MICROBIOLOGY

Programme Specific Outcomes:	
Programme offered by the Department	**Programme Outcomes**
B.Sc. Honours	• The course aim to inculcate interest with critical and analytical based understanding of the subject with encouragement and scope for creative learning. • The course is helpful in advancing the understanding and impact of Microbiology by connecting and empowering the transition of resource based communities to an intellectually vibrant knowledge based communities. • Ensuring an atmosphere conducive to teaching and learning process. • Boosting student's confidence in preparing for the hyper-competitive world. • Holistic intellectual development of young adults enrolled as students. • Providing Quality Higher Education and taking care of intellectual, social, economic needs of students. • Adopting student-friendly approaches to reaching and learning as far as practicable. • Igniting interests in students not only in their subjects but also in related fields and help them ramify and diversify areas of interest. • Encouraging participation of faculty in discussions to teach students with different learning paces for heterogeneous group of students. • Promotion of leadership qualities by promoting soft skills. • Taking periodic feedbacks of students. • To develop excellence in academics.

Course Outcomes:

SEMESTER	COURSE CODE	COURSE TITLE	OUTCOMES
I	CC1	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY)	**Course Objective:** The aim of this course is to familiarize the students with the elementary history of the subject Microbiology and the various theories proposed for Microbial existences which are used in understanding the basics of Microbiology in general. The core course will also help to describe the world-changing scientific contributions of pioneering scientist of the 17th to 18th century. The core course will help the students to understand the importance of morphological distinctness with respect to species diversity of Algae, Fungi and Protozoa and their Evolutionary relationship that exist in between them. Describe the contributions of eminent pioneer microbiologist, Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky and Selman A. Waksman in the establishment of the field of Microbiology
	CC1.1	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (PRACTICAL)	**Course Objective:** The Purpose of the lab course is to introduce students to the various types of instruments used in microbiology laboratory. They will learn to take weight measurements using electronics balance for preparing microbial media and reagents required in laboratory along with the art of sterilization using autoclaves,and hot air oven. The main objective of this subject is to help students identify the different latest measurement and sterilization techniques available for specific microbiological applications. Lastly, the course is so designed to provide greater safety awareness and to alert students to potential hazards in performing certain experiments in working laboratory. This course will lead the students to ➢ Understand the basic working of instruments used for measurement. ➢ Understand the errors in measurements and their rectification. Understand the importance of aseptic practices in Microbiology laboratory.
	CC2	BACTERIOLOGY (THEORY)	**Course Objective:** Bacteriology paper provides a thorough background on anatomical and structural organization of the basic fundamental unit of all living organisms called cell. Students get to understand the basic microbial structure, function and study the comparative characteristics of prokaryotes and eukaryotes and also understand the structural similarities and differences among various physiological groups of bacteria/archaea. This course also helps to understand various physical and chemical means of sterilization, historical background of culture growth media and their applications also various microbial techniques for the isolation of pure cultures in an artificial growth media along with the safe laboratory practices. Moreover, the topics also provide an opportunity to understand the importance of three distinct Domain system of life (Eubacteria, Archaebacteria and Eukaryotes).
	CC2.1	BACTERIOLOGY (PRACTICAL)	**Course Objective:** The course aims at developing an appreciation about the principles, functions of culture media used in microbiology laboratory and functioning of various instruments. Know various types of culture media and their applications and also understand various physical and chemical means of sterilization. After completion of course students will be able to work independently in microbiological laboratory, they will be able apply the principles and theories learned in the theory in the practical work context.

