



Hindi Vidya Prachar Samiti's

## **Ramniranjan Jhunjhunwala College**

**of Arts, Science & Commerce**

**(Autonomous College)**

Affiliated to

**UNIVERSITY OF MