Master of Science (Biotechnology)

Program Outcomes (POs)

Program Outcome	Description
PO1	Foster learning through accumulation of knowledge in Science.
PO2	Identify complex problems in the society which can be addressed through science.
PO3	Formulate strategies and design experiments to address the societal problems using first principles of basic sciences and applied sciences
PO4	Adopt appropriate scientific techniques and resources, to solve societal issues with an understanding of the limitations
PO5	Critically and analytically evaluate and interpret research based data to provide valid conclusions and solutions
PO6	Demonstrate leadership qualities by working collaboratively in a team, to set goals, communicate scientific information to stakeholders, comprehend and write reports, develop documentation, make presentation and to give and receive clear instructions
PO7	Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practice
PO8	Engage in life-long learning in the broadest context of scientific advancement.

PROGRAM SPECIFIC OUTCOMES:

PSO	Description
PSO1	Communicate and analyse the core concepts and theories in Biological Sciences (Cell Biology, Biochemistry, Microbiology, Immunology, Molecular Biology, Genetic Engineering, Computer basics, Biostatistics and Biophysics)
PSO2	Apply basic concepts/ theories of Life Sciences for current social issues, and in key fields such as agriculture, environment, human health, Transgenic animals, transgenic plants and GMOs, plant diseases, drug designing
PSO3	Plan and design systematic research activities in the field of Biotechnology including necessary skills for collecting, processing and interpreting data and drawing logical inferences

Course Outcomes (COs)

2019-20 Batch

Semester	Course Code	Course Name	Course Outcomes (COs)
I	**18MSBT1H01**	**Basic Mathematics and Biostatistics**	**CO1:** Describe and discuss the key concepts, tools and techniques used in mathematical sciences, including graphs and functions, trigonometry, ratio and proportion **CO2:** Recognize and critically discuss the theory related to sampling, significance and applications **CO3:** Employ appropriate analyses from a variety of numerical summaries including measures of central tendency and variation; statistical procedures and interpret the analyses with clarity **CO4:** Choose appropriate strategies for correlation and regression studies **CO5:** Examine statistical hypothesis, dissect the results correctly and test conclusions consistent with the theory
	18MSBT1H02	**General Microbiology**	**CO1:**Explain evolution of microbiology; identify and characterize microorganisms based on its morphology and biochemical characteristics; Discuss and apply microbial techniques to isolate, preserve and study various microbial isolates **CO2:**Appreciate and illustrate microbial diversity; Demonstrate microbial growth and interpret the physical factors affecting microbial growth **CO3:** Describe photosynthesis and autotrophic CO_2 fixation; Discuss carbohydrate metabolism in microorganisms under aerobic & anaerobic conditions; Explain biogeochemical cycles; Describe extremophiles. **CO4:**Comprehend and analyze the role of microorganisms in plant nutrition; water purification and management of human diseases **CO5:**Illustrate and sketch the structure of various bacteria and fungi by staining and observing under the microscope **CO6:** Isolate and identify bacteria and fungi from various sources such as air and soil. To identify and describe microbial characterization using various biochemical reactions.

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	18MSBT1H03	**Cell Biology and Molecular Genetics**	**CO1:**Recall and describe the structure, functions of plasma membrane and cell organelles along with different types of transport across the membrane. Able to define and tell about cytoskeleton and description of muscle contraction. **CO2:** Explain and discuss cell cycle events, its regulation. Articulate and discuss about the cause of tumor, role of proto-oncogenes and oncogenes and analyze the importance of Tumor suppressor gene- p53 and Rb. Able to write an account and describe the various cell membrane receptors and discuss about cAMP and Ca2+ as secondary messengers **CO3**: Able to compare and contrast the genome organization in prokaryotes and eukaryotes and explain the molecular process in genetic recombination. Able to explain the concept of transposons with various examples. **CO4:**Appraise about cytoplasmic, maternal inheritance and able to solve the problems in genetics, elaborate concepts involved in genetic variation and heritability and the relationship of prokaryotic and eukaryotic species through molecular phylogeny. **CO5**:Able to plan the experiments, independently prepare slides, able to work with binocular microscopes and analyze the cell structure and its organelles. Demonstrate skills in isolating chloroplasts from fresh samples **CO6**:Skills of dissection and staining chromosomes from various tissues and analyze the different types of cell divisions, demonstrate their ability for slide preparation and identification of mitotic and meiotic stages in plant and animal tissues