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II	CC3	BIOCHEMISTRY (THEORY)	**Course Objective:** The biochemistry course helps students to acknowledge the fundamentals required for understanding the chemical biology of microbes and human health. Students will be able to incorporate these concepts into their basic learning of chemical structures that are used as a precursor for the generation of biological macromolecules i.e. integration of metabolism with biochemistry. This course includes the laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions. It gives an overview of major biomolecules –carbohydrates, lipids, proteins, amino acids, nucleic acids, vitamins, enzymes, their classification, structure, and function will be dealt in details along with fundamental and conceptual knowledge of properties, structure, and function of enzymes, enzyme kinetics and their regulation will be covered using models.
	CC3.1	BIOCHEMISTRY (PRACTICAL)	**Course Objective:** The purpose of this practical course is to provide a basis for understanding the basic working design and use of spectrophotometer for determination of linear quantitative curve for the estimation of biological macromolecules. The course is intended to equip students with a basic understanding of the underlying principles of quantitative and qualitative research methods. This course also helps the students to understand the preparation of reagents and serial dilutions for preparation of standard curve. They will also learn the effect of physical factors and inorganic components mainly the heavy metals on the activity of functional molecules like enzymes.
	CC4	VIROLOGY(THEORY)	**Course Objective:** This course is offered to students to gain basic knowledge on Introduction to Virology and is followed by an exploration of theories of viral origin. The Virology course is designed in a lucid manner outlining the essential morphological architecture, physiological, and genetic elements of viruses as well as viroids, satellites, and prions. After successful completion of this course students will be able to: ➢ Contrast non-enveloped and enveloped viruses ➢ What are the possible ways available for the classification of viruses ➢ Describe the structure of lamda phage virus ➢ Compare and contrast DNA and RNA viruses. ➢ Compare and contrast animal and plant viruses. ➢ Describe the life cycle patterns of lamda phage ➢ Explain the various modes of Persistent, non-persistent, Vertical and Horizontal transmissions. ➢ Differentiate between oncogenes and protooncogenes ➢ Explain vaccine strategies and mechanisms of antiviral drugs and Interferons

	CC4.1	**VIROLOGY(PRACTICAL)**	**Course Objective:** To reinforce learning in the virology course through hands-on experience with plaque assay determination using agar double layer technique and plant assay using focal lesion technique. This course is intended to understand the students to critically analyze the operation of various electron microscopes for ultra-structure determination and morphological characterization of viruses. After completion of this course, the students will be: ➢ Capable of working with sewage sample for water quality analysis using plaque assay. ➢ To understand the importance of various method used in studying viruses. ➢ Describe electron micrographs of both the animal and plant viruses. ➢ Know viral diversity using electron micrograph.

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III	CC5	**MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)**	**Course Objective:** This course is offered to students to understand the basic of bacterial metabolism and nutrient translocation. The chapter included in the course will be helpful for the student to know the nutritional requirements needed for the biosynthesis and energy yielding and energy-conserving process of each nutritional type. Microbial metabolism is the means by which microbes obtain the energy and nutrients it needs to love and reproduce. After successful completion of this course students will be able to: ➢ Explain the concept of diauxic growth. ➢ Classify organism on the basis of temperature, pH, salt, oxygen requirements ➢ Explain the concepts of aerobic respiration, anaerobic respiration and fermentation and various intermediary mechanism involved. ➢ Comment on the various sugar degradation pathways ➢ Describe with flow diagram , EMP,ED, TCA cycle and electron transport phosphorylation
	CC5.1	**MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)**	**Course Objective:** This course is offered to student to understand the basics of bacterial metabolism and nutrient translocation. The chapter included in the course will be helpful for the students to know the nutritional requirements needed for the biosynthesis and energy yielding and energy conserving process of each nutritional type. The concept of microbial metabolism is presented by discussing the chemical reactions, mainly the redox reactions for understanding the interconnected biochemical pathways used by the cells. Moreover, the coverage of nitrogen metabolism is expended and updated for better physicochemical understanding of nitrogen fixation by nitrogen fixers.
	CC6	**CELL BIOLOGY (THEORY)**	**Course Objective:** This course introduces the concept of cell biology. The chapters included in different unit deals with the morphology, types, ultrastructure and function of cells. It also discusses the mechanics of cell signalling with respect to second messenger and cell sorting to various cellular compartments. The course also throws light on the mechanism of cell division and its regulatory mechanism through CDK phosphorylation. Moreover, a very significant topic of cancer biology and apoptosis has been covered to a greater extent. After successful completion of this course students will be able to: ➢ Describe the cell organisation in relation to plant, animals and bacterial cells ➢ What are the various mode available for the transport of small molecules across the biological membrane ➢ Describe the general cell wall structure of Eukaryotes ➢ Explain the importance of cell organelles in the survival of living organisms ➢ Describe the ultra structure of various cell organelles present in eukaryotic microorganisms ➢ Describe the overall structure of nuclear envelope nuclear pore complex and nuclear lamina

	CC6.1	**CELL BIOLOGY (PRACTICAL)**	**Course Objective:** The purpose of this course is to introduce the students the basics of cell biology. The course provides the opportunity to observe cell undergoing mitotic and meiotic division in a real time basis using compound microscope. Moreover, the experiments in this laboratory course enable the students to gather basic knowledge on chromosomal material through cytochemical staining. After completion of this course, the students will be: ➢ Capable of counting chromosome under the microscope. ➢ Describe the size and shape of chromosome at various stages of mitotic phase.
	CC7	**MOLECULAR BIOLOGY (THEORY)**	**Course objective:** The purpose of this course is to introduce the students the basics of molecular biology. The course provides To study in detail the structure of DNA and RNA with elaborate knowledge on the replication of the former and in-depth knowledge on the transcription and translation of the latter. This course develops concepts in molecular biology: DNA packaging, DNA damage and repair, gene structure, expression and regulation in both prokaryotes and eukaryotes. After completion of this course, the students will be: ➢ Understanding of gene structure, expression and regulation of gene expression in both prokaryotes and eukaryotes for application in molecular research. ➢ To study concept and general prossess of replication in Prokaryotes. ➢ To study concept and general prossess of transcription. ➢ To study process of translation in Prokaryotes.
	CC7.1	**MOLECULAR BIOLOGY (practical)**	**Course objective:** The purpose of this course is to introduce the students the basics of molecular biology. The course provides to study of different types of DNA and RNA using micrographs and elaborate knowledge on the replication of the former and in-depth knowledge on the transcription and translation of the latter. After completion of this course, the students will be: ➢ Capable of isolate genomic DNA from *E.coli.* ➢ Capable of visualize DNA by Agarose Gel Electrophoresis.
	SEC 1 (PAPER 2)	**BIOFERTILIZERS AND BIOPESTICIDES**	**Course objective:** The purpose of this course is to introduce the students the basics of biofertilizer and biopesticides. Biofertilizers supplement the requirements of fertilizers and do not replace them. The use of biofertilizers is being emphasized along with chemical fertilizers and organic manures.Biofertilizers are live products (or latent cells of microbes) and require care in storage, transport, application and maintaining field conditions. Applied to seed/seed material/seedlings/soil/waste matter/crop

			residues in order to increase the population. Accelerate some biochemical processes. **Learning Outcome:** ➢ How biofertilizers are used for various crop plant productionand their advantages ➢ Development of integrated management for best results uses both nitrogenous and phosphatic biofertilizers ➢ Make more nutrients available to the crops ➢ How microbes are used as bioinsecticides and their advantages over synthetic pesticides

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IV	**CC8**	**MICROBIAL GENETICS (THEORY)**	**Course Objective:** Microbial genetics have revolutionized the field of microbiology and the present course covers genome organization, mutations and mechanism in the context of genetic variation into populations. Content also focuses on the mechanism of viral multiplications and stresses on phage genetics and molecular switch. It will enable the students to know the terms and terminologies related to molecular biology. It will help student to understand the properties, structure and function of genes at the molecular level. After successful completion of this course students will be able to: ➢ Demonstrate the ability to make connections between concepts across Microbiology. ➢ Know the terms and terminologies related to molecular biology and microbial genetics ➢ Describe the structure and function of plasmids.
	CC8.1	**MICROBIAL GENETICS (PRACTICAL)**	**Course Objective:** Microbial genetics have revolutionized the field of microbiology and the present course covers genome organization, mutations and mechanism in the context of genetic variation into populations. Content also focuses on the mechanism of viral multiplications and stresses on phage genetics and molecular switch. The main objective of this course is to help student's physical understanding of the genetic material present in all living organism. After completion of this course, the students will be; ➢ Able to prepare master plate and replica plate ➢ Able to isolate plasmid DNA ➢ Able to demonstrate bacterial transformation
	CC9	**ENVIRONMENTAL MICROBIOLOGY (THEORY)**	**Course Objective:** **t**he study of microbes helps us to understand our world and our place within it. It gives us insights into the complexity of nature and society, which in turn provide many different health environmental, social, cultural, industrial and economic benefits. Microorganisms are intimately involved in the geochemical cycles, transport and transformations of the elements in nature, including pollutants. Learning and understanding these processes allow us to use microorganisms to solve environmental problems. After completion of this course, the students will be; ➢ To study presence of pathogens in drinking water. ➢ To study the relationship between microorganisms and geochemistry.
	CC9.1	**ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)**	**Course outcomes:** It is a diverse discipline that ranges from the study of pathogens in drinking water to the relationship between microorganisms and geochemistry. This is a specific paper which will train students for sustainable development by maintaining soil health. Besides this, they will be acquainted with the microbiological quality of water. After completion of this course, the students will be; ➢ Able to analysis the soil pH, moisture, water content.

			➢ Able to isolate microbes (bacteria,fungi)from soil in different temperature. ➢ Able to isolate microbes from rhizosphere and rhizoplane.zone of soil. Able to assessment of microbiological quality of water
	CC10	**FOOD AND DIARY MICROBIOLOGY (THEORY)**	**Course objective:** The purpose of this course is to introduce the students the basics of food and dairy microbiology. The course provides. To study general principles of food microbiology, food preservation, fermented and microbial foods. To study epidemiology of food-borne microorganisms of public health significance and food spoilage microorganisms.To study microbiological examination of foods, microbiological quality Control and quality schemes. ➢ Students will gain knowledge of significance and activities of microorganisms in food. ➢ Students will also study interaction between microorganisms and factors influencing their growth and survival. ➢ Students will study use of standard methods and procedure for the microbiological analysis of milk. ➢ Students will study the characteristics of food-borne microorganisms and spoilage microorganisms and preventive.
	CC10.1	**FOOD AND DIARY MICROBIOLOGY (PRACTICAL)**	**Course objective:** ➢ Students will gain knowledge about microbiology of milk and fermented products. ➢ Students will also know the microbial quality control and quality schemes used in food industries. ➢ To understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in food and dairy. ➢ To know the spoilage mechanisms in foods and dairy and thus identify methods to control deterioration and spoilage ➢ To recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods and dairy. ➢ To learn various methods for their isolation, detection and identification of microorganisms in food and dairy. ➢ To understand of the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food and dairy.
	SEC2 (PAPER 4)	**FOOD AND FERMENTATION TECHNIQUES**	**Course objective:** Students will be able to learn about the isolation, maintenance, improvement processes of various industrially important strains and how they are used for mass production of industrially important products such as antibiotics, vitamins, enzymes, including enzyme immobilization. After successful completion of this course students will be able to: . ➢ To list the different types of fermented foods ➢ State the health benefits advantages of fermented foods ➢ To learn the various types of milk based fermented foods like Dahi, Yogurt, Buttermilk (Chach) and cheese ➢ Describe the importance of cereal based fermented foods

Semester	Course Code	Course Title	COURSE OUTCOME
V	**CC11**	**INDUSTRIAL MICROBIOLOGY (THEORY)**	**Course objective:** Students will be able to learn about the isolation, maintenance, improvement processes of various industrially important strains and how they are used for mass production of industrially important products such as antibiotics, vitamins, enzymes, including enzyme immobilization.
	CC11.1	**INDUSTRIAL MICROBIOLOGY (PRACTICAL)**	**Course objective:** This course helps students to learn about the various parts of a bio reactor and its function. They will get a hands-on experience at a lab scale production and estimation of enzymes. Along with that, this paper includes an industrial tour where they can correlate their theoretical knowledge with real time learning.
	CC12	**IMMUNOLOGY (THEORY)**	**Course objective:** The aim of immunology course is to introduce students to the concept of immunological cells, organs, antigens, antibodies and also about immune response. Along with that they get to learn about the immunological techniques, which will be beneficial to students, who want to pursue research or a carrier in medical field.
	CC12.1	**IMMUNOLOGY (PRACTICAL)**	**Course objective:** This course aims at developing skills in practicals such as blood grouping, serum separation and leukocyte count etc. that provide students the knowledge that can be utilized by them in future research or lab work. They will learn to perform the total leukocyte count, differential count and immunodiffusion (ouchterlony method).
	DSE 1(PAPER 1)	**INSTRUMENTATION AND BIOTECHNIQUES (THEORY)**	**Course objective:** This course introduces the concept of various biotechniques that are essential for day-to-day laboratory work. This course offers detailed theoretical knowledge on microscopic techniques and its types, chromatographic techniques, electrophoresis and spectroscopy.
	DSE 1.1	**INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)**	**Course objective:** The ray diagrams and micrographic studies incorporated in this course ensures better learning experience. Also, chromatographical practical help students to bridge a connection between theoretical and practical approach. They will get to learn about the density gradient centrifugation. Separation of mixtures with the help of paper chromatography is also incorporated in this course.
	DSE 2 (PAPER 4)	**MICROBIAL BIOTECHNOLOGY (THEORY)**	**Course objective:** Microbial biotechnology has revolutionized the field of microbiology and the present course covers detailed study on therapeutic and industrial biotechnology, application of microbes in bioinformatics. The bio disel, ethanol production,

			immobilization techniques and knowledge on copyright and patents form the foundation for training undergraduate students as applied biotechnologists.
	DSE 2.1	**MICROBIAL BIOTECHNOLOGY (PRACTICAL)**	Here the students will learn about various immobilization techniques (both whole cell and enzyme). They will also learn the techniques needed for isolation of industrially important bacteria such as lipase producers. The study of single cell protein is also incorporated. Students will gain the knowledge of microbial gene and genome structure and how this can be manipulated.

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VI	**CC13**	**MEDICAL MICROBIOLOGY (THEORY)**	**Course objective:** The medical microbiology course introduces basic principles and applications, relevance of clinical diseases for students who are in preparation for medical line. The content of this course includes the study of many etiological agents responsible for global infectious diseases, understanding about immune system, antigen-antibody interaction. Students can gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.
	CC13.1	**MEDICAL MICROBIOLOGY (PRACTICAL)**	**Course objective:** The medical microbiology course help students to learn about the application of medical microbiology. Identification of bacteria on the basis of cultural, morphological and biochemical characteristics. They will also learn to prepare complex media used for differential selection of targeted microbes. The skills of antibacterial sensitivity test, minimum inhibitory concentration of antibiotics is also acquired by students after successful completion of this course. Photomicrographical studies of various infectious microbes and the symptoms of the respective diseases are also studied in this course.
	CC14	**RECOMBINANT DNA TECHNOLOGY (THEORY)**	**Course objective:** The course provides theoretical bases along with the applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants. Also, about various gene transfer techniques and screening of transformants. With this knowledge students will be able to design a workflow to carryout RDT experiments.

	CC14.1	**RECOMBINANT DNA TECHNOLOGY (PRACTICAL)**	**Course objective:** Students will acquire knowledge on tools and techniques in rDNA technology, also about DNA manipulative enzymes. They will learn to prepare competent cells, methods for selection of transformants. Also the restriction digestion of DNA, followed by it's interpretation with the help of electrophoresis is incorporated in this course.
	DSE 3 (PAPER 5)	**BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)**	**Course objective:** This course introduces the concept and use of biosafety practices and principles to reduce health related risks associated with handling infectious agents, toxins and other biological hazards that is important in a laboratory setting. Along with that the trademark, copyright and patent knowledge will help the students during their research work.
	DSE 3.1	**BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)**	**Course objective:** The study of components and design of BSL laboratories will make sure the students are well aware of the instruments, organisms and safety measures while working in the lab. Filling application forms for approval of biosafety lab or patent will benefit them if they peruse research work. The case study incorporated in this course will give them a detailed step by step insight. They will be able to demonstrate understanding of some of the legislative and ethical issues related to microbiology.
	DSE 4 (PAPER 7)	**MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)**	**Course objective:** At the end of this course students will have a clear knowledge on the use of biofertilizers and its types. This course also provides a clear knowledge of soil composition and microflora that are responsible for various mineralization processes in soil. Biofuel processing parameters, biogas production, genetically modified crops will teach them about the sustainable and advanced alternatives.
	DSE 4.1	**MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)**	**Course objective:** Students opting for higher studies in agricultural field will specially be benefited by this course as they will get to study about field application of various plant growth promoting bacteria, study about their characteristics and importance. Along with that the study of different soil microbes are essential in understanding soil properties and in selection of suitable agricultural crops. They will be able to demonstrate an understanding of the processes involved in small-scale and industrial scale biogas plant. Lastly, they will get to isolate a cellulose degrading organism.