Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Refer to page no: 08
highlighting component
of Field Project

Syllabus for the M.Sc. Part I

Program: M.Sc. BIOTECHNOLOGY

Program Code: RJSPBT

(CBCS 2022-2023)

THE PREAMBLE

Why Biotechnology?

Biotechnology is a fast growing field of science where biological systems are used in diverse applications in the areas of fermentation, environment, diagnosis, treatment, agriculture, food industry etc. It is the most recent offshoot of biological sciences thriving on the latest technological advancements in engineering technology, recombinant DNA technology, computer sciences and many more. Biotechnology is an interdisciplinary field that brings together knowledge from diverse fields such as physics, statistics, mathematics, chemistry, microbiology, biological sciences, information technology, as well the most current technological advancements such as Artificial Intelligence and Machine Learning.

Biotechnology as a field of science is the most application oriented field where the knowledge gained in this course has direct and immediate application in the real world, be it pharmaceutical industry, food industry, diagnostics, personalized medicine, genetically modified crops and animals, bioprinting of organs, bioinformatics or clinical research.

Why PG Biotechnology in R J College?

The Department of Biotechnology was established in 2002. In 2005 MSc (By Papers & Research) and PhD Biotechnology approval from University of Mumbai was received. The department hosts 3 state of the art laboratories equipped with all the required instruments and facilities for carrying out practical sessions of UG and PG courses as well as research projects. We have experienced and well qualified teaching and supporting staff. The department organizes talks by eminent personalities from industry, research organizations and academia on a regular basis to acquaint the students with the current research and industrial developments.

The Department also has its Departmental Library and reading area which the students use after their daily schedule. The library holds more than 1000 subject reference books and journals, and many e-books. Along with these there are books for preparing for Entrance Exams such as CSIR-NET, SET, DBT, ICMR & GRE.

The Department also offers PG Diploma courses such as Clinical Studies, Data Management & Medical Writing, Post Graduate Diploma in Industrial Hygiene, and Safety and Post Graduate Diploma in Medical Laboratory Techniques, that our students can opt for simultaneously with post

graduation or job.

We are proud to share that many of our alumni are very well placed in national and international institutes such as Yale university, Max Plank, Pasteur Institute, CCMB, and companies such as Biocon Ltd, Reliance Life Sciences to name a few.

PROGRAM OUTCOMES FOR POST GRADUATE DEGREE PROGRAMS IN BIOTECHNOLOGY

The Post graduate program in Biotechnology has been designed to empower students to obtain domain knowledge, analyze and apply. The courses have been designed to hone the analytical skills of students so as to solve real life situations. Modern tools have been introduced for studying biotechnology without compromising on the basic concepts. All the courses in the program are carefully designed to equip students for teaching the subject as well as qualify competitive examinations like CSIR NET, SET, DBT, ICMR, GRE etc.

Some basic attributes which a student would acquire after completion of postgraduate program are listed below.

Application of Knowledge

Maintain a high level of scientific excellence in research with specific emphasis on the technological advances in molecular biology techniques and bioinformatics. Create, select and apply appropriate techniques and modern technology in a multidisciplinary way. Apply the subject knowledge to design experiments, analyze and interpret data to reach an effective conclusion.

Ability to convey the concept clearly

They would identify, formulate, and analyze the complex problems and reach a conclusion. Logical thinking with application of biological, physical, and chemical sciences. Learning that develops analytical skills and integrative problem-solving approaches.

Teamwork

Students would perform functions that demand higher competences in national/international organizations with team spirit and helping each other. Develop qualities of empathy and sympathy for fellow beings

Honesty and Integrity and Ethics

Students will be aware of ethical issues and regulatory considerations while addressing societal needs for growth with honesty.

Environment and Sustainability

The problem-solving skills in students would encourage them to carry out innovative research projects to solve environmental issues. All actions are towards achieving United Nations Sustainable Development Goals.

Lifelong learning and motivating others to learn

Students would lend support to one another for self and institutional growth, contribute to national development and provide equal opportunity.

Global thinking

Students would be equipped with life and technical skills and would be empowered with domain knowledge in thrust areas; these attributes will make them globally competitive.

PROGRAMME SPECIFIC OUTCOMES (PSOs) FOR MSc BIOTECHNOLOGY

Sr. No	A Student Specific completing M.Sc. Biotechnology will be able to :
PSO1	Understand the structures and metabolism of carbohydrates, proteins and nucleic acids
PSO2	Understand development, activation and differentiation of immune cells and their role in imparting immunity to the host.
PSO3	Gain insight about different methods of gene sequencing and understand the concepts and applications of omics including next generation sequencing and editing.
PSO4	Understand and apply various analytical tools used in industry and understand its working and principles.
PSO5	Understand the amino acid and lipid metabolism. Gain insight into endocrinology and secondary metabolites of plants and microbes
PSO6	Gain an understanding of the basic concepts of mechanisms of autoimmunity, Transplantation immunology, animal models in immunological studies and cell imaging.
PSO7	Understand the role of the immune system in cancer, their causes and cure & psychological modulation of the immune system.
PSO8	Understanding of Bioprocess technology, exploring the enzymes used in the food industry, product formulation and development.
PSO9	Gain an understanding of the basic concepts of IPR and safety, gain insights on prior art and infringement, and explore the area of patent filing.
PSO10	Understand the importance of presence of calcium and phosphorus in serum, separation of their proteins. Also gain insights on the concept of phagocytosis, separation of lymphocytes and Isoagglutination titer.
PSO11	To understand the fundamental concepts of molecular biology and techniques involved.
PSO12	Gain an understanding about the importance of cell imaging and cell tracking. Also gain insights on the importance of urate/creatinine ratio, presence of phenylalanine in urine samples.
PSO13	To understand the functions of enzymes used in the food industry, its preservation and action of secondary metabolites. To gain expertise in SOP writing.

MSc I BIOTECHNOLOGY SEMESTER I

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT101	Paper - Biochemistry			60 hours
	I	Carbohydrate, lipid and nucleic acid Metabolism	4	
	II	Protein Biochemistry		
	III	Physiological Biochemistry		
	IV	Neurobiology		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT102	Paper - Immunology 1			60 hours
	I	Humoral Immunology	4	
	II	Cellular Immunology		
	III	Clinical Immunology		
	IV	Immune cell behavior		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT103	Paper - Genomics			60 hours
	I	Genome evolution	4	
	II	Genome sequencing		
	III	Mapping genomes		
	IV	Genome editing		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT104	Paper - Biophysics			60 hours
	I	Microscopy	4	
	II	Spectroscopy		
	III	Structure Analysis		
	IV	Mass spectrometry		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSPBTP101	Practicals of RJSPBT101 & RJSPBT102	4	60 hours
RJSPBTP102	Practicals of RJSPBT103 & RJSPBT104	4	60 hours

MSc I BIOTECHNOLOGY SEMESTER II

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT201	Paper - Metabolism			60 hours
	I	Amino acids and nucleotides metabolism	4	
	II	Lipoprotein		
	III	Protein folding		
	IV	Plant and microbial metabolism		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT202	Paper - Immunology II			60 hours
	I	Autoimmunity and transplantation	4	
	II	Hypersensitivity and immunodeficiency		
	III	Experimental systems		
	IV	Cancer and PsychoneuroImmunology		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT203	Paper - Bioprocess technology			60 hours
	I	Enzymes in Industry	4	
	II	Food spoilage and preservatives		
	III	Nutraceuticals		

	IV	Product formulations		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT204	Paper - IPR & Biosafety			60 hours
	I	Introduction to Intellectual Property	4	
	II	Concept of 'prior act'		
	III	Patent filing and Infringement		
	IV	Biosafety		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSPBTP201	Practicals of RJSPBT201 & RJSPBT202	4	60 hours
RJSPBTP202	Practicals of RJSPBT203 & RJSPBT204	4	60 hours

SYLLABUS GRID

YEAR	SEMESTER	CORE SUBJECT				PRACTICALS OF CORE SUBJECT	SKILLED BASED PROJECT	TOTAL
MSc I	**I**	4	4	4	4	8	-	24
	II	4	4	4	4	8	-	24
TOTAL		8	8	8	8	16	-	48
MSc II	**III**	4	4	4	4	4	4	24
	IV	4	4	4	4	8	-	24
TOTAL		8	8	8	8	12	4	48

COURSE OUTCOMES (COs) M. Sc. I BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOCHEMISTRY
COURSE CODE	:	RJSPBT101
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Discuss the Structure and function of Carbohydrate, lipid and physiological biochemistry
2	Understand protein structure and folding
3	Understand the physiological biochemistry of acid base balance, electrolyte balance and mineral metabolism
4	Describe the structure and functions of neurons and the physiologic anatomy of synapse.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To study in detail the structure, functions of Glycolipids, Glycosaminoglycans, Glycolipids and Eicosanoids. Also to discuss the properties of different types of DNA structure.	1	BT levels 1,2 & 3
CO2	To discuss the primary, secondary, tertiary and quaternary structures of	1	BT levels 1,2 & 3

	proteins.		
CO3	To study the various regulatory mechanisms to maintain acid -base and electrolyte homeostasis. Also to understand the role of minerals in the body and their metabolic pathways.	1	BT levels 1,2 & 3
CO4	To study the basics of neurobiology and understand the mechanism of neurochemistry of gustatory, visual, olfactory & auditory functions.	1	BT levels 1,2 & 3

Paper Code: RJSPBT101	**Paper-I: Biochemistry**	**Credits 4**
Unit I	Carbohydrate, lipid and nucleic acid biochemistry	15 hrs
	Structure and functions of – Glycosaminoglycans, Glycoprotein's (N6, O6, GPI6 linked and proteoglycans) Glycolipids and Lectins.Biosynthesis, structure and functions of Eicosanoid: Prostaglandins and Thromboxane. DNA topology – types of DNA – A/B/C/Z and R/L form and triple helix.	
Unit II	Biochemistry	15 hrs
	Primary structure of proteins and their determination, Peptide mapping. Secondary structure of peptides Ramachandran plot, protein denaturation, stability of thermostable proteins. Quaternary structure-subunit interaction, symmetry, subunit composition determination.Structure and binding mechanism of Hemoglobin and Myoglobin.	
Unit III	Physiological Biochemistry	15 hrs
	Regulation of acid-base balance, types and functions of acid-base buffers, respiratory and renal mechanism of acid-base balance, clinical abnormalities. Water and electrolyte balance, clinical abnormalities. Mineral metabolism: Dietary macro elements- Calcium, Phosphorus, Magnesium. Trace elements- Fe, I, Zinc, Copper, selenium	
Unit IV	Neurobiology	15 hrs
	Structure and functions of neuron, types and physiologic anatomy of the Synapse, transmission of nerve impulses, ion channels, neurotransmitters and neuropeptides, Electrical events during neuronal excitation and inhibition. Neurotoxins. Neurochemistry of senses- taste, vision, odor and hearing.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	IMMUNOLOGY I
COURSE CODE	:	RJSPBT102
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Understand the mechanism of B and T cell development, activation and differentiation.
2	Describe the therapeutic uses of cytokines and vaccines
3	Get in-depth knowledge of immune cell behavior

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce the basics of immunological diversity and its origin, also immune cell behavior at the time of innate and acquired immune response.	2	BT levels 1,2 & 3
CO2	To acquaint students with concepts of B and T cell development, maturation and activation and their role in eliminating different types of pathogens	2	BT levels 1,2 & 3
CO3	To understand cytokine properties, vaccine development strategies	2	BT levels 1,2 & 3

Paper Code: RJSPBT102	**Paper-II : Immunology - I**	**Credits 4**
Unit I	Humoral Immunology	15 hrs
	Organization and expression of immunological genes. B-cell development, activation, differentiation and memory.	
Unit II	Cellular Immunology	15 hrs
	T- cell development (Early thymocyte development, Positive and negative selection, Apoptosis). T-cell development, activation, differentiation and memory	
Unit III	Clinical Immunology	15 hrs
	Cytokines: properties, receptor, antagonists, diseases. Therapeutic use of cytokines, Vaccine development (Recombinant, Multivalent vaccines)	
Unit IV	Immune cell behavior	15 hrs
	Immune cell behavior before introduction of antigen, during innate immune response. Adaptive immune response and in peripheral tissues.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	GENOMICS
COURSE CODE	:	RJSPBT103
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Gain insight about different methods of gene sequencing
2	Understand the concepts and applications of omics including next generation sequencing and editing.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce the concept of genome evolution describing the content of the human nuclear genome; origin of genomes, acquisition of new genes and further evolution.	3	BT levels 1,2 & 3
CO2	To acquaint students with sequencing techniques like Chain termination; Chemical degradation, Whole genome shotgun sequencing and Pyrosequencing.	3	BT levels 1,2 & 3

CO3	To understand the mapping of genomes and ways in which the human genome was mapped and sequenced.	3	BT levels 1,2 & 3
CO4	To learn different genome editing tools.	3	BT levels 1,2 & 3

Paper Code: RJSPBT103	**Paper-III: Genomics**	**Credits 4**
Unit I	Genome evolution	15 hrs
	The content of the human nuclear genome, tandemly repeated DNA, interspersed genome wide repeats.The origin of genomes, Acquisition of new genes, non-coding DNA and genome evolution.	
Unit II	Genome sequencing	15 hrs
	Chain termination DNA sequencing; Chemical degradation sequencing and Pyrosequencing. Assembly of Contiguous DNA Sequence – Clone contig methods. Whole genome shotgun sequencing.	
Unit III	Mapping genomes	15 hrs
	Genetic and physical maps- DNA markers for genetic mapping, restriction mapping, Sequence tagged site mapping. The Human Genome Project – Mapping Phase, Sequencing and Future.	
Unit IV	Genome editing	15 hrs
	RNAi, ZNF (Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases). CRISPR/Cas system (Clustered Regularly Interspersed Repeats)	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOPHYSICS
COURSE CODE	:	RJSPBT104
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Gain an understanding of the basic principles of Atomic force, Fluorescence, Confocal and Electron Microscopy.
2	Understand the principles and analysis using Spectroscopy including fluorescence, CD, ORD, NMR and ESR.
3	Deduce molecular structure using analytical techniques.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To acquaint students with the working principle of different microscopic methods and establish an understanding of their applications.	4	BT levels 1,2 & 3
CO2	Introduce them to the methods of analyzing samples at atomic/molecular level using spectroscopy and diffraction methods.	4	BT levels 1,2 & 3
CO3	To study the molecular structure of the sample using the ionization method and	4	BT levels 1,2 & 3

	to understand the working principle of various forms of mass spectrometry.		

Paper Code: RJSPBT104	**Paper-IV: Biophysics**	**Credits 4**
Unit I	Microscopy	15 hrs
	Principle, working and applications of - Confocal microscopy, fluorescent microscopy, Scanning tunneling microscopy, Scanning probe microscopy, High resolution TEM, atomic force microscopy.	
Unit II	Spectroscopy	15 hrs
	Introduction, principle and analysis using UV/visible Spectrophotometer, Fourier Transform IR, Raman IR spectroscopy, circular dichroism, ORD, NMR and ESR spectroscopy.	
Unit III	Structure Analysis	15 hrs
	Molecular structure determination using X-ray diffraction, Molecular analysis using Dynamic light scattering.	
Unit IV	Mass spectrometry	15 hrs
	Mass spectrometry and LC-MS, GC-MS, and surface plasmon resonance methods.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	METABOLISM
COURSE CODE	:	RJSPBT201
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Gain an understanding of the basic concepts of amino acids and nucleotides metabolism.
2	Describe the properties and importance of lipid aggregates and lipoproteins
3	Understand the concept of protein folding
4	Develop an understanding of impact of stresses on plants, role of nitrogenase, relation between hydrogen production & photosynthesis, anaerobic ammonium oxidation and light production microbial reaction.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To study the metabolic reactions, role of various cofactors , regulations, disorders associated with netaboilm of amino acids and nucleotides.	5	BT levels 1,2 & 3
CO2	To understand the properties and applications of liposomes and micelles. Also to discuss the structure &	5	BT levels 1,2 & 3

	functions of lipoproteins and their role in disorders.		
CO3	To study the various theories and pathways of protein folding with the associated role of chaperons.	5	BT levels 1,2 & 3
CO4	To discuss the physiological effects of various stresses and the response of plants to these stresses. Also to study the principle of biosynthesis of hydrogen, nitrogen fixation, anammox reaction and bioluminescence.	5	BT levels 1,2 & 3

