

B.Sc. (Hons.) Microbiology

| PAPER NAME | COURSE LEARNING OUTCOME |
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| Introduction to Microbiology and Microbial Diversity | Upon successful completion of the course, the student have : <ol style="list-style-type: none">1. Understanding on the development of microbiology as a separate discipline and its scope2. Gained knowledge on different classification systems3. Acquired in-depth knowledge of protozoa, algae and fungi |
| Bacteriology | Upon successful completion of the course, the student will have: <ol style="list-style-type: none">1. Knowledge about the different cell components, structure and organization of bacterial cell wall and cell membranes. able to explain different staining reactions2. Acquainted with the practical knowledge on bacterial isolation, cultivation and preservation techniques.3. Understand bacterial nutritional requirements and composition of different medium used4. Able to briefly explain methods of asexual reproduction in bacteria, different phases of their growth curve, generation time and growth rate.5. Can define and differentiate various types of classification systems.6. Will get acquainted with differences between archaea and eubacteria and can list their important general characteristics along with their ecological significance and economic importance. |
| Introduction and Scope of Microbiology | Upon successful completion of the course, the students: <ol style="list-style-type: none">1. Will be acquainted with the historical developments and different scientific contributions2. Will have learned the different systems of classification and would have acquired knowledge on the characteristics and diversity prevalent among different groups of acellular and cellular microorganisms.3. Will be able to list important human diseases and their causative agents. Will also acquire knowledge about the immune system.4. Will be conversant with microbial interactions; the impact of microorganisms on agriculture and environment will also be dealt with.5. Will have gained an insight into the types of fermentation processes, fermenters and the application of microorganisms in the mass-scale production of metabolites/biomass. Will also be able to list microorganisms used as food and food supplements and discuss the desirable and undesirable activities of microorganisms in association with foods.6. Will be aware of the physical and chemical agents of microbial control used for sterilization and disinfection. |

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| <p>Biochemistry</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have developed an understanding of the principles of thermodynamics applied to biological systems and will be able to calculate free energy changes accompanying metabolic reactions and comment on their feasibility. 2. Will be thoroughly conversant with the structures of carbohydrates and their key properties and be able to detect their presence in samples by performing chemical tests. 3. Will be able to explain the properties of storage and membrane lipids. Will be acquainted with different types of lipid aggregates and their applications. 4. Will be conversant with the structure and properties of amino acids, formation of polypeptides and protein folding. Will become familiar with the use of spectrophotometer and would have gained practical knowledge of biochemical techniques with proteins. 5. Will be familiar with the structures of the building blocks of nucleic acids. Will become conversant with the key conventions used in nucleic acid description. 6. Will have learnt the basic concepts of enzyme biochemistry including enzyme kinetics, and will become aware of different variants of enzymes found in living cells. |
| <p>Cell Biology</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. CO1: Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanisms and cytoskeleton. 2. CO2: Will be able to understand the structures and functions of the nucleus and different cell organelles. The structural organization and function roles of chromatin will be learnt. 3. CO3: Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export. 19 4. CO4: Will have gathered understanding of how cells perceive and respond to various signals from within and outside. 5. CO5: Will have learnt the mechanisms of cell division and the significance of cell cycle and its regulation. Will become familiar with stem cell technology and its applications. 6. CO6: Will understand the basics of cancer biology including diagnostic techniques and therapy |

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| <p>Bacteriology and Virology</p> | <p>Upon successful completion of course the student:</p> <ol style="list-style-type: none"> 1. Will have gained knowledge about structure and organization of different cell components of bacteria. Will be able to differentiate between Gram positive and Gram-negative bacteria; archaebacteria and eubacteria cell wall and cell membrane. 2. Will get familiar with various media and techniques used for cultivation and maintenance of different types of bacteria. Will also gain insight into different phases of growth in batch culture and binary fission as a method of reproduction. 3. Will understand the concept of different types of classification. Will learn about the morphology, ecological significance and economic importance of the various bacterial genera. 4. Will understand morphology of viruses with important examples. 5. Will have learnt structure and replication of different groups of viruses. Will get acquainted with the concept of lytic cycle and lysogeny. 6. Will become aware of viral pathogens of plant, animal and human diseases. Will also gain knowledge about prevention and control of viral diseases. |
| <p>Microbial Physiology and Metabolism</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have got acquainted with the diverse physiological groups of bacteria/archaea and microbial transport systems. 2. Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation of generation time and specific growth rate, and effect of the environment on growth. 3. Will understand the variety of pathways used by bacteria for energy generation and conservation during growth on glucose under aerobic and anaerobic conditions. 4. Will become conversant with two important fermentation pathways in microbes. 5. Will have an added knowledge on the groups and families of chemolithotrophs and phototrophs, based on their ability to extract energy from inorganic compounds and assimilate carbon from CO₂. 6. Will have learnt about a typical capability of prokaryotes to reduce nitrogen gas to ammonia. Will become familiar with the physiology of nitrogen fixation and assimilation of inorganic nitrogen by bacteria. |