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	18MSBT1H04	**Molecular Biology**	**CO1:** Describe the mechanism of replication of genetic materials, their variations in different groups of organisms; explain the DNA repair and types of genetic recombinations. **CO2:** Differentiate the process of transcription in Prokaryotes and Eukaryotes, their post transcription modifications. **CO3:** Explain the concepts of genetic code; Discuss various stages of protein synthesis in prokaryotes and eukaryotes, the importance of inhibitors and their applications, describe the pathways of protein transport into different organelles. **CO4: D**ifferentiate the mechanisms of Gene regulation in prokaryotes and eukaryotes **CO5:** Assess the significance and the applications of Ribozymes, Antisense, and RNAi technologies in plants and animals for the benefit of mankind.
	18MSBT1H12L	**Biostatistics and General Microbiology**	**CO1:** Students should be able to apply appropriate statistical tools**.** **CO2:** Students should be able to isolate, preserve and study various microbial isolates. **CO3:** Students should be able to identify microorganisms based on its morphology and biochemical characteristics.
	18MSBT1H3L	**Cell Biologyand Molecular Genetics**	**CO1:** Students should demonstrate knowledge about karyotyping and differentiate normal karyotype from abnormal karyotypes and interpret the clinical symptoms. **CO2**: Able to plan the experiments, independently prepare slides, able to work with binocular microscopes and analyze the cell structures and its organelles. **CO3**: Students should be able to demonstrate skills in isolating chloroplasts from fresh leave samples. **CO4**: Skills of dissection and staining chromosomes from various tissues and analyze different types of cell divisions, demonstrate their ability for slide preparation and identification of mitotic and meiotic stages in plant and animal tissues
	18MSBT1H4L	**Molecular Biology**	**CO1**: Illustrate the isolation of DNA and RNA from different sources – animal tissues, plant tissues and microbes; Demonstrate ability to isolate plasmid DNA from bacteria. **CO2:**Examine and conduct experiments on gel electrophoresis of nucleic acids. **CO3:** Demonstrate and interpret the separation and quantification of nucleic acids.

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II	18MSBT2H01	Molecular Biophysics	**CO1:**Explain the unique properties of carbon atom and it relevance to the structures of organic molecules **CO2:** Recall the chemical structures of various biological macromolecules in the cell **CO3:** Compare the structures of bio-molecules in cell and also comprehend structure-function relationship in organisms **CO4:** Illustrate the concept of absorption and emission spectra in different spectroscopy methods **CO5:** Differentiate the working principle, and applications of various spectroscopy techniques; molecular structure determination techniques and radioactive detection methods
	18MSBT2H02	Biological Chemistry	**CO1:** Summarize the Historical Basis and overview of Biochemistry. Outline the Biochemical organization of cell. Explain the fundamental scientific principles of thermodynamics, concept of redox reactions. Classify the different types of enzymes: explain their mechanism of actions and illustrate the applications of enzymes in industry. **CO2:** Discuss the concept of photosynthetic mechanisms and pigments involved in the process. Describe the pathways behind synthesis and breakdown of energy-rich molecules and their regulations. **CO3:** Make use of the concept of Oxidative Phosphorylation and apply to explain the concept of ATP synthesis. Build on the metabolism of lipids and the synthesis of different membrane lipids. **CO4:** Distinguish between different types of inborn errors of metabolism and analyze their role in diseases. Inspect on the biosynthesis of steroid hormones and their effects. **CO5:** Classify and distinguish between different types of Chromatography, Electrophoresis and Centrifugation. Analyze their applications in biochemical research. **CO6:** Estimate and interpret on different Biological chemistry experiments which will help to carry out research involving various tools for biochemical research.