Paper Code: RJSPBT201	**Paper-I: Metabolism**	**Credits 4**
Unit I	Amino acids and nucleotides metabolism	15 hrs
	Biosynthesis of essential amino acids. Metabolic breakdown of amino acids leading to Krebs cycle intermediates. Disorders of amino acids metabolism. Biosynthesis and degradation of purine and pyrimidine nucleotides and metabolic disorders.	
Unit II	Lipoproteins	15 hrs
	Properties of lipid aggregates –micelles and liposomes. Lipoproteins- Structures, functions and dysfunction in Alzheimer's and Atherosclerosis.	
Unit III	Protein folding	15 hrs
	Secondary structures-types, motifs, domains. Protein folding- pathways, mechanism of chaperons, heat shock proteins.	
Unit IV	Plant and microbial metabolism	15 hrs
	Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, and heavy metals, and their impact on plant growth and metabolism, criteria of stress tolerance. Secondary metabolites in Plants - Nature, distribution and their role in plant protection. Photosynthetic formation of hydrogen. Nitrogen fixation and role of nitrogenase, Anammox reactions and Bioluminescence.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	IMMUNOLOGY II
COURSE CODE	:	RJSPBT202
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Gain an understanding of the basic concepts of mechanisms of autoimmunity, Transplantation immunology, animal models in immunological studies and cell imaging.
2	Understand the role of the immune system in cancer, their causes and cure.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To understand the mechanisms of autoimmunity, hypersensitivity and immunodeficiency.	6	BT levels 1,2 & 3
CO2	To know the process of Cancer development and its treatment strategies	6	BT levels 1,2 & 3
CO3	To deduce the significance of animal models and route of inoculations for the study of immune systems.	6	BT levels 1,2 & 3
CO4	To appreciate the interrelationship between CNS and immune system	6	BT levels 1,2 & 3

Paper Code: RJSPBT202	**Paper-II: Immunology II**	**Credits 4**
Unit I	Autoimmunity and transplantation	15 hrs
	Autoimmunity mechanisms, altered antigens, Systemic Lupus erythematosus, Graves diseases, Rheumatoid arthritis, Myasthenia Gravis, Multiple sclerosis. Transplantation immunology, GvH, Immunodeficiency: phagocytic, humoral, CMI, combined HLA association with disease.	
Unit II	Hypersensitivity and immunodeficiency	15 hrs
	Hypersensitivity - Types, causes and treatment. Immunodeficiency - Primary and secondary	
Unit III	Experimental systems	15 hrs
	Microscopic visualization of cells and cellular structure, immunofluorescence technique, Cell death assays. Whole animal experimental system, Routes of Inoculation. Antibody engineering, Chimeric antibodies.	
Unit IV	Cancer and PsychoneuroImmunology	15 hrs
	Types of cancer, malignant transformation of cells, tumor antigens, immune response to cancer, immunotherapy. Connections of CNS to immune system – HPA axis, Psychological modulation of immunity, stress and immunity, implication for diseases; connections from immune system to CNS – immune modulator of behavior,functional significance-inflammation and acute phase response, energy demand and balance, role of glucocorticoids and stress response.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOPROCESS TECHNOLOGY
COURSE CODE	:	RJSPBT203
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Have a detailed understanding of the concepts of upstream, fermentation and downstream processes.
2	Understand the mechanisms of enzyme functions in bioprocess technology and the role of microorganisms in the food processing industry.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To understand the role of enzymes in industry and methodologies used for its application.	8	BT levels 1,2 & 3
CO2	To know the causative agents leading to food spoilage and use of different preservatives to improve food storage .	8	BT levels 1,2 & 3
CO3	To gain knowledge about the nutraceutical products; its advantages, limitations and its use in livestock.	8	BT levels 1,2 & 3

CO4	To discuss product formulations details like production, assessment and route of administration.	8	BT levels 1,2 & 3

Paper Code: RJSPBT203	**Paper-III: Bioprocess Technology**	**Credits 4**
Unit I	Enzymes in Industry	15 hrs
	Enzymatic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein baking by amylases, deoxygenation and desugaring by glucose oxidase. Immobilization of enzymes and cells: methods and applications.	
Unit II	Food spoilage and preservatives	15 hrs
	Spoilage – microbial food spoilage (Psychotropic bacteria, milk, cereals, fresh food). Physical, chemical and biological methods (Lactic acid bacteria, Bacteriocins from lactic acid bacteria, yeast metabolites) of food preservation.	
Unit III	Nutraceuticals	15 hrs
	Prebiotics and probiotics – potential benefits, characteristics of probiotic cultures, probiotics for livestock.	
Unit IV	Product formulations	15 hrs
	Introduction, formulation assessment, route of administration and dosage, formulation development.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	IPR & BIOSAFETY
COURSE CODE	:	RJSPBT204
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Gain an understanding of the basic concepts of Patents, Trademarks, Copyrights, Geographical indications AND Patent database.
2	Understand the historical background, importance and levels of Biosafety at laboratory and industrial scale.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To acquaint the students with a background knowledge of legal aspects involved in patenting a biotechnological invention and to understand other forms of IPRs, it's evolution & process.	9	BT levels 1,2 & 3
CO2	To provide the students a better knowledge about country wise database searches, sites involved and report analysis for the same.	9	BT levels 1,2 & 3

CO3	To brief students about the process of filing a patent and financial assistance available in different countries.	9	BT levels 1,2 & 3
CO4	To understand the use of different types of Biosafety levels depending upon the level of infectious agents & also the role of various committees involved in the risk associated with BSLs.	9	BT levels 1,2 & 3

Paper Code: RJSPBT204	**Paper-IV: IPR & Biosafety**	**Credits 4**
Unit I	Introduction to Intellectual Property	15 hrs
	Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, GI, Protection of New GMOs; International framework for the protection of IP. Biotechnology & the law: objective, evolution, basic structure of gene techniques, applications, commercial potential of biotech inventions, rational for IPR protection.	
Unit II	Concept of 'prior act'	15 hrs
	Patenting biotech inventions: objectives, concept of novelty, concept of inventive step, microorganisms, and moral issues in patenting biotech inventions.Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.	
Unit III	Patent filing and Infringement	15 hrs
	Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs. Financial assistance for patenting- introduction to existing schemes; Publication of patents gazette of India, status in Europe & US. Patenting by research students, lecturers & scientists,University/organizational rules in India & abroad, credit sharing by workers, financial incentives. Patent infringement-meaning, scope, litigation, case studies .	
Unit IV	Biosafety	15 hrs
	Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific	

	Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk Management and communication.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICAL I - PRACTICALS BASED ON RJSPBT101 & RJSPBT102
COURSE CODE	:	RJSPBTP101
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Physiological role of calcium and phosphorus and their significance in diagnosis.
2	Relationship between protein denaturation and viscosity
3	Use of electrophoresis in proteomics
4	Neurochemistry of vision, sensory regions of the brain
5	Use of density gradient centrifugation for separation of lymphocytes
6	Use of electrophoresis in diagnosis of various disorders on the basis of serum proteins fractions
7	Agglutination of the red blood cells of an individual by antibodies in the serum of another individual of the same species.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of chemical method for estimation calcium and phosphorus in serum sample	10	BT levels 2, 3 & 4
CO2	Use of relative viscosity to determine	10	BT levels 2, 3 & 4

	the degree of denaturation of protein		
CO3	Casting of continuous, discontinuous Polyacrylamide gel, preparation of the sample and separation of proteins in denaturing and native conditions and study the number of chains present in the protein	10	BT levels 2, 3 & 4
CO4	Functions of different parts of the brain and use of various tests for the study of blindspot, color blindness, optical illusion.	10	BT levels 2, 3 & 4
CO5	Use of Ficoll for separation of lymphocytes from peripheral blood sample	10	BT levels 2, 3 & 4
CO6	Use of low EEO agarose in separation of serum proteins electrophoretically	10	BT levels 2, 3 & 4
CO7	Use of isoagglutinins in determining the compatibility of blood transfusion	10	BT levels 2, 3 & 4

