; gene within genes and overlapping genes, mechanism of translation in prokaryotes and eukaryotes, ribosome assembly. Regulation of Gene Expression in Prokaryotes and eukaryotes, Enzyme induction and repression, operon concept, Lac operon, Trp operon, eukaryotic gene arrangements.	12
IV	**Mutation and Repair** Mutation: molecular basis of mutation, types of mutation, dominant and recessive mutations, spontaneous and induced mutations. Mutagenicity testing: Correlation of mutagenicity and carcinogenicity: Ames testing, Random and site directed mutagenesis. DNA Repair- Types and evidences.	12
	TOTAL	48

TEXTBOOKS:

.1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

Reference Books:

1. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
2. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
3.Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

Subject Name: Practical IV	**Scheme of Evaluation: (P)**

Subject Code: MIB152C412 **Credit Units: 0-0-8-4**

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts in molecular biology.	**BT 1**
CO 2	**Demonstrate** the concepts in understanding the formation of various molecular events in life forms.	**BT 2**
CO 3	**Apply** the theoretical knowledge in carrying out practicals assigned.	**BT 3**
CO 4	**Analyze** and **categorize** the various molecular reactions involved in mutations and DNA repair	**BT 4**

Modules	**Topics / Course content**	**Periods**
I	1. Isolation of genomic DNA from plants/animal cell 2. Agarose gel electrophoresis for the separation of DNA.	**24**
II	3. Primer designing for gene-specific DNA amplification 4. DNA amplification through PCR. 5.Isolation of Mitochondria	**24**
III	6. Quantification and purity determination of isolated genomic DNA by UV-spectrophotometry and agarose gel electrophoresis. 7.Extraction of RNA from Bacterial cell	**24**
IV	8.Restriction digestion of DNA 9.ORF Finding in the genome, blast, phylogenic tree development	**24**
Total		**96**

TEXTBOOKS:

.1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.

5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

Reference Books:

1. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
2. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
3.Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

Paper : Microbial Physiology and Metabolism		**Subject code: MIB152D401**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course is design with an objective to provide the basic idea about the microbial growth and the impact of different environmental factors on their growth and adaptation. Further, this course also provides information regarding assimilation of different nutrients and detail idea about microbial metabolism.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the growth characteristics of the microorganisms capable of growing under unusual environmental condition of temperature, oxygen, and solute and water activity	**BT 1**
CO 2	**Understand** various physical parameters which affect production of industrial products by the microorganisms and the safety aspects of the production and use of these products	**BT 2**
CO 3	**Apply** the knowledge to Identify different food born microorganism and develope food preservation techniques.	**BT 3**

CO 4	**Analyze** the practical knowledge to Develope laboratory skills in the production of alcohol and enzymes by fermentative process using bacteria/yeast; skills for laboratory testing and quality control of food.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Microbial Growth and Environmental Effect on Microbial Growth** Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy– Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.	**12**
II.	**Nutrient uptake and Transport** Passive and facilitated diffusion; Primary and secondary active transport, concept of uniport, symport and antiport; Group translocation; Iron uptake.Aerobic Respiration:Concept of aerobic respiration, anaerobic respiration and fermentation; Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway: TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.	**12**
III.	**Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation** Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.	**12**
IV	**Chemolithotrophic and Phototrophic Metabolism** Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria.	**12**
	TOTAL	**48**

Textbooks:

1. Madigan MT, and Martinko JM (2014).Brock Biology of Microorganisms.14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology.4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism.2nd edition. Springer Verlag

References:

1.Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,
McMillan Press.

2.Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology.9th edition.McGraw Hill Higher Education.

Paper: Mushroom cultivation and processing		**Subject code: MIB152S401**
L-T-P-C-0-0-0-2	**Credit units: 2**	**Scheme of evaluation: (p)**

Course Objective: Course objective: To Identify edible types in mushroom, Selection of appropriate cultivation sites, Designing and construction of Mushroom Farm, Packaging, storing and grading of Mushrooms.

Learning Outcomes: On completion of this course students will be expected to –

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Remember** the basic requirement to grow Mushroom	**BT 1**
CO 2	**Understanding** of prospects of Mushroom cultivation	**BT 2**
CO 3	**Apply** the knowledge of cultivation of different types of edible Mushroom.	**BT 3**
CO 4	**Analyze** the concepts for the betterment of the methods of harvesting of Mushroom and methods of grading, packing and	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Introduction to Mushroom Cultivation, Its natural growth aspects and climatic requirement, Mushroom edible types, Appropriate Mushroom Cultivation sites	**12**
II.	Designing and construction of Mushroom farm, Role of composting in Mushroom Cultivation and methods of composting, Types of Mushroom growing facilities and fixtures, Disease control and pest management	**12**
III.	Harvesting packaging & grading and storage of Mushroom, Post harvest procedures.	**12**
IV	Value added products of Mushroom.	**12**
TOTAL		**48**

Textbooks:

CAR – Directorate of Mushroom Research. O.P. Ahlawat,Satish Kumar, T. Arumuganathan, R.P. Tewari, 25 Years ofAICRP (Mushroom), All India Coordinated Research Projecton Mushroom [Printed: 2008, 1000 Copies]: Available from:http://www.nrcmushroom.org/25_Years_of_Mushroom__AICRIP_.pd

(PDF) Mushroom: Cultivation and Processing. Available from: https://www.researchgate.net/publication/330894412_Mushroom_Cultivation_and_Processing [accessed Dec 26 2022].