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| <p>Environmental Microbiology</p> | <p>Upon successful completion of the course, the students:</p> <ol style="list-style-type: none"> 1. Will get acquainted with natural habitats of diverse microbial population. And be familiar with microbial succession and concept of metagenomics. 2. Will understand how microbes interact among themselves and with higher plants and animals with the help of various examples. 3. Will become aware of the important role microorganisms play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance. 4. Will gain in-depth knowledge of different types of solid wastes and their management with emphasis on advantages and disadvantages of various methods used for their treatment. 5. Will acquire knowledge about composition and strength of sewage and its treatment using primary, secondary and tertiary methods. Will have learnt about treatment and safety of drinking water and be conversant with different methods to test its potability. 6. Will get familiar with problems of pollution and applications of clean-up technologies (bioremediation) for the pollutants such as pesticides, oil, e-waste and plastic in the ecosystem and gain insights into the importance of finding sustainable and novel methods for treating such pollutants. |
| <p>Molecular Biology</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms. 2. Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication. 3. Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved. Will be able to distinguish between the process in prokaryotes versus eukaryotes. 4. Will understand the concept of split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA. 5. Will get a clear understanding of translational mechanisms in both prokaryotes and eukaryotes along with the inhibitors of protein synthesis. 6. Will understand various mechanisms involved in regulation of gene expression in prokaryotes and eukaryotes at the level of transcription, post-transcriptional processes, and modifications in chromatin structure |

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| <p>Microbial Quality Control in Food and Pharmaceutical Industries</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have knowledge about Good Laboratory Practices and biosafety. 2. Will have understanding of the various tests used in food and pharmaceutical industries to detect and assess microbial load. 3. Will have learnt the concepts of TQM and will understand the checks that can be performed to manage microbiological issues. Will become familiar with various standards and certifications for food and pharmaceutical products. |
| <p>Applications of Microbes in Biotechnology</p> | <p>Upon successful completion of the course, the students:</p> <ol style="list-style-type: none"> 1. Will get an overview the versatile role and applications of microbes in biotechnology. 2. Will get familiarized with how genetic manipulation of microbes may yield products of immense medical/therapeutic value like vaccines. 3. Will learn how microorganisms are used in the production of important industrial products like enzymes, SCP's etc. Whole cell/enzyme immobilization strategies would help the students to understand how fermentation processes can be improved and made commercially feasible. 4. Will understand the importance of microorganisms in environmental management and combating pollution through degradation of xenobiotics and bioremediation and in production of renewable energy alternatives like biofuels. 5. Will become conversant with the role of microbes in agricultural biotechnology especially in development of transgenic crops with desirable traits like disease resistance etc. The use of microbes in formulation of biopesticides and biofertilisers will also be discussed. 6. Will obtain information on IPR and its main components in protection of recombinant products. |
| <p>Microbial Genetics and Genomics</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will be acquainted with the organization of prokaryotic and eukaryotic genomes and organelle genomes in eukaryotes. 2. Will get acquainted with basic and applied aspects of mutations and mutagenesis and their importance and the role of mutator genes. Will learn of the use of a microbial test in detecting the carcinogenic potential of chemicals. Will become aware of different repair mechanisms. 3. Will have learnt the role of plasmids and their types in microorganisms. Will get acquainted with plasmid replication and partitioning as well as aspects related to plasmid copy number, its regulation and plasmid curing. 4. Will be aware of detailed mechanisms of genetic exchange in bacteria. Will be familiarized with molecular aspects and applications of transformation, conjugation, and transduction. Will learn how to map genes using interrupted mating technique and recombination. 5. Will be familiar with the lytic/lysogenic switch in phage lambda. Will be able to discuss the role of CRISPR-Cas in bacterial defense mechanisms. 6. Will be acquainted with fundamentals and applied aspects of transposons, types and mechanisms of transposition. Will have learnt |