Paper Code: RJSPBTP101	**Practical-I: Practicals based on RJSPBT101 and RJSPBT102**	**Credits 4**
1	Serum calcium and phosphorus estimation.	
2	Viscosity study of protein	
3	Separation of proteins (native, SDS treated and Mercaptoethanol treated) by electrophoresis.	
4	Chemistry of thinking: a) Study of different regions of the brain using models. b) Stroop test and blind spot test. c) Color blindness and optical illusions	
5	*In-vitro* demonstration of phagocytosis and calculating phagocytic index.	
6	Separation of lymphocytes on Ficoll - Histopaque, viability count and separation of B and T lymphocytes using Fenwall wool.	
7	Serum electrophoresis.	
8	Isoagglutination titer	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICAL-II: PRACTICALS BASED ON RJSPBT103 AND RJSPBT104
COURSE CODE	:	RJSPBTP102
CREDITS	:	4
DURATION	:	60 hours

LEARNING OBJECTIVES	
1	Use of AGE in separation and detection of gDNA
2	Activity of RE and use of RFLP in mapping
3	Properties of ligation reaction with respect to RE used for cutting, and insert size.
4	Use of Bacterial transformation for horizontal gene transfer
5	Principle of PCR and primer designing
6	Significance of pigments from biological sources
7	Importance of UV spectrophotometer in detecting the contamination in protein and DNA samples

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of lysis and precipitation steps for extraction of genomic DNA from bacteria and blood and its detection using AGE.	11	BT levels 2, 3 & 4
CO2	Cutting of DNA with RE and study of RFLP	11	BT levels 2, 3 & 4
CO3	Use of AGE in study of ligation reaction	11	BT levels 2, 3 & 4
CO4	Making of competent cells using calcium chloride, carrying out transformation by heat shock treatment and identification of transformed cells with selective media.	11	BT levels 2, 3 & 4
CO5	Use of Tm value in designing of primer and preparation of PCR mixture	11	BT levels 2, 3 & 4
CO6	Use of various solvents in extraction of biological pigments and their characterization using absorption spectrum	11	BT levels 2, 3 & 4
CO7	Use of 260/280 ratio in determining purity of DNA and protein samples	11	BT levels 2, 3 & 4

Paper Code: RJSPBTP102	Practical-II: Practicals based on RJSPBT103 and RJSPBT104	Credits 4
1	Extraction of genomic DNA from bacteria and blood	
2	RE digestion	
3	RFLP	
4	Ligation reaction using insert and vector	
5	Transformation of competent cells	
6	PCR amplification.	
7	Extraction of pigments from biological sources (plants and/or microorganisms) and study of their absorption spectrum in visible light.	
8	Use of UV spectrophotometry to determine the concentration of protein and DNA	
9	Visit to a facility housing EM and other analytical tools	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICAL I - PRACTICALS BASED ON RJSPBT201 & RJSPBT202
COURSE CODE	:	RJSPBTP201
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Significance of leghemoglobin in nitrogen fixation
2	Effect of impaired salvage pathway in Lesch -Nyhan Syndrome
3	Causes, symptoms, diagnosis and potential treatment of PKU
4	Significance of bioluminescence
5	Principle of affinity chromatography
6	Use of rheumatoid factor in diagnosis

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Isolation and estimation of leghemoglobin from root nodules	12	BT levels 2, 3 & 4
CO2	Estimation of creatinine and uric acid from serum and use of their ratio in presumptive diagnosis of Lesch -Nyhan Syndrome.	12	BT levels 2, 3 & 4
CO3	Use of paper chromatography in presumptive diagnosis of PKU	12	BT levels 2, 3 & 4
CO4	Use of salt water organisms to isolate bioluminescent bacteria	12	BT levels 2, 3 & 4
CO5	Separation of serum proteins by column chromatography and fractions study by PAGE.	12	BT levels 2, 3 & 4
CO6	Passive agglutin	12	BT levels 2, 3 & 4

Paper Code: RJSPBTP201	**Practical-I: Practicals based on RJSPBT201 and RJSPBT202**	**Credits 4**
1	Isolation of Rhizobia from root nodules of leguminous plants.	
2	Estimation of leghemoglobin	
3	Estimation of urate/creatinine ratio to diagnose Lesch Nyhan syndrome	
4	Detection of phenylalanine for PKU	
5	Proline estimation in germinated seeds with and without stress.	
6	Isolation of bioluminescent organisms	
7	Purification of antibodies from serum and analysis using PAGE.	
8	Demonstration of HLA typing	
9	Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF).	
10	Raising antibodies in laboratory animals	
11	Cell imaging Techniques *In vitro* and *In vivo*	
12	Immuno-electron microscopy	
13	*In vivo* cell tracking techniques	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICAL-II: PRACTICALS BASED ON RJSPBT203 AND RJSPBT204
COURSE CODE	:	RJSPBTP202
CREDITS	:	4
DURATION	:	60 hours

LEARNING OBJECTIVES	
1	Extraction and detection of food enzymes and study of their significance at large scale.
2	Pickling process
3	Properties of lactic acid bacteria and role of bacteriocins as antimicrobial agent
4	Role of temperature in food spoilage and preservation
5	Use of patent as IPR

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Qualitative analysis of food enzymes- amylase, catalase, invertase, papain, pectinase, pepsin	13	BT levels 2, 3 & 4
CO2	Making of sauerkraut and its analysis using physical, chemical /biochemical and biological parameters	13	BT levels 2, 3 & 4
CO3	Isolation of lactic acid bacteria on Rogosa medium and also AST of bacteriocins.	13	BT levels 2, 3 & 4
CO4	Effect of temperature in food preservation	13	BT levels 2, 3 & 4
CO5	Process of application for a hypothetical product / process.	13	BT levels 2, 3 & 4

Paper Code: RJSPBTP202	Practical-II: Practicals based on RJSPBT203 and RJSPBT204	Credits 4
1	Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin).	
2	Study of the pickling process (sauerkraut / pickled cucumbers) with respect to physical, chemical / biochemical and biological changes occurring during the pickling process.	
3	Effect of temperature on food preservation.	
4	Isolation of lactic acid bacteria	
5	Antimicrobial activity of bacteriocins	
6	Study of a patent and developing a hypothetical patent application for a hypothetical product / process.	
7	Writing of SOP for laboratory equipment's / instruments.	
8	Compilation of information on recommended biosafety practices in a biotechnology laboratory.	
9	Use of Microsoft PowerPoint / Corel Draw to prepare a poster from a peer reviewed journal no more than 5 years old.	

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Scheme of Examinations

1. For Theory exam - Two Internals of 20 marks each (IA1 and IA 2), in the form of Objective Tests, Assignments, Presentations, Posters etc.

2. One External Theory exam (Semester End Examination, SEE) of 60 marks. Duration: 2 1/2 hours.

3. Practical evaluation will be done using continuous assessment as well as semester end practical examination totaling up to 100 marks in each of the 2 practical papers

4. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of M. Sc. Biotechnology or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of M. Sc. Biotechnology as per the minimum requirements.

5. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.

6. Minimum marks for passing the Theory Exam is 40% (Internal and SEE separate passing in each paper) and in the Practical Exam 40 % individual passing in each practical.

7. For any KT examinations, there shall be ODD-ODD/EVEN-EVEN pattern followed.

8. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment

Evaluation (Theory): Total marks per paper - 100.

- **IA- 40 marks**
  - IA 1: Presentations/ Objective Assessment -20 marks
  - IA 2: Objective Assessment / Assignment -20 marks
- **Semester End Examination – 60 marks**
  - Question paper covering all units

- **Course Semester End Examination in Semester I -Paper I to IV (RJSPBT101 to RJSPBT104) and Semester II - Paper I to IV (RJSPBT201 to RJSPBT204)**

Question	Knowledge	Understanding	Application And Analyses	Total Marks- Per Unit
Unit 1	08	03	04	15
Unit 2	08	03	04	15
Unit 3	08	03	04	15
Short notes from topics covering all the units	08	03	04	15
-TOTAL- Per objective	32	12	16	**60**
% WEIGHTAGE	53	20	27	**100%**

- **Evaluation of Practicals 200 marks with individual paper passing 100 marks for each practical Sem I - RJSPBTP101, RJSPBTP102; Sem II - RJSPBTP201, RJSPBTP202**
- Continuous Evaluation of components which requires adequate duration for completion of the task, observation and interpretation
- Course end Practical Evaluation of skills of students in terms of skill, analysis, interpretation and conclusion.

Mapping of the course to employability/ Entrepreneurship/skill development

M.Sc. BIOTECHNOLOGY SEM I

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/skill development	Employability/ Entrepreneurship/Skill development	Specific activity
MSc Biotech	Biochemistry	RJSPBT101	Protein Biochemistry, Physiological biochemistry, Neurobiology	Skill development, Employability in R&D, QA/QC, and Food industry	Protein Three dimensional structure, Homeostasis
	Immunology I	RJSPBT102	Clinical immunology .	Skill development, employability in R&D, Pathology lab, sales and marketing and QA/QC, and Entrepreneurship	Cytokines and Immune system behavior
	Genomics	RJSPBT103	Genome sequencing; Genome mapping, editing	Skill development, employability in R & D, pharmaceutical industry	Latest gene editing tools for genome modification
	Biophysics	RJSPBT104	Microscopy, Spectroscopy, Mass spectrometry, XRD	Skill development, Employability in R&D, Pathology lab, sales and marketing and QA/QC, and Entrepreneurship	Analytical techniques
	Practicals of	RJSPBTP101 RJSPBTP102		Experimental skills Observational skills Analytical skills Interpretation skills Experiment Planning and execution skills Writing skills	

M.Sc. BIOTECHNOLOGY SEM II

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/skill development	Employability/ Entrepreneurship/Skill development	Specific activity
M.Sc Biotech	Metabolism	RJSPBT201	Amino acids and nucleotides metabolism Lipoproteins, Protein folding, Plant and microbial metabolism	Skill development and Employability in Pathology laboratory, R & D, QA/QC and Pharma industry.	Catabolic and anabolic reactions and integration of metabolic pathways
	Immunology II	RJSPBT202	Autoimmunity, Transplantation immunology, animal models in immunological studies and cell imaging	Skill development, Employability in Pathology laboratory, R & D, sales, marketing and Entrepreneurship	Study of immune system abnormalities
	Bioprocess technology	RJSPBT203	Fermentation process and down- stream processing	Skill development, Employability in food processing industry, QA/QC, R&D.	Industrial Bioprocesses
	IPR & Biosafety	RJSPBT204	Patents, Trademarks, Copyrights, Geographical indications and Patent database	Skill development, Employability in Intellectual property	Implementation of IPR and GLP/GMP
	Practicals of	RJSPBTP201, RJSPBTP202		Experimental skills Observational skills Analytical skills Interpretation skills Experiment Planning and execution skills Writing skills	

Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Refer to page no: 30
highlighting component
of Research Project/Internship

Syllabus for the M.Sc. Part II

Program: M.Sc. BIOTECHNOLOGY

Program Code: RJSPBT

(CBCS 2022-2023)

PROGRAM OUTCOMES FOR POST GRADUATE DEGREE PROGRAMS IN BIOTECHNOLOGY

The Post graduate program in Biotechnology has been designed to empower students to obtain domain knowledge, analyze and apply. The courses have been designed to hone the analytical skills of students so as to solve real life situations. Modern tools have been introduced for studying biotechnology without compromising on the basic concepts. All the courses in the program are carefully designed to equip students for teaching the subject as well as qualify competitive examinations like CSIR NET, SET, DBT, ICMR, GRE etc.

Some basic attributes which a student would acquire after completion of postgraduate program are listed below.

Application of Knowledge

Maintain a high level of scientific excellence in research with specific emphasis on the technological advances in molecular biology techniques and bioinformatics. Create, select and apply appropriate techniques and modern technology in a multidisciplinary way. Apply the subject knowledge to design experiments, analyze and interpret data to reach an effective conclusion.

Ability to convey the concept clearly

They would identify, formulate, and analyze the complex problems and reach a conclusion. Logical thinking with application of biological, physical, and chemical sciences. Learning that develops analytical skills and integrative problem-solving approaches.

Teamwork

Students would perform functions that demand higher competences in national/international organizations with team spirit and helping each other. Develop qualities of empathy and sympathy for fellow beings

Honesty and Integrity and Ethics

Students will be aware of ethical issues and regulatory considerations while addressing societal needs for growth with honesty.

Environment and Sustainability

The problem-solving skills in students would encourage them to carry out innovative research projects to solve environmental issues. All actions are towards achieving United Nations Sustainable Development Goals.

Lifelong learning and motivating others to learn

Students would lend support to one another for self and institutional growth, contribute to national development and provide equal opportunity.

Global thinking

Students would be equipped with life and technical skills and would be empowered with domain knowledge in thrust areas; these attributes will make them globally competitive.

PROGRAMME SPECIFIC OUTCOMES (PSOs) FOR MSc BIOTECHNOLOGY

Sr. No	A Student Specific completing M.Sc. Biotechnology will be able to :
PSO1	Understanding application of central tendency, non-parametric tests, statistical tests, and ANOVA techniques effectively in various statistical analyses
PSO2	Comprehensive understanding of viral infections, bacterial infections, bacterial, fungal, and protozoal infections, as well as biofilm formation and its implications in healthcare
PSO3	To gain knowledge and skills to analyze and work with genetically modified organisms, genetically engineered crops, bioremediation techniques, and biodegradation processes
PSO4	To understand and analyze post-fertilization events, implantation processes, principles and applications of assisted reproductive technology
PSO5	Gain critical thinking, and analytical skills, enabling them to make significant contributions to Biotechnology field
PSO6	To study synthesis and characteristics of nanomaterials, apply nanorobotics in various contexts, utilize nanomedicine for healthcare advancements
PSO7	To understand new drug discovery process, preclinical toxicology studies and the intricacies of clinical trials
PSO8	Understanding phylogenetics, proteomics, genomics, and drug discovery, enabling them to make significant contributions to the field of life sciences and biomedical research
PSO9	To study genetic engineering of plants, transgenic plant technology, the fundamentals of animal cell culturing, and advanced cell culture techniques
PSO10	Gain understanding of medical diagnostics of organisms, Weil-Felix reactions, bioremediation, validation of GMOs, synthesis of nanoparticles using chemical and biological methods, spectroscopic analysis of nanoparticles, and evaluation of their antibacterial effects
PSO11	To understand hairy root culture techniques, establishing primary cultures (ATC), assaying radical scavenging activity using the DPPH Method, constructing phylogenetic trees, utilizing BLAST for the identification of orthologs, paralogs, and homologs, exploring KEGG pathways, CATH/SCOP classification for a given protein

MSc II BIOTECHNOLOGY SEMESTER III

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT301	Paper - Biostatistics			60 hours
	I	Central Tendency	4	
	II	Non-parametric tests		
	III	Statistical tests		
	IV	ANOVA		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT302	Paper - Medical Microbiology			60 hours
	I	Viral Infection	4	
	II	Bacterial Infection		
	III	Bacterial, fungal and Protozoal infection		
	IV	Biofilms		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT303	Paper - GMO and Environment			60 hours
	I	Genetically Modified Organism	4	
	II	GE-Crops		
	III	Bioremediation		
	IV	Biodegradation		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT304	Paper - Developmental Biology			60 hours
	I	Post Fertilization events	4	
	II	Implantation		
	III	Contraceptives and Infertility		
	IV	Assisted Reproductive Technology		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSPBT301	Skill Based Project	8	120 hours

MSc II BIOTECHNOLOGY SEMESTER III

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT401	Paper - Nanotechnology			60 hours
	I	Synthesis and Characterization	4	
	II	Nanorobotics		
	III	Nanomedicine		
	IV	Applications		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT402	Paper - Clinical Studies			60 hours
	I	New drug discovery process	4	
	II	Pre clinical toxicology		
	III	Clinical Trials		
	IV	Medical writing		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT403	Paper - Bioinformatics			60 hours
	I	Phylogenetics	4	
	II	Proteomics		
	III	Genomics		
	IV	Drug discovery		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSPBT404	Paper - Plant and animal tissue culture			60 hours
	I	Genetic Engineering of plants	4	
	II	Transgenic plants		
	III	Basics of animal cell culturing		
	IV	Cell culture techniques		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSPBTP401	Practicals of RJSPBT301, RJSPBT302, RJSPBT303 & RJSPBT304	4	60 hours
RJSPBTP402	Practicals of RJSPBT401, RJSPBT402, RJSPBT403 & RJSPBT404	4	60 hours

SYLLABUS GRID

YEAR	SEMESTER	CORE SUBJECT				PRACTICALS OF CORE SUBJECT	SKILLED BASED PROJECT	TOTAL
MSc I	**I**	4	4	4	4	8	-	24
	II	4	4	4	4	8	-	24
TOTAL		8	8	8	8	16	-	48
MSc II	**III**	4	4	4	4	4	4	24
	IV	4	4	4	4	8	-	24
TOTAL		8	8	8	8	12	4	48

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOSTATISTICS
COURSE CODE	:	RJSPBT301
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To study parameters of central tendency and types of statistical samples
2	To understand the meaning of parametric and nonparametric tests, their formulae and uses.
3	To acquaint students with application of ANOVA

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of Sampling in statistics	1	BT levels 1,2 & 3
CO2	Understanding of the concepts of Gaussian distribution, Hypothesis testing	1	BT levels 1,2 & 3
CO3	Understand the concept of correlation and regression.	1	BT levels 1,2 & 3

Paper Code: RJSPBT301	**Paper-I: Biostatistics**	**Credits 4**
Unit I	Central tendency	15 hrs
	Statistical population, sample from population, Random sample. Central Tendency: Mean, Median and Mode, Standard Deviation Confidence intervals	
Unit II	Non-parametric tests	15 hrs
	Gaussian Distribution and testing for normality, Non-parametric tests (Sign test, Wilcoxon test, Mann-Whitney Test, Kruskal-Wallis test,), transforming data to create Gaussian Distribution	
Unit III	Statistical tests	15 hrs
	Test of Significance. Hypothesis testing: - Theory of errors- Type I and Type II errors, Null hypothesis, P values-one v/s two tail P values, t-test (paired & unpaired), z-test, Chi square test, contingency table. Use of softwares in biostatistics	
Unit IV	ANOVA	15 hrs
	Comparing three or more groups- Introduction to ANOVA, One-way ANOVA, repeated measures ANOVA, Friedman Test. Correlation and Regression: Linear and multiple Correlation and Regression	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	MEDICAL MICROBIOLOGY
COURSE CODE	:	RJSPBT302
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To understand different viral, bacterial, fungal and protozoal infections.Symptoms, Diagnosis and treatment associated with respective infections.
2	To gain knowledge about the structure, function and consequences of biofilm formation in environment and health.
3	To study the pathogenesis, epidemiology of viral, bacterial fungal and protozoal infections
4	To understand the concept of biofilms and their applications in various fields

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of infections caused by viruses, bacteria, fungi and protozoa.	2	BT levels 1,2 & 3
CO2	Understand the importance of Biofilms in environment and health.	2	BT levels 1,2 & 3

Paper Code: RJSPBT302	**Paper-II : Medical microbiology**	**Credits 4**
Unit I	Viral infections	15 hrs
	Airborne – Chicken pox and Shingles, Arthropod – Yellow fever, Direct contact – Hepatitis, Food borne – Poliomyelitis	
Unit II	Bacterial infections	15 hrs
	Airborne – Diphtheria, Direct contact – Clostridial myonecrosis, Food borne – Cholera, *S aureus* Food poisoning, Nosocomial infections	
Unit III	Bacterial, Fungal and Protozoal infections	15 hrs
	Chlamydial infections - Trachoma, Mycoplasma infection – genitourinary diseases, atypical pneumonia, Rickettsial infection – Rocky mountain spotted fever Fungal mycosis, Protozoal diseases – Malaria, Amoebiasis	
Unit IV	Biofilms	15 hrs
	Structure, formation and control, consequences in environment and health.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	GMO AND ENVIRONMENT
COURSE CODE	:	RJSPBT303
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To understand the strategies used for generation of GMOs, their applications and risks involved. Ethical and moral issues associated with GMOs and identification and detection using latest techniques.
2	To understand the role of Arabidopsis as a model plant for studies in genetic engineering and Protocols on Food and feed safety
3	To gain the knowledge of various bioremediation mechanisms using plants and microorganisms, also various biodegradation measures taken for treatment of biological wastes.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of Food and Feed safety assessment, livestock feeding study and biodegradation of xenobiotics.	3	BT levels 1,2 & 3

CO2	Understand the concepts of bioremediation of petrochemical and paper industry waste and Indian GMO research information system.	3	BT levels 1,2 & 3

Paper Code: RJSPBT303	**Paper-III: GMO and Environment**	**Credits 4**
Unit I	Genetically Modified Organisms	15 hrs
	Genetically Modified Organisms, examples and methods Humulin, ice minus bacteria, GM bacteria in bioremediation, and use of PCR as a GMO identification tool, risks and controversies related to use of Genetically Modified Microorganisms. Indian GM research information system. About Indian GMO Research Information System (IGMORIS); about the website; Biosafety data of any two approved genes available on the database.	
Unit II	GE- Crops	15 hrs
	GE- crops- Arabidopsis as a model plant for studies in genetic engineering; Protocols on Food and feed safety in rats and mice, sub chronic feeding study in rodents, Protein thermal stability, pepsin digestibility, Livestock feeding study.	
Unit III	Bioremediation	15 hrs
	Solid waste treatment, pollution indicators and biosensors, biodegradation of Xenobiotics, pesticides, phytoremediation	
Unit IV	Biodegradation	15 hrs
	Biodegradation of waste from food, textile, petrochemical, paper industries, biological detoxification, Removal of oil spillage and grease deposits.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	DEVELOPMENTAL BIOLOGY
COURSE CODE	:	RJSPBT304
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To study the process of formation of Morula, Blastula, germ layers.
2	To acquaint students with different methods used for tracking of cells during gastrulation.
3	To Study the formation of placenta and how immune-tolerance is developed at mother-fetal interface.
4	To understand the causes and potential treatments of infertility; need and methods of contraception and also to study the various methods Assisted reproductive technology

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of events during fertilization, early embryonic development and molecular mechanisms of sex hormones.	4	BT levels 1,2 & 3

CO2	Understand the new frontiers in contraceptive research and ethical issues related to embryo research.	4	BT levels 1,2 & 3

Paper Code: RJSPBT304	**Paper-IV: Developmental biology**	**Credits 4**
Unit I	Post fertilization events	15 hrs
	Early embryonic development, establishing multicellularity, formation of blastula, Embryonic germ layer, tracking of migrating cells	
Unit II	Implantation	15 hrs
	Molecular mechanism of sex hormone action and regulation of gene expression, Implantation and endometrium antigens involved in implantation. Immunology of pregnancy.	
Unit III	Contraceptives and Infertility	15 hrs
	Frontiers in contraceptive research. Infertility and reproductive vaccines. Ethical issues related to embryo research	
Unit IV	Assisted reproductive technology	15 hrs
	Manipulation of reproduction in animals – artificial insemination, Superovulation, embryo culture, embryo transfer, *in vitro* fertilization, embryo cloning. Manipulation of reproduction in humans - Causes of infertility, intrauterine insemination, *in vitro* fertilization, embryo transfer and applications of assisted reproductive technology.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	NANOTECHNOLOGY
COURSE CODE	:	RJSPBT401
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To study various synthesis and characterization methods of nanomaterials.
2	To understand the properties of nanorobotics
3	To study the impact and future prospects of nanomaterials in various fields.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of biological methods of nano material synthesis and analysis techniques.	5	BT levels 1,2 & 3
CO2	Understand the applications of carbon nano-tubes and other materials in medicine, food, cosmetics and environment management.	5	BT levels 1,2 & 3

Paper Code: RJSPBT401	**Paper-I: Nanotechnology**	**Credits 4**
Unit I	Synthesis and characterization	15 hrs
	Introduction, synthesis of nanomaterials, biological methods, use of microbial system & plant extracts, use of proteins & templates like DNA.Characterization of nanomaterials, analysis techniques, properties of nanomechanical, optical, magnetic properties, electrical conductivity, thermal conductivity.	
Unit II	Nanorobotics	15 hrs
	Carbon nanotubes, Nanorobotics devices of nature: ATP synthase, the kinen, myosin, dynein, flagella modulated motion.	
Unit III	Nanomedicine	15 hrs
	Biopharmaceutics, implantable materials, implantable chemicals, surgical aids, diagnostic tools, nanosensors, nano scanning, nano enabled drug delivery systems, nanorobotics in medicine.	
Unit IV	Application	15 hrs
	Application of nanomaterials in food, cosmetics, agriculture, environment management	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	CLINICAL STUDIES
COURSE CODE	:	RJSPBT402
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To study the requisition and process of new drugs discovery.
2	To understand the concept of preclinical toxicity, clinical trials and ethical issues of clinical research
3	To acquaint students with nuances of medical writing

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of single and double blind studies and systemic toxicology	6	BT levels 1,2 & 3
CO2	Carry out literature search, Scientific article writing and generate clinical study reports.	6	BT levels 1,2 & 3

Paper Code: RJSPBT402	**Paper-II: Clinical studies**	**Credits 4**
Unit I	New drug discovery process	15 hrs
	Purpose of new drug discovery process, main steps involved in new drug discovery, process, timelines of each step, advantages and purposes of each step, ethics in clinical research, unethical trials, thalidomide tragedy, Phase- I,II,III,IV trials. Introduction and designing- various phases of clinical trials- Post Marketing surveillance – methods	
Unit II	Pre- clinical toxicology	15 hrs
	General principles, Systemic toxicology (Single dose and repeat dose studies) Carcinogenicity, Reproductive, Local toxicity, Genotoxicity, animal toxicity requirements.	
Unit III	Clinical trials	15 hrs
	Types of clinical trials, single blinding, double blindings, open label, randomized trials and their examples, interventional study and its members, cross over design, Project management and data management, Pharmacovigilance, Trial Monitoring. Ethics Committee/ Regulatory bodies.	
Unit IV	Medical writing	15 hrs
	Literature search & Medical Articles, Contract writing, Publication, Abstracts, Bibliography, Clinical Study Reports; Principles and software's in Clinical data management.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOINFORMATICS
COURSE CODE	:	RJSPBT403
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To learn the Global and Local alignment principles and online tools for obtaining the sequence comparison results
2	To understand the application of Protein structure visualization, motif finding and pattern recognition bioinformatics tools.
3	To study the online tools used for gene identification, prediction and primer designing and understand drug discovery technologies and strategies.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of Genomics and Proteomics analysis and exon intron finder.	7	BT levels 1,2 & 3
CO2	Understand in detail tools and techniques used for gene finding, gene expression, microarray	7	BT levels 1,2 & 3

Paper Code: RJSPBT403	**Paper-III: Bioinformatics**	**Credits 4**
Unit I	Phylogenetics	15 hrs
	Alignment and phylogenetic analysis, submitting data sequences to databases, Querying in databases.	
Unit II	Proteomics	15 hrs
	Protein classification and structure visualization. Motifs, profiles, patterns and fingerprints, tools and techniques.	
Unit III	Genomics	15 hrs
	Gene identification and prediction, Gene expression profiling and its applications. Microarray analysis and organization of data Primers in biology (Designing of primers, kinds of primers)	
Unit IV	Drug discovery	15 hrs
	Introduction to drug discovery, technologies and strategies	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PLANT AND ANIMAL TISSUE CULTURE
COURSE CODE	:	RJSPBT404
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	To understand the principle and requirements of production of haploid plants, somatic variation, germplasm conservation
2	To discuss various applications of transgenic plants and their future prospects
3	To study the characteristics of cultured animal cells and requirements of an animal tissue culture laboratory with respect to culture media and equipments
4	To study the principle and applications of various animal cells culturing techniques

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain an understanding of the basic concepts of Biosynthesis and biotransformation of plant metabolites, Transgenic plants.	8	BT levels 1,2 & 3

CO2	Understand the types, isolation and culturing of animal cells.	8	BT levels 1,2 & 3

Paper Code: RJSPBT404	**Paper-IV: Plant and animal tissue culture**	**Credits 4**
Unit I	Genetic engineering of plants	15 hrs
	Production of haploid plants, somatic variation, germplasm Conservation; genetic engineering of plants – methods, application of transgenic plants – herbicide resistance, abiotic and biotic stress tolerance.	
Unit II	Transgenic plants	15 hrs
	Transgenic plants as bioreactors, molecular-marker aided breeding, RFLP, PCR- amplification, RAPD, AFLP, molecular marker assisted selection, green house and green home technology.	
Unit III	Basics of animal cell culturing	15 hrs
	Biology and characterization of cultured cells, Culture vessels, Culture Media, Microbial contamination, cross contamination. Cryopreservation.	
Unit IV	Cell culture techniques	15 hrs
	Primary culture and Cell lines; cell viability and cytotoxicity; cell transformation; organ, histotypic cultures and tissue engineering.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	SKILL BASED PROJECT
COURSE CODE	:	RJSPBTP301
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Understanding and working of various analytical instruments and methods
2	Recent developments in various fields

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Gain valuable work experience	9	BT levels 2, 3 & 4
CO2	Develop and refine skills	9	BT levels 2, 3 & 4
CO3	Explore a career path	9	BT levels 2, 3 & 4

Paper Code: RJSPBTP301	**Practical-I:Skill based project**	**Credits 8**
1	Dissertation	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Practicals of RJSPBT301, RJSPBT302, RJSPBT303 & RJSPBT304
COURSE CODE	:	RJSPBTP401
CREDITS	:	4
DURATION	:	60 hours

LEARNING OBJECTIVES	
1	Characterization and identification of pathogen
2	Concept of quorum and significance of biofilm
3	Rickettsial infections and their diagnosis
4	Use of microorganisms in bioremediation
5	Significance of validation methods in regulation GMOs
6	Characterization of compost by chemical and physical parameters
7	Principle of biological synthesis of nanoparticles and parameters that can be used for their characterization
8	Potency of nanoparticle against bacteria and its potential application

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of culture methods, biochemical tests and direct microscopic examination for characterization of the pathogen.	10	BT levels 2, 3 & 4
CO2	Use of rhizosphere in biofilm formation and observation of biofilm	10	BT levels 2, 3 & 4
CO3	Use of cross reactivity in presumptive diagnosis of rickettsial infection	10	BT levels 2, 3 & 4
CO4	Use of growth curve and generation time in isolation of metal tolerant organisms	10	BT levels 2, 3 & 4
CO5	Principle of various methods for validation of GMOs	10	BT levels 2, 3 & 4
CO6	Principle of methods used for estimation of carbon, phosphorus, and calcium and physical parameters of a compost.	10	BT levels 2, 3 & 4
CO7	Use of various plant leaves in synthesis of silver nanoparticles and their characterization using	10	BT levels 2, 3 & 4

	spectrophotometer and absorption spectrum		
CO8	Use of agar well diffusion method to assess the antibacterial activity of synthesized nanoparticles against Gram negative and Gram positive bacteria.	10	BT levels 2, 3 & 4