Paper: Biosafety and Intellectual property rights		**Subject code: MIB152G401**
L-T-P-C-3-0-0-3	**Credit units: 3**	**Scheme of evaluation: (T)**

Course Objective:

This course is designed with an objective to provide students about the fundamentals of research methods and to enable students to understand, also to gain familiarity with a phenomenon or to achieve new insights into research process. The course will also provide a foundation for the course on IPR and biosafety.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the necessary preventive measures, handling of live bacteria.	**BT 1**
CO 2	**Demonstrate** the how to dispose infectious waste, care of the equipment requiring safety audit.	**BT 2**
CO 3	**Apply** the theoretical knowledge for patent and copyright	**BT 3**
CO 4	**Analyze** the issue in patent filing and other related issue	**BT 4**

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	**Biosafety:** Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.	**12**
II.	**Biosafety Guidelines:** Biosafety guidelines and regulations (National and International);GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM,GEAC etc. for GMO applications in food and agriculture.	**12**
III.	**IPR:** Introduction, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, World Intellectual Property Rights Organization (WIPO).	**12**
IV	**Types of patent applications and Agreements**: Ordinary, PCT, Conventional,Divisional and Patent of Addition,GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement.	**12**
TOTAL		**48**

Reference Books

1. Indian Patent Act 1970 Acts & Rules, BAREACT, Universal Law Publishing Co. Pvt. Ltd., 2007

2. Genetic Patent Law & Strategy, 1st Edition, Kankanala C., Manupatra Information Solution Pvt. Ltd., 2007

Reference book:

1.Cr, K. (2020). Research methodology methods and techniques.

2.Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Important Links:

- http://www.w3.org/IPR/
- http://www.wipo.int/portal/index.html.en
- http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
- www.patentoffice.nic.in
- www.iprlawindia.org/ - 31k - Cached - Similar page
- http://www.cbd.int/biosafety/background.shtml
- http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm

Paper: Microbial Biotechnology		**Subject code: MIB152G402**
L-T-P-C-3-0-0-3	**Credit units: 3**	**Scheme of evaluation: (T)**

Course objectives:

This course is designed with an objective to provide students about the biotechnology-based application of microbes and their enzymes. The course will also provide the utility of genetically modified microbes in bioenergy and in solving environment related issue.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the important concept of Agriculture Microbiology.	**BT 1**
CO 2	**Demonstrate** the on how microbiology is relevant to technological developments for agriculture and environment	**BT 2**
CO 3	**Apply** the knowledge of recombinant DNA technology is juxtaposed with microbially-based technological developments for agriculture, industry and environment	**BT 3**

CO 4	**Analyze** the current problems related to microorganisms and apply the knowledge in solving the problems related to human health, agriculture	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Microbial Biotechnology and its Applications** Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology, Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast	**12**
II.	**Therapeutic and Industrial Biotechnology** Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors	**12**
III.	**Applications of Microbes in Biotransformations** Microbial based transformation of steroids and sterols Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute	**12**
IV	**Microbes for Bio-energy and Environment** Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents	**12**
	TOTAL	**48**

Reference Books

1. Richard H. Baltz. Julian E Davies and Arnold L.DemainManual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).

2. Daniel Forciniti. Industrial Bioseperation:Principles and practice. 1st edition edition, Wiley-Blackwell (2008).

3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).

4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
5. EL Mansi. E.M.T., FermentationMicrobiologyand Biotechnology. 2ndEdition,CRC Taylor&Francis (2007).
6. Waites,M.J.,Morgan, N.L.,Rockey, J.S.andHigton,G.Industrial M i cr o b i o l o g y : An lntroduction. Blackwell SciencePublishers(2002).