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	18MSBT2H03	**Immunology and Immunotechnology**	**CO1:** Explain the different components of the Immune system, the fundamental principles of the immune system. **CO2:** Describe antigens and immunogens, T and B cells, cell mediated and humoral immunity, antibody diversity, their structure and functions. **CO3:** Illustrate the different types of vaccines, tumor antigens, tumor vaccines and role of protective immunity on humans. **CO4:** Differentiate normal immune responses from hypersensitivity/immunodeficiency/autoimmune conditions. **CO5:** Critically comment on the immunological basis of tissue transplantation and rejection reactions. **CO6:** Assess the significance of *in vitro* antigen-antibody reactions in disease diagnosis, the role of MoAbs in treating various complex diseases.
	18MSBT2H04	**Genetic Engineering**	**CO1:** Describe the functions, properties and applications of various molecular tools i.e. enzymes; cloning vectors and expression vectors. **CO2:** Differentiate the methods of gene transfer in plant and animal cells and compare the construction of recombinant clones **CO3:** Demonstrate the construction of different gene libraries and their applications. **CO4:** Discuss the labelling methods and their significance; describe and the various gene analysis techniques (PCR, blotting, DNA sequencing, DNA fingerprinting) and their applications **CO5: C**ompare and Examine the appropriate molecular tools/approaches employed in gene therapy for treating various diseases (genetic, metabolic, cardiovascular and neurological). **CO6:** Assess the significance and limitations of the applications of gene editing and developments in the field of gene therapy.

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	18MSBT2H2L	**Biological Chemistry**	**CO1:**Employ methods to prepare solutions with particular (specified) normality and molarity. **CO2**: Calculate the amount required for preparing solutions of required strength **CO3:**Plan experiments on preparation of different concentration of acids and base solutions. **CO4**: Demonstrate using appropriate biochemical methods quantification of various biomolecules and protein purification by ammonium sulphate precipitation method and dialysis. **CO5**: Examine and Conduct experiment on purification of biomolecules using different techniques like electrophoresis and chromatography. **CO6**: Plan and design experiments to synthesize industrially relevant enzymes from plant/microbial sources and estimate/calculate enzyme activity cells.
	18MSBT2H34L	**Immunology and Genetic Engineering**	**CO1:** Illustrate experiments on separation of Serum and Lymphocytes from whole blood. **CO2:** Demonstrate their ability to precipitate immunoglobulins from serum. **CO3:** Demonstrate the immunological Tests involved in diagnostics such as Immuno- diffusion, Immuno-electrophoresis and ELISA. **CO4:** Examine and conduct experiments on gene analyses such as restriction digestion, southern blotting and transformation.
III	**18MSBT3H01**	**Plant and Agricultural Biotechnology**	**CO1:** Explain the principles, practices and applications of plant tissue culture and thereby, describe clear procedures for the maintenance of sterile condition and maintenance of plant tissue cultures **CO2:** Differentiate different genetic transformation techniques in plants and their commercial application for proteins and vaccine development **CO3:**Apply and demonstrate the diverse purposes and practices of molecular breeding in plants. **CO4:**Analyze strategies for crop improvement by applying diverse methodologies including plant molecular breeding and agricultural practices. Examine the relevance and impact of genetic modification in genetically modified crops (GM crops) **CO5:**Compare and contrast genome engineering and other technologies for crop improvement.

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	18MSBT3H02	**Animal Biotechnology**	**CO1:** Explain the basic laboratory set-up, essential lab equipment, principles, practices and applications of animal cell and tissue culture. Explain the composition of the media used for culturing cells and the role of physicochemical parameters in cell culture. **CO2**: Differentiate between primary culture, secondary culture and cell lines, normal and abnormal growth curve of animal cells. Analyze the various methods used for isolation of cells **CO3**: IIllustrate the applications of cell lines in production of pharmaceutical products, drug toxicity screening, cancer drug discovery **CO4**: Discuss about the importance of cell line characterization in research involving animal cells, discuss about various methods of engineering cells (gene transfer techniques), transgenic animals and their applications **CO5:** Critically analyze and Comment on the significance of *in-vitro* fertilization in humans and animals. Comment on the ethical issues involved in animal cloning, transgenic animal and stem cell research **CO6:** Design experiment and carry out independent research involving cell lines
	18MSBT3S31	**Elementary Methods in Computational Biology**	**CO1** :Define different types of computer network **CO2** :Discuss the steps for generating phylogenetic tree **CO3**: Explain the principle of sequence alignment and summarize the output generated by the servers (BLAST , Clustal omega, etc); Discuss the significance of QSAR in rational drug design **CO4**: Demonstrate the application of gene prediction server (using example sequences) and interpret the output for gene sequence of your interest **CO5:** Demonstrate the application of homology modelling / docking server and SPDV package in generating the 3D model of protein and visualizing the protein-ligand complex

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	18MSBT3S32	**Phytochemistry and Pharmacognosy**	**CO1:**Illustrate the origin of drugs from natural sources; describe the role of natural products as the source of many drugs and pharmaceutical ingredients. Explain Systematic pharmacognostic study of medicinal and aromatic plants. Outline the biological and geographical sources of medicinal and aromatic plants**.** Summarize knowledge of the important natural products, their origin, properties and biological activity. **CO2**: Develop relevant concepts of phytochemical extraction techniques and other knowledge, important for the production and evaluation of herbal extracts of pharmaceutical importance. Apply the acquired knowledge of extraction on commercial application of various secondary metabolites containing drugs. **CO3**: Compare and contrast the different methods of extraction; merits and demerits. Distinguish different conventional and modern methods of phytochemical extraction. Apply their knowledge on industrial production of some therapeutically important phytoconstituents. **CO4:**Interpret the importance of some drugs available in the healthcare system that are obtained or sourced from natural products. Explain and critically analyze chemical structures, biosynthetic origin and pathways of important natural products. **CO5:**Analyze the strategies for the standardization of herbal formulations, understand the importance of unit operations in pharmaceutical manufacturing, compile WHO regulations and discuss the different parameters for standardization of herbal formulations.
	18MSBT3H01L	**Plant and Agricultural Biotechnology**	**CO1:** Demonstrate knowledge and understanding of basic techniques involved in plant tissue culture under aseptic conditions and practice GLP in tissue culture laboratory. **CO2:**Experiment and examine different plant cell culture techniques, including preparation and evaluation of media and troubleshoot problems common to routine plant cell cultures. **CO3:**Select a specific method andperform the plant tissue culture and agriculture biotechnology techniques. **CO4:** Develop and organize modern approaches to scientific investigation in field of agriculture.

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	18MSBT3H02L	**Animal Biotechnology**	**CO1**: Set-up the lab, identify essential lab equipments, prepare the media and culture animal cells and tissues. **CO2**: Independently plan and carry out experiments using cell lines establish primary cultures and propagate them. **CO3**: To screen drugs for cytotoxicity in laboratory set up and perform viability assays, result analysis, analyze and interpret the experimental data **CO4**: Design experiments and research projects based on the above experimental knowledge and able to work in a team in its execution
IV	**18MSBT4H01**	**Bioprocess Engineering**	**CO1:** Explain the isolation, screening, and maintenance of industrially important microbes and the different techniques for microbial strain improvement. Able to explain and interpret the structure and functioning of different types of bioreactors **CO2**: Demonstrate experiments involving inoculum development, design, formulation, optimization and sterilization of media; various energy sources and growth of cultures in the bioreactor to increased product formation. **CO3**: Interpret the principle and applications of various techniques that are used for downstream processing and drying of the purified products. **CO4**: Explain, critically comment on the concept of immobilization and its application in bioprocess engineering; describe the synthesis of industrially important products.
	18MSBT4H02	**Clinical Research, IPR and Entrepreneurship**	**CO1:** Interpret the biosafety regulations at both national and international levels including convention on biodiversity and Cartagena protocol; explain and discuss the biosafety guidelines set by the Government of India; Good Manufacturing Practices. **CO2:** Elaborate on intellectual property rights (IPR) and types of intellectual properties; Acts, Agreements, and treaties on IPR – National and International**.** **CO3:** Explain the rules and regulations laid out by the international / national drug regulatory bodies while approving novel drug molecules. **CO4:** Summarize the route of drug development path (FDA). **CO5:** Discuss the procedure required for new drug application.

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	18MSBT4H03	**Advanced Bioinformatics**	**CO1:**Explain why databases are the backbone of bioinformatics research. Discuss how flat files were the first type of database, and why they are still used today Discuss how many different types ofdatabase exist. **CO2 :**Describe different uses of protein and DNA sequence alignments Explain local and global alignment techniques for matching whole sequences Discuss the steps required for performing sequence alignment and 3D modelling of proteins Select the appropriate online tool / server for sequence alignment, 3D modelling of proteins and report the output **CO3:** Demonstrate the application of alignment tool for analyzing a new biological sequence of interest and interpret the results; choose the appropriate databases for identifying homologus sequences Demonstrate the application of molecular modeling servers for generating 3D model of protein of interest and interpret the results **CO4:** Identify regions with nonprotein gene features Discuss how homology aids gene prediction Explain why prokaryotic gene prediction is generally easier than eukaryotic Identify separate gene components such as introns, exons, splice sites, promoter regions etc Discuss how genome comparison can help resolve ambiguities in gene prediction **CO5:** Compare / examine the outputs generated by different gene prediction servers using the gene sequence of interest **CO6:** Recount the methods of detecting tRNA genes **CO7:** Using appropriate online bioinformatics tool, assess / evaluate the quality of the 3D model of the proteins **CO8:** For the given biological sequence of interest (nucleotide / protein), create a flow chart showing retrival of the sequences from the databases- gene prediction - sequence alignment - homology modeling of proteins Using a raw (primary) protein sequence of interest, construct 3D model of protein using online bioinformatics server

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	18MSBT4S41	**Medical Biotechnology**	**CO1:** Students should be able to discuss and explain about Human Genome Project and it applications in the field of medicine. Students should be able to analyze the genetic basis of diseases affecting mankind and explain and discuss the gene therapy strategies to treat them. Explain the role of humanized antibodies and Stem cell therapies in treating diseases. **CO2:** Students should be able to identify, analyze and discuss about stem cells and their applications in tissue repair, transplantation, tissue engineering and regenerative medicine. Should be able to analyze and discuss on the causes, role of genes, prevention, diagnosis and treatment modalities of cancer. **CO3:** Students should be able analyze the causes, modes of infection, symptoms, epidemiology and control measures of microbial diseases by Viruses, Bacteria (Typhoid, TB); Fungi (Aspergillosis, Histoplasmosis) and Protozoa that affects human beings. Able to critically review and apply various immunological and molecular diagnostic methods in disease diagnosis and forensic science. **CO4:** Able to explain and discuss about the importance of nanomaterials and protein based Nano structures in the field of medicine and their potential applications in disease diagnosis and cancer therapy.
	18MSBT4S42	**Applied Environmental Biotechnology**	**CO1:** Define the environmental pollution, its causes and remediation **CO2:** Summarize the waste water treatmentstrategies of industrial and domestic effluents **CO3;**Discriminate the composition of effluents from various industries and able to give a comparative analysis of degradation of xenobiotics **CO4:** Interpret the solid waste management and able to experiment towards solving this issue. **CO5:** Support and value the global environmental problems. **CO6:** Examine and decide various biotechnological approaches for sustainability and their management
	18MSBT4H12L	**Bioprocess Engineering and Entrepreneurship**	**CO1:** Students should be able to understand the structure of a bioreactor **CO2:** Should demonstrate the optimization of physical conditions to maximize production, sterilize medium and the bioreactor, separate, purify and preserve the product of interest **CO3:** Discuss the project idea