Paper Code: RJSPBTP401	**Practical-I: Practicals of RJSPBT301, RJSPBT302, RJSPBT303 & RJSPBT304**	**Credits 4**
1	Medical diagnostic – *S. aureus, Pseudomonas spp.*	
2	Staining of Biofilms	
3	Weil – Felix reactions	
4	Bioremediation- isolation of metal tolerant organisms & study their growth characteristics and pattern	
5	GMO – Validation – kit based/ demo	
6	Composting – physical & chemical parameters	
7	Nanoparticles – synthesis chemical and biological methods; Spectroscopic analysis	
8	Antibacterial effects of nanoparticle	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Practicals of RJSPBT401, RJSPBT402, RJSPBT403 & RJSPBT404
COURSE CODE	:	RJSPBT402
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Concepts of PTC and hairy root culture
2	Working and requirements of an ATC lab & ex vivo culturing of cells freshly obtained from a multicellular organism.
3	Free radicals, role of antioxidants as scavengers in ATC
4	Stages of Chick embryo development
5	Deciphering a phylogenetic tree and understanding of evolutionary relationship based on it
6	Concepts of motifs and domains
7	Use of Integrated database
8	Concept of hierarchical domain classification of protein structures

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Aseptic seed germination, preparation of PTC media and the concept of culturing of transformed roots.	11	BT levels 2, 3 & 4
CO2	Use of candeling in study of embryo development	11	BT levels 2, 3 & 4
CO3	Tissue Disintegration methods, preparation of ATC media and cells culturing.	11	BT levels 2, 3 & 4
CO4	Use of DPPH in scavenger activity assay	11	BT levels 2, 3 & 4
CO5	Concept of sequence alignment and use of various bioinformatic tools in alignment	11	BT levels 2, 3 & 4
CO6	Use of BLAST in study of orthologs and paralogs, homologs	11	BT levels 2, 3 & 4
CO7	Use of bioinformatic tools in study of conserved sequence pattern	11	BT levels 2, 3 & 4
CO8	Use of KEGG for exploring advanced data analysis and inter-pathway dependence	11	BT levels 2, 3 & 4

CO9	Structural Classification of proteins using CATH and SCOP	11	BT levels 2, 3 & 4

Paper Code: RJSPBTP402	Practical-II:Practicals of RJSPBT401, RJSPBT402, RJSPBT403 & RJSPBT404	Credits 4
1	Hairy root culture	
2	Establishing primary culture (ATC)	
3	To assay the radical scavenging activity of a tissue hydrolysate DPPH Method	
4	Study and present published findings of any clinical trial	
5	Multiple alignment - Phylogenetic tree	
6	BLAST - orthologs and paralogs, homologs	
7	Motif finding	
8	KEGG	
9	Structure of proteins - identification of chains, helices, special groups, metal ions etc. CATH / SCOP classification of a given protein / RASMOL	
10	Use protein docking tools	

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7. Bioinformatics: Sequence and Genome Analysis (Second Edition 2004), David W. Mount, Cold spring Harbor, Laboratory Press
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13. Essential Developmental Biology (2ndEdition 2006), J. M. W. Slack, Blackwell Publishing
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18. Nano forms of carbon and its applications (2007), Prof. Maheshwar Sharon and Dr. Madhuri Sharon Manad Nanotech Pvt. Ltd.

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24. Clinical Pharmacology, Laurence D. R and Bennet P.M, Scientific book agency
25. Clinical Pharmacokinetics, Krishna D.R & Klotz V., Springer Verlab
26. Remington Pharmaceutical sciences, Williams and Wilkins, Lippincott
27. Drug Interaction, Hamsten, Kven Stockley
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30. Practical Guide to clinical data management, Sussane Prokscha
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33. Medical Writing, Taylor Robert, Springer

Scheme of Examinations

1. For Theory exam - Two Internals of 20 marks each (IA1 and IA 2), duration 30 min each.
2. One External Theory exam (Semester End Examination, SEE) of 60 marks. Duration: 2 ½ hours.
3. Practical evaluation will be done using continuous assessment as well as semester end practical examination totaling up to 100 marks in each of the 2 practical papers
4. Skill based project will be marked by Principal investigator out of 100 marks and marks out of other 50% will be awarded based on the presentation of the same by external examiner and internal examiner.
5. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of M. Sc. Biotechnology or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of M. Sc. Biotechnology as per the minimum requirements.
6. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.
7. Minimum marks for passing the Theory Exam is 40% (Internal and SEE separate passing in each paper) and in the Practical Exam 40 % individual passing in each practical.
8. For any KT examinations, there shall be ODD-ODD/EVEN-EVEN pattern followed.
9. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment

Evaluation (Theory): Total marks per paper - 100.

- **IA- 40 marks**
  - IA 1: Presentations/ Objective Assessment -20 marks
  - IA 2: Objective Assessment / Assignment -20 marks
- **Semester End Examination – 60 marks**
  - Question paper covering all units

- **Course Semester End Examination in Semester III -Paper I to IV (RJSPBT301 to RJSPBT304) and Semester IV - Paper I to IV (RJSPBT401 to RJSPBT404)**

Question	Knowledge	Understanding	Application And Analyses	Total Marks- Per Unit
Unit 1	08	03	04	15
Unit 2	08	03	04	15
Unit 3	08	03	04	15
Short notes from topics covering all the units	08	03	04	15
-TOTAL- Per objective	32	12	16	**60**
% WEIGHTAGE	53	20	27	**100%**

- **Evaluation of Practicals 200 marks with individual paper passing 100 marks for each practical Sem III - RJSPBTP301; Sem IV - RJSPBTP401, RJSPBTP402**
- Continuous Evaluation of components which require adequate duration for completion of the task, observation and interpretation
- Course end Practical Evaluation of skills of students in terms of skill, analysis, interpretation and conclusion.

Mapping of the course to employability/ Entrepreneurship/skill development
M.Sc. BIOTECHNOLOGY SEM III

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/skill development	Employability/ Entrepreneurship/Skill development	Specific activity
MSc Biotech	Biostatistics	RJSPBT301	Techniques in ATC and PTC	Skill development, Employability in R&D, Pathology lab, sales and marketing and QA/QC, and Entrepreneurship	Cell culture techniques
	Medical microbiology	RJSPBT302	Infections caused by viruses, bacteria, fungi and protozoa.	Skill development in understanding of epidemiology, virulence factors Employability in Diagnostics field	Identification of infectious agents
	GMO and environment	RJSPBT303	GMOs, Bioremediation	Skill development, employability in environmental sciences fields and Entrepreneurship	Bioremediation techniques
	Developmental Biology	RJSPBT304	Contraceptives and Infertility, Assisted reproductive technology	Skill development, Employability Employability in IVF Centres, Genetic counselling, Pathology lab and R&D	IVF techniques study
	Practicals of	RJSPBTP301		Experimental skills Observational skills Analytical skills Interpretation skills Experiment Planning and execution skills Writing skills	

M.Sc. BIOTECHNOLOGY SEM IV

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/skill development	Employability/Entrepreneurship/Skill development	Specific activity
M.Sc Biotech	Nanotechnology	RJSPBT401	Biosynthesis and characterization of nanoparticles	Skill development in nanomaterials and Employability in sales and marketing, R & D, QA/QC and Pharma industry.	Biosynthesis and characterization of nanoparticles
	Clinical studies	RJSPBT402	Medical writing, clinical trials study	Skill development, Employability in Pathology laboratory, R & D and epidemiology	Clinical case study
	Bioinformatics	RJSPBT403	Use of various bioinformatic tools	Skill development, Employability in R&D and Bioinformatics	Identification of infectious agents
	Plant and animal tissue culture	RJSPBT404	Use of various biostatistics tools	Skill development, Employability in Pathology laboratory, R & D and epidemiology	Interpretation of data
	Practicals of	RJSPBTP401, RJSPBTP402	ATC PTC Bioinformatics	Experimental skills Observational skills Analytical skills Interpretation skills Experiment Planning and execution skills Writing skills	