Suggested Readings

1. Casida LE, Industrial Microbiology, J. Wiley, (1968).
2. James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
3.Jayanta Kumar Patra Gitishree Das Han-Seung Shin. Microbial Biotechnology. Springer

5TH SEMESTER

Paper : Immunology		**Subject code: MIB152C501**
L-T-P-C-3-1-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- This course is designed to provide knowledge about the immune response in the body along with the basic structure of antigens and antibodies. Further, the syllabus also includes the application of antigens and antibodies in the different serological tests.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts about the innate and adaptive immune	**BT 1**
CO 2	Understanding of the antigen, antibody structure, and working mechanism of the Immune system.	**BT 2**
CO 3	**Apply** the knowledge of antigen, antibody, RIA and other techniques in HLA typing and related research	**BT 3**
CO 4	**Analyze** the immune system related disease and other related issues.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	History of immunology, Types of immunity: Innate and Acquired immunity; Cells and Organs of the immune system.	**12**
II.	Antigen – Antigenecity, Immunogenecity, Epitopes, Haptens, Adjuvants; MHC self-antigen – Class and structure. Antibodies- Structure, classes and function, Isotype, Allotype, and Idiotype; Genetic diversity of antibody class, Antigen and antibody interaction, affinity and avidity, cross reactivity, precipitation and agglutination reaction; Cytokines.	**12**
III.	Complement system. Allergy and Hypersensitivity – type – I, II, III and IV their clinical manifestation; Autoimmune disorders; Immunity to Bacteria & Virus.	**12**
IV	Transplantation – Allograft rejection, Graft vs Host rejection, Immunosuppressor drugs. Single Radial Immuno-diffusion, Immuno-electrophoresis, Electro immuno-diffusion; Principle and applications of RIA and ELISA, Tumor immunology.	**12**
	TOTAL	**48**

Text Books:

1. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
2. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

Reference Books:

1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman,2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
3. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

Practical V		**Subject code: MIB152C512**
L-T-P-C- 0-0-8-4	**Credit units: 4**	**Scheme of evaluation: (P)**

Course Objective:

- ❖ The objective of the course is to familiarize the student with basic practical knowledge regarding different tests related to immune cells and its responses

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts the concepts of blood grouping and other related test .	**BT 1**
CO 2	Understanding of the antigen, antibody reaction and working mechanism of the Immune system..	**BT 2**
CO 3	**Apply** apply the practical knowledge to confirm blood group and detection of infectious pathogen	**BT 3**
CO 4	**Analyze** the the sample to understand the infection and disease.	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	1:Demonstration of haemagglutination with reference to *Treponema pallidum* Haemagglutination test. 2: Haemeagglutination tests for identification of human blood groups 3: Demonstration of agglutination reaction with reference to the widal test. 4: Demonstration of agglutination reaction with reference to the VDRL test.	**24**
II	5:Demonstration of ODD (Ouchtlerlony Double Diffusion)-an immunological technique used in the detection, identification, and quantification of antibodies and antigens. 6:Separation and characterization of lymphocytes from blood, Demonstration of Antigen-antibody reaction by ELISA.	**24**
III	7: Osmotic fragility of RBC 8: Estimation of Haemoglobin (Hb)	**24**

IV	**9:**RH factor test in human blood sample **10: Antibiotic senstivity test**	**24**
Total		**96**

Text Books:

5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
6. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

References:

1. Kathleen park Talaro (2017). Foundations in Microbiology. 10th Edition, McGraw Hill. Science
2. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.

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Paper: Instrumentation and Biotechniques **Subject code: MIB152D501**

L-T-P-C-3-1-0-4 **Credit units: 4** **Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives: To enable the students to develop a proper understanding of different instruments used in microbiological and molecular research. Further, this course will also introduce students to the rapidly evolving field of bioinformatics and biostatistics.

Course outcome:

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of various biotechniques	**BT 1**
CO 2	Understanding the working principles of biotechniques and data analysis	**BT 2**
CO 3	**Apply** the techniques for a better understanding of life functions	**BT 3**

CO 4	**Analyze** of the structure of the protein, DNA, RNA, and other related functions	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Electrochemistry: pH and Buffers Potentiometric and Conductometric titration. Principal and application of Light, phase contrast, Fluorescence Scanning and Transmission electron microscopy, confocal microscopy, cytophotometry and flow cytometry, Preparation samples for microscopy.	**12**
II	Principle Methodology and applications of gel filtration, ion exchange and affinity chromatography, Thin layer and gas chromatography, High performance liquid chromatography, FPLC, Centrifugation: Basic principal and application, differential – density gradient and ultra centrifugation.	**12**
III	Principle of biophysical method for analyzing biopolymer structure, X ray diffraction Fluorescence, UV ORD/CD Visible IR, NMR and ESR spectroscopy, Atomic absorption and plasma emission spectroscopy,	**12**
IV	MS and MALDI –TOF, Electrophoresis, Principle and application of Native, SDS Agarose and 2D gel Electrophoresis. Blotting techniques – Southern blotting, Northern blotting, Western blotting	**12**
Total		**48**

Textbooks:

1. DA Skoog , Instrument method of analysis
2. Plummer, An introduction to practical Biochemistry
3. Chatwal and Anand, Instrumentation

Reference Books:

1. Boyer, Modren experimental Biology
2. Principles and Techniques Of Biochemistry And Molecular Biology, Keith Wilson, John Walker. Cambridge University Press India Pvt. Ltd.
3. Biochemistry by Lubert Stryer
4. Biostatistics A.nd Microbiology: A Survival Manual by Daryl S. Paulson. Springer Verlag
5. Sharma BK, Instrument method of chemical analysis

Paper : Medical microbiology		Subject code: MIB152D502
L-T-P-C-3-1-0-4	Credit units: 4	Scheme of evaluation: (T)

Course Objective:

This course is design with an objective to provide the basic information related to bacterial, viral, fungal and protozoan diseases and their diagnosis. Further, this course also provides up to date information regarding different serological and molecular based methods to detect the pathogens involve in causing disease

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of pathogenesis and transmission and life cycle	**BT 1**
CO 2	Understanding of normal microflora of human body; role of resident flora. Host-parasite relationships, Infection type	**BT 2**
CO 3	Apply the knowledge of antimicrobial agents and antibiotics as chemotherapeutic agents.	**BT 3**
CO 4	**Analyze** of the Emerging communicable diseases (Plague, Anthrax) and their control.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Importance of Diagnosis of Diseases** Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.	**12**
II.	**Collection of Clinical Samples** Method of collecting clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	**12**

III.	**Direct Microscopic Examination and Culture.** Examination of sample by staining-Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsastained thin blood film for malaria, Preparation and use of culture media-Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.	**12**
IV	**Serological and Molecular Methods** Serological Methods-Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Testing for Antibiotic Sensitivity in Bacteria:Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.	**12**
TOTAL		**48**

Suggested Reading

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, MelnickandAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

Reference Books:

1. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
2. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology2nd edition, Elsevier India Pvt Ltd

Paper : Environmental and Agricultural Microbiology		**Subject code: MIB152D503**
L-T-P-C-3-1-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

To provide students a basic understanding of environmental and agricultural microbiology including; microbial diversity in the environment in relation to environment and agricultural welfare, ecosystem wellness, microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and agricultural fields.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of microbial diversity biofertilizers and pesticides, microbial waste recycling and bioremediation	**BT 1**
CO 2	Understanding of the microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and	**BT 2**
CO 3	apply the knowledge to recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection	**BT 3**
CO 4	**Analyze** the Emerging problems in current environmental and agricultural issues.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Soil Microbiology:, soil as a habitat for micro-organisms, microflora of various soil types, rhizosphere and rhizoplane. Nitrogen fixation: asymbiotic and symbiotic nitrogen fixation systems, root nodulation, symbiotic bacteria (process of root nodule formation), leghemoglobin, nitrification and ammonification. Microbial interactions: Symbiosis, mutualism, commensalism, amensalism, competition, antibiosis, actinorrhiza, mycorrhizal fungi and its effect on plants.	**12**
II.	Aquatic Microbiology: Water ecosystems (fresh water, pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents), eutrophication, cyanobacterial and microlagal blooms: ecological implications and human health, toxins produced by cyanobacteria and other microalgae.; Extreme environments and extremophilic microbes: Habitats, diversity, adaptations and potential applications. Aero-microbiology - droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes – bacteria, fungi, and viruses, their diseases and preventive measures	**12**
III.	Bio-fertilizers and Biopesticides in agriculture: Principles of crop inoculation with microbial agents, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, cyanobacteria and microalgae for biofertilizer production, phosphate solubilizing microorganisms, AM fungi, plant	**12**

	growth promoting rhizobacteria, (PGPR), biocontrol agents. Bacterial and mycopesticides.	
IV	Bioremediation of Xenobiotics, petroleum, oil spill, Microbial remediation of heavy metal pollution, tolerance to heavy metal by microbes, resistance developed in microbes to heavy metals, Microbial deterioration and degradation of plant food materials, leather, store and buildings materials, paper and other cellulosic materials, fuel and lubricants, metals, plastics, cosmetics, pharmaceutical products. Global warming and Climate Change	**12**
TOTAL		**48**

Suggested Reading

1. Subba Rao NS (1995). Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, 4th edition.
2. Rangaswami G, Bhagyaraj DJ (2001). Agricultural Microbiology, Prentice Hall of India, New Delhi, 2nd edition.

Reference Books:

1. Ljungdahl LG, Adams MW, Barton LL, Ferry JG, Johnson MK (2003). Biochemistry and Physiology of Anaerobic Bacteria, Springer. 8. Madigan MT, Martinko JM, Dunlap PV, Clark DP (2012).
2. Brock Biology of Microorganisms, Prentice Hall, USA.
3. Environmental Biotechnology: Principles and Applications by Bruce E Rittman and Perry L McCarty, McGraw-Hill International editions
4. Dubey RC, Maheswari DK (1999). Textbook of Microbiology, S. Chand & Co. 4. Evans GM, Furlong JC (2011).
5. Environmental Biotechnology- Theroy and application. Wiley-Blackwell.
6. Maier RM, Pepper IL, Gerba CP (2009). Environmental microbiology, Elsevier.
7. Osborn AM, Smith CCJ (2005). Molecular microbial ecology, Taylor & Francis US.

SYLLABUS (6TH SEMESTER)

Paper: Genetic Engineering		**Subject code: MIB152C601**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course is design with an objective to provide the basic idea about the genetic manipulation, role of different enzymes used and different techniques involve in the identification and amplification of specific DNA sequences. Further, this course also provides information regarding basic marker technique used in DNA fingerprinting.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of genome organization and omics approaches	**BT 1**
CO 2	Understanding of the replication, Transcription, and mechanism in the cell	**BT 2**
CO 3	apply the knowledge of genome organization in mutation and virulence gene study	**BT 3**
CO 4	Analysis of genetic material to correlate gene mutation and its impact on function	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Introduction to Genetic Engineering, Recombinant DNA technology (r-DNA technology), Restriction enzymes- Introduction, types and its functions; Restriction modification, DNA polymerases, Ligases, and DNA modifying enzymes, Cohesive and blunt end ligation. Linkers, adaptors, homopolymeric tailing.	**12**
II.	Cloning vectors: Plasmids, types of plasmids, cosmids, phagemids, artificial chromosome vectors (BAC, YAC), Phage biology Lytic and Lysogenic cycle, phage as a cloning vector, replacement and integrated vector.	**12**
III.	Hybridization techniques- Southern, Northern and Western Hybridization, DNA and RNA probes; Construction of libraries and its screening (genomic and c DNA libraries), PCR and its applications, types of PCR- Gradient, Reverse transcriptase, Real time PCR.	**12**
IV	Basics of marker methods in molecular biology: RAPD, RFLP, AFLP, microarrays, DNA fingerprinting. Introduction of DNA into mammalian cells, transfection techniques; vectorless DNA delivery. Synthetic biology definition, the subfield of synthetic biology (DNA synthesis, DNA-based bio circuits, minimal genome, protocells, Chemical synthetic biology), Genetic manipulation, Gene editing tools (CRISPER-CAS system, Tallen etc.)	**12**
TOTAL		**48**

Reference Books:

1) S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6thEdition, S.B.University Press, 2001.
2) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

Suggested Readings:

1) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols1-3, CSHL, 2001.
2) Campbell AM &Heyer LJ, Discovering Genomics, Proteomics & Bioinformatics, 2ndEdition. Benjamin Cummings 2007.
3) Singh, B.D. Biotechnology, Kalyani publishers, India.

4-N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.

5-Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006. Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.

6-S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.

Paper : Practical VI		**Subject code: MIB152C612**
L-T-P-C-0-0-8-4	**Credit units: 4**	**Scheme of evaluation: (P/P)**

Course Objective:

This course is design with an objective to provide the practical knowledge and procedure of genomic and plasmid DNA isolation, primer designing, role of different enzymes used in DNA digestion and different techniques involve in the identification and amplification of specific DNA sequences. Further, this course also provides information regarding gene cloning and mutation.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic concept of genome organization and omics approaches	**BT 1**
CO 2	Understanding of the replication, Transcription, and mechanism in the cell.	**BT 2**

CO 3	apply the knowledge of genome organization in mutation and virulence gene study	**BT 3**
CO 4	Analysis of genetic material to correlate gene mutation and its impact on function.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1.Isolation of Bacterial Genomic DNA. 2.Isolation of Plasmid from bacterial cell. 3. Study different conformations of plasmid DNA through agarose gel electrophoresis. 4.Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells. 5.Study survival curve of bacteria after exposure to ultraviolet (UV) light.	**24**
II.	6.Study different conformations of plasmid DNA through agarose gel electrophoresis. 7.Demonstration of bacterial conjugation	**24**
III.	8.Competent cell preparation in *E.coli* 9.Transformation through heat shock method in Ecoli. 10.Natural transformation in Bacterial cell 11.Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis	**24**
IV	12.Designing of primers for DNA amplification 13.Amplification of DNA by PCR	**24**
TOTAL		**96**

Reference Books:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings

2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning

4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings

5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Suggested reading

1. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

2. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

3. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publisher

Paper : Industrial Microbiology		**Subject code: MIB152D601**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective: :

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic concept of the suitability of microbes in industrial processes and their source types	**BT 1**
CO 2	Understanding of Batch culture in fermentation, growth kinetics of micro-organisms	**BT 2**
CO 3	apply the knowledge for Continuous culture and scale-up –productivity and product formation	**BT 3**
CO 4	Analysis of the selection, improvement, and maintenance of industrial important strain	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**