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| | of various eukaryotic transposons and their uses. |
| Virology | <p>Upon successful completion of the course the student will have acquired the knowledge in the following areas and:</p> <ol style="list-style-type: none"> 1. Will be able to describe the nature, properties and structure of viruses and will also gain knowledge of taxonomy of different groups of viruses. 2. Will be familiar with diversity and multiplication of lytic and lysogenic bacteriophages. 3. Will be able to describe different ways of viral transmission, and prominent and unusual genomic features of different viruses with their significance. 4. Will understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses. 5. Will have gained knowledge about strategies to prevent viral infections: interferons, vaccines and antiviral compounds 6. Will understand the concept of oncogenesis, DNA and RNA cancer causing viruses and will learn of newly emerging viruses which have the potential to cause serious threats to public health and have become a global concern. |
| Food and Dairy Microbiology | <p>On successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will be aware of the possible sources of contamination of foods and the parameters affecting microbial growth in foods. 2. Will gain insight into the microbial spoilage of some foods 3. Will acquire an in-depth knowledge of various physical and chemical methods used for food preservation. 4. Will be acquainted with microbial production of fermented dairy and non-dairy food products. Will also be able to understand the health benefits of prebiotics, probiotics and synbiotics. 5. Will be conversant with some food-borne diseases and will be able to explain methods for detection of food borne pathogens. 6. Will be able to understand the concept of quality control of food. |
| Microbial Diagnosis in Health Clinics | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have understood the importance and challenges in detecting pathogens. Will have a fair understanding of various methods used for collection, transport and storage of clinical samples. 2. Will have been acquainted with the principles of various classical and newer approaches for the identification of microbial pathogens such as microscopy, culturing, biochemical tests, serological and molecular methods. 3. Will have an understanding of the applicability of various detection methods in the form of kits for rapid detection of pathogens. Will have learnt various methods for determination of antimicrobial resistance in bacterial pathogens. |

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| <p>Industrial and Food Microbiology</p> | <p>On successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have acquired knowledge about different types of fermentation processes feasible using both solid and liquid state substrates/media. They will also be acquainted with types of fermenters and the components of a typical fermenter. 2. Will have learnt the various techniques involved in the isolation, screening, preservation, and maintenance of industrial strains. They will also be familiar with the ingredients used in a fermentation medium. 3. Will have gained in-depth knowledge about the microbial production of various products and enzymes in the industry along with their downstream processing. 4. Will have gathered an understanding of important parameters affecting microbial growth in foods. Spoilage of some common foods by microorganisms will also be discussed. And student will acquire knowledge of commonly occurring food borne diseases. 5. Will become acquainted with different physical methods and chemicals used in food preservation. The student will also be aware of the concept of quality control of food. 6. Will be conversant with the use of microorganisms in the production of fermented foods (dairy and non-dairy), and microorganisms as food supplements. |
| <p>Industrial Microbiology</p> | <p>Upon successful completion of the course the student:</p> <ol style="list-style-type: none"> 1. Will understand the development and importance of industrial microbiology and will be conversant with different types of fermentation processes in liquid media as well as solid state substrates media. 2. Will learn about the design, operation and uses of different types of fermenters of laboratory, pilot and industrial scale. 3. Will gain insight into the techniques of isolation, screening, preservation and maintenance of industrially important microbial strains and different types of media used in fermentation processes. 4. Will be acquainted with principles of techniques used for the extraction and purification of industrial products produced using microbial fermentation processes. 5. Will have gained in-depth knowledge of the principles of microbial production and recovery of industrial products at large scale. 6. Will have an understanding of the methods of enzyme immobilization, its advantages, drawbacks and its applications in the industry |

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| Immunology | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defense. 2. Will have gained an in-depth knowledge of characteristics and functions of the cells of the immune system and the organization of organs of the immune system. 3. Can understand the characteristics that make the molecules to act as antigens. The students will also be conversant with the types, properties and functions of antibodies made against the antigens. 4. Will be able to outline the production and use of monoclonal antibodies.O4: Will understand the cell surface proteins essential for generation of acquired immune response to differentiate self and non-self molecules and the pathways for antigen processing and presentation. 5. Will be acquainted with the mechanisms by which the complement system is recruited and enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from an organism, promotes inflammation, and attacks the pathogen's cell membranes. 6. Will be acquainted with the generation and the killing mechanisms of humoral and cell mediated immunity. Will have gained in depth knowledge of various immunological techniques. |
| Bioinformatics | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will be acquainted with bioinformatics and its relation with molecular biology, genetics and genomics, understanding of relational databases, various modes of data transfer and simultaneously learning the advantages of encrypted data transfer, gained an in-depth knowledge of primary, secondary and composite databases, organization of diverse types of biological databases. 2. Will be familiar with the file formats of sequence ad molecular file formats. This allows students to apply the acquired knowledge in retrieving and analyzing biological information on the web. 3. Will have learnt the concept and significance of sequence alignment, use of scoring matrices and gaps penalty, comparative assessment of global and local sequence alignment, approaches and softwares used for pairwise and multiple sequence comparisons and their applications 4. Will be conversant with phylogeny, types of phylogenetic trees, and approaches of phylogenetic tree construction and will be able to choose appropriate phylogenetic method for the desired group of sequences 5. Will have gathered understanding of diversity of viral, prokaryotic, eukaryotic genomes and their organization, sequencing strategies, also the knowledge of current techniques in genomic and interactomics along with current concepts in gene organization, challenges in gene prediction, primer designing |

