Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part I

Program: M.Sc. BIOTECHNOLOGY

Program Code: RJSPBT

(CBCS 2019-2020)

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	