I	Brief History of Industrial Microbiology, suitability of microbes in industrial processes and their sources types of fermentation and bioreactors, Recent development in industrial microbiology, the structure of fermentor, and Economic aspects of fermentation processes. Isolation, selection, improvement and maintenance of industrial important strain. Metabolic pathways and metabolic control mechanisms; primary metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins); substrates for industrial fermentation	**12**
II	Batch culture in fermentation, growth kinetics of micro-organisms, classification of fermentation process; growth and nutrient, growth and product formation, heat evolution, the effect of environment (temperature, pH, high nutrient concentration), media formulation and sterilization, the kinetics of thermal death of micro-organisms.	**12**
III	Continuous culture and scale-up **–** Continuous culture system, productivity, product formation, power requirement oxygen transfer kinetics, foam, and antifoam-instrument control, physical and chemical environment sensors.	**12**
IV	Downstream processing objectives and criteria, foam separation Precipitation methods filtration devices industrial scale centrifugation and cell disruption methods. liquid –liquid extraction solvent I recovery chromatography. Two phase aqueous extraction, super criticalfluid extraction, ultrafiltration drying devices crystallization and whole broth processing, IPR and bioethics.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, Gary Higton. Wiley-blackwell

References:

1. Peppler, H. J. and Pearlman, D. (1979). Microbial Technology, Vol 1 and 2, Academic press.
2. Demain, A. L. and Soloman INA, (1986). Manual of Industrial Microbiology and Biotechnology, American society for Microbiology, Washington DC.
3. Chisti, Y., Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology, Vol. 5, John Wiley and Sons, N. Y.
4. Belter, P.A., Cussler, E.L. and Hu, W.S., Bioseparation: Downstream processing for Biotechnology, John Wiley and Sons, N.Y.
5. Agarwal AK &PradeepParihar (2006). Industrial Microbiology. Published by Student Edition, Behind Nasrani Cinema, Chopasani Road, Jodhpur.
6. Patel A H (2005). Industrial Microbiology.Laxmi Publications, New Delhi; Second edition.

7. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd
8. Stanbury, P.F., Whittaker, A and Hall, S.J., (1995) Principles of fermentation technology, Elsevier; 3rd edition.
9. Crueger and Crueger, A., Biotechnology: A text book of Industrial Microbiology, Sinavos association, InoSundeland; 2nd edition.
10. Cassida, J.E., (1968). Industrial Microbiology, New Age International (2007).
11. Presscott and Dunn, S., (1982) Industrial Microbiology. The AVI Publishing Company Inc., USA; 4th edition.

Paper II: Food Microbiology		**Subject code: MIB152D602**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (TP)**

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the Micro-organisms and their importance in food microbiology – molds, yeast, bacteria	**BT 1**
CO 2	Understanding of the organisms, and different factors those influence microbial growth in food.	**BT 2**
CO 3	apply the knowledge of microbes in Food fermentation **–** Bread, vinegar, fermented vegetables, fermented dairy products	**BT 3**
CO 4	Analysis of the microbial potential for fermentation and product development	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**

I	Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors; chemical preservation and food additives; canning process for heat treatment. Contamination and Spoilage **–** Cereals, Sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry spoilage of canned food; detection of spoilage and characterization.	**12**
II	Food-borne infections and intoxications **–** bacterial: *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia* and non-bacterial intoxication (withexamples of infective and toxic types) – Protozoa, algae, fungi and viruses; food borne outbreaks– laboratory testing procedures, preventive measures, GMP and Hazard Analysis and Critical Control Point. Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.	**12**
III	Food fermentation **–** Bread, vinegar, fermented vegetables, fermented dairy products; experimental and industrial production methods; spoilage and defects of fermented dairy products; oriental fermented foods – its quality standard and control. Preservation of food: High temperature (Boiling, Pasteurization. Appertization) Low temperature (Freezing): Dehydration. Osmotic Pressure. Chemical Preservations. Radiation	**12**
IV	Microbial cells as food (Single cell protein), mushroom cultivation; fermented beverages –beer and wine; steroid conversion – industrial enzymes, production of amylases, proteinases, cellulases, amino acid production – glutamic acid and lysine; pickles, olives, soy sauce,genetically modified (GM) foods.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Food Microbiology by William C Frazier. Tata Mgraw Hill
3. Food Microbiology by dams and Moss. Springer Verlag

References:

1. Adams MR & MO Moss (2005). Food Microbiology, New Age International (P) Limited. Publishers; 1st Edition, New Delhi.
2. James M Jay (2004). Modern Food Microbiology, CBS Publishers & Distributors; 4th Edition, New Delhi.
3. William Frazier and Dennis Westhoff (2008) - Food Microbiology McGraw Hill Education; 4 edition.
4. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
5. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
6. Fundamental Principles of Bacteriology A J Salle

DSE: Inheritance Biology		**Subject code: MIB152D603**
L-T-P-C-4-0-0-4 (T)	**Credit units: 4**	**Scheme of evaluation:**

Course Objective:

The course is developed with an objective to understand the fundamental principles of Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission. The course is also designed to enable the students to apply the principles of inheritance as formulated by Mendel and understand basic aspects of the flow of genetic information from DNA to proteins. Further, this course will enable students to understand the structure and its functional role in encoding genetic material.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic concept of genetics.	**BT 1**
CO 2	Understanding the transmission of character from one generation to t generation.	**BT 2**
CO 3	Apply the Mendelian law and another concept to recognize the genetic disorder	**BT 3**
CO 4	Analysis Patterns of inheritance of character generation to generation	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	Rules of Inheritance: Milestones in genetics, Mendelian genetics- Examples In pea plants, Drosophila and human, Patterns of inheritance, concept of gene.	**12**

II	Chromosomes as genetic material: Inheritance, Types, structure, Mitosis, Meiosis, polytene chromosome. DNA as the genetic material: - Structure, replication, gene expression-transcription, translation, and recombination.	**12**
III	Genome – Prokaryotic and Eukaryotic genome organization, Organelle genomes and Jumping genes, Genetic basis of heritable change – Mutation and its effects, chromosomal variations, Chromosomal syndromes	**12**
IV	Animal development – Embryogenesis, Genes involved in early development in Drosophila, Basic body axis formation, Evolution of body plan	**12**
Total		**48**

Textbooks:

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.

2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.

Reference Books:

1. Griffiths,AJF, Wessler SR, Lewontin RC, Gelbart WM and JH Miller 2005, Introduction to genetic analysis W.H. Freeman and Company, New York.

2. Simmons S 2006, Principles of genetics, 4th Edition, John Wiley & Sons (Asia) Pte Ltd. New Jersey.

3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.

4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork

5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

DSE: Pharmaceutical Microbiology **Subject code: MIB152D604**

L-T-P-C-3-1-0-4 **Credit units: 4** **Scheme of evaluation: (T)**

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the concept in Pharmaceutical microbiology, important microbes, and microbial products	**BT 1**
CO 2	Understanding the basics of pharmaceutical microbiology and in microorganism playing a role pharmaceutically	**BT 2**
CO 3	Apply the knowledge to develop the valuable microbial product	**BT 3**
CO 4	Analysis of the issue in the pharmaceutical industry related to microbes	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	An introduction and application of pharmaceutical microbiology; Basic aspects of pharmaceutical microbiology; Biology of pharmaceutically important microorganisms: Bacteria and fungi (yeast and molds); Study of microbial growth cycle, Microbiological growth media; Assessment of microbial growth; Isolation, identification, and characterization methods of microorganisms; Handling, cultivation, and preservation methods of microorganisms; Physical and chemical factors influencing microbial growth.	**12**
II	Microbial products in pharmaceutical industry: impacts and opportunities; antibiotics, production of antibiotics antifungal agents, antiviral, antiprotozoal drugs, small molecules, growth factors, hormones, vitamins, therapeutic enzymes, recombinant proteins, immunological products and vaccines etc.;	**12**
III	Microbial sources, contamination and spoilage of pharmaceuticals; Factors affecting microbial spoilage of pharmaceutical products; Microbial control in pharmaceutical industries; Antimicrobial resistance, Methodologies for testing of antimicrobial activity (broth-dilution methods and agar diffusion methods); Antimicrobial/preservative efficacy testing	**12**
IV	Microbial production of pharmaceuticals; Primary metabolic products, Secondary metabolic products; History and discovery of microbial natural products; Screening and development approaches for new microbial natural products; Good laboratory/manufacturing practices for pharmaceuticals production, validation and regulation; Government regulatory practices and policies for pharmaceutical industry: Food and Drug Administration (FDA), The Central Drugs Standard Control	**12**

	Organisation (CDSCO), the Drug Controller General of India (DCGI); patenting of pharmaceutical products.	
Total		**48**

Textbooks:

1. Geoff Hanlon & Norman A (2013). HodgesEssential Microbiology for Pharmacy and Pharmaceutical Science, Wiley-Blackwell
2. Madhu Raju Saghee , Tim Sandle , Edward C. Tidswell (2011). Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices,Business Horizons.
3. Geoff Hanlon, Norman A. Hodges (2013). Essential Microbiology for Pharmacy and Pharmaceutical Science,Wiley-Blackwell. 41
4. Stephen P. Denyer , Norman A. Hodges, Sean P. Gorman , Brendan F. Gilmore (2011). Hugo and Russell's Pharmaceutical Microbiology,Wiley-Blackwell.
5. Prahlad Singh Mehra (2011). A Textbook of Pharmaceutical Microbiology,I K International Publishing House

DSE: Microbes in Sustainable Agriculture and Development		**Subject code: MIB152D605**
L-T-P-C-3-1-0-4 (T)	**Credit units: 4**	**Scheme of evaluation:**

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the information about the microbes that play a crucial role in soil formation, Mineralization, and green house gas production	**BT 1**
CO 2	Understanding the basics of Soil as Microbial Habitat, Soil profile and prope	**BT 2**
CO 3	Apply the knowledge to use microbes for the betterment of Agriculture	**BT 3**
CO 4	Analysis of the issue in the implementation of microbes in agriculture	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil; Mineralization of Organic & Inorganic Matter in Soil; Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium.	**12**
II	Microbial Activity in Soil and Green House Gases: Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control; Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	**12**
III	Biofertilization, Phytostimulation, Bioinsecticides: Plant growth promoting bateria, biofertilizerssymbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. Secondary Agriculture Biotechnology: Biotech feed, Silage, Biomanure, biogas, biofuelsadvantages and processing parameters. GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.	**12**
IV	Microbial technology in agriculture: Crop improvement, molecular methods for improvement of crop yield, shelf life, etc. Microbial Consortia: Promising Probiotics as Plant Biostimulants. Microbe farming: methods, advantages, future in agriculture. From flask to field: Role of microorganisms in improving the soil quality and production, molecular methods for development of agriculturally important microbes.	**12**
Total		**48**

Suggested Reading:

1. Soil Microbiology, Ecology and Biochemistry 4th edition by Paul E., Academic Press, Elsevier. 2.Microbes and Sustainable Agriculture (2017); Prasad R., Kumar N., I.K. International Publishing House Pvt. Ltd.

DSE: IPR and Bioethics		**Subject code: MIB152D606**
L-T-P-C-3-1-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the definition of bioethics, IPR, Function and importance	**BT 1**
CO 2	Understanding trademark, copy right, trade secreat etc	**BT 2**
CO 3	Apply the knowledge of to protect copy right and related things	**BT 3**
CO 4	Analysis of the issue related to patenting the novel things	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Definition of IPR, function and importance. Forms of protection: Copyright and related rights, Patents, Industrial Designs, Trademarks, Trade Secrets, Geographical Indicators, Semiconductor layout circuits, Plant breeder, farmer rights etc. Patentable subject matter: Novelty and Application. International conventions and Treaties (WIPO). Importance of IPR in developing world with special reference to India.	**12**
II	IPRs in Biotechnology/Microbiology. Intellectual Property Management: Patent application process (national and International), Patent infringement, Patent Claims and Legal decision-making process. Structure of patent application including specifications, claims, prior art and patent designs. Landmark cases in Indian patent history. Guidelines for examination of biotechnology application for patent (Section 2, 3 and 10). Traditional knowledge digital library (TKDL) and Biological Diversity Act 2002.	**12**
III	Bioethics & legal issues: Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to microbiology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global issues.	**12**
IV	The legal, institutional and socioeconomic impacts of microbiology; Microbiology and social responsibility, Public education to increase the awareness of bioethics with regard to	**12**

	generating new forms of life for informed decision making-with case studies.	
Total		**48**

Suggested Reading:

1. Guidelines for examination of biotechnology application for patent (2013) Office of the Controller General of Patents, Trademarks and Designs.
2. Guidelines for processing patent applications relating to traditional knowledge and biological material (2013) Office of the Controller General of Patents, Trademarks and Designs. 56
3. Intellectual Property Rights: Legal and Economic Challenges for Development: Cimoli

Microbial Quality Control in Water and food		**Subject code: MIB152S113**
L-T-P-C-0-0-4-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objective:

This course is designed with the objective to provide an overview to students about different methods to study different kinds of Microbes present in water bodies and soil. The course will also provide a basic understanding about the presence of microbes in water bodies such as ponds, river water, ground water and soil such as agricultural land soil and contaminated soil with crude oil.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the different types of microbes present in water bodies and soil.	**BT 1**
CO 2	understanding the practical aspects of soil and water bodies	**BT 2**
CO 3	Apply various detection methodologies and use to identify beneficial and harmful microbes	**BT 3**
CO 4	Analyze and Identify problems associated with soil and water bodies contaminated with harmful microbes	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. Detection of faecal contamination in water bodies. 2. Measurement of coliform load in water bodies. 3. comparative study of coliform load in different water bodies	**12**
II.	4.Determination of microorganism in water Samples: Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical test 5. Twitching motility test of bacteria	**12**
III.	4. Isolation of Microbes from soil sample. 5. Serial dilution sample, plating and colony counting	**12**
	6. Morphological and chemical characterization of Bacteria 7. Molecular Characterization of Bacteria. 8. Antibiotic sensitivity test	**12**
TOTAL		**48**

Text Books :

1.Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

2. Maier RM, Pepper IL and Gerba CP. (2009).Env.Microbiology. 2nd edition, Academic Press

3. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

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Reference Books:

1.Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

2. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.

3.Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. NewYork.

4. Campbell RE. (1983). Microbial Ecology.Blackwell Scientific Publication, Oxford, England