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| Instrumentation and Biotechniques | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none">1. Will have identified the principle components of a light microscope, fluorescence microscope, phase contrast microscope, confocal and electron microscope, simultaneously learning about their principles and practical applications in visualizing, identifying and measuring cell, its components and biomolecules. The student will be familiar with staining and preparation of samples for microscopy.2. Will have gained an in-depth knowledge of principles and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, GC, HPLC. This enables the students to apply the acquired knowledge in isolation and separation of biomolecules for analysis.3. Will have learnt basic concepts of various techniques used to resolve and analyze nucleic acids and proteins - agarose gel electrophoresis, native polyacrylamide gel electrophoresis, SDSpolyacrylamide gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, zymogram preparation.4. Will comprehend details of working principle and outline of UV-visible spectrophotometer as well as be able to understand absorption spectra of biomolecules, and will be able to interpret UVvisible and fluorescence spectroscopy outputs.5. Will have clear fundamentals of centrifugation, RCF, sedimentation coefficient, different types of rotors used, principle and working of differential and density gradient centrifugation, preparative and analytical scales of centrifuge, and the specific uses of ultracentrifuge. Students will also be acquainted with limitations of each method. |
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| <p>Medical Microbiology</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Will have understood the diverse nature of the normal microflora of the body and its significance as well. Student will have also acquainted themselves with the terminology and scientific nomenclature used in describing disease causation and pathogenic features of microbial agents of disease. 2. Will have gained an in depth knowledge about the spectrum of diseases caused by bacterial pathogens, and an understanding of the course of disease development and accompanying symptoms. Will become familiar with the methods of transmission, epidemiological aspects as well as prevention and control methods. 3. Will become acquainted with the spectrum of diseases caused by viral pathogens. Also will understand the course of disease development and symptoms seen in diseases of different organ systems. 4. Will understand the causation of fungal and protozoal diseases and methods of prevention and control. 5. Will learn about the current approaches to diagnosis of diseases. 6. Will have learnt basic concepts of handling clinical specimens and approaches used to aid in detection/diagnosis of diseases using immunological and molecular biology based methods. Will also understand the mode of action of different antimicrobial agents and concept of antimicrobial resistance. |
| <p>Recombinant DNA Technology</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. CO1: Will get an overview of developments and contributions of scientists in the field of genetic engineering. 2. CO2: Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors. 50 3. CO3: Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and protein analysis. 4. CO4: Will gather in-depth knowledge of DNA amplification and sequencing methods. 5. CO5: Will become conversant with construction and screening of genomic and cDNA libraries. 6. CO6: Will become aware of the applied aspects of all major techniques being used for the benefit of humankind in the areas of agriculture and pharmaceuticals. Students will design a strategy outlining all the steps of developing a novel recombinant. |

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| <p>Microbial Biotechnology</p> | <p>Upon successful completion of the course, the students:</p> <ol style="list-style-type: none"> 1. Will get an overview of the possibility of using microbes in a number of technologies and fields for the direct/indirect benefit of mankind and the environment. 2. Will get familiarized with how manipulated producer microbes and/or procedures may yield products of medical/therapeutic value, hence contributing to human longevity. 3. Will learn how microorganisms are the mightiest candidates in fighting environmental pollution and minimizing xenobiotics, thereby elevating human living conditions. Biosensors and whole cell/enzyme immobilization would be appealing illustrations to the students as some of the strategies towards this goal. 4. Will delve deep into the role of microorganisms in maintaining environmental homeostasis, combating pollution, eliminating xenobiotics and inexpensive energy production from waste natural lignocellulosics. 5. Will become familiar with the contribution of specific microorganisms in traditional agriculture practices, and will become acquainted with GM crops, RNA interference and edible vaccines. 6. Will obtain information on IPR, its main components, national institutes related to the same, the know-how of start-ups and the importance of innovative research. |
| <p>Advances in Microbiology</p> | <p>Upon successful completion of the course, the student:</p> <ol style="list-style-type: none"> 1. Gains knowledge about features of sequenced genomes and ways of DNA transfer in nature and virulence in bacteria. 2. Will be able to acquire, articulate, retain and apply specialized knowledge and understanding of the core concept of CRISPR/Cas system for the future implication of research. 3. Will have learnt the concepts of metagenomics which circumvents the unculturability and genetic diversity of microbes, the biggest roadblocks to advances in biotechnology. 4. Will have gathered understanding of how plants protect them from pathogens and role of biofilms. 5. Will have learnt basic concepts of biological networks, their applications and get introduced to the basic principles of synthetic biology. 6. Will get acquainted with the basic concepts of nanotechnology, its development and the current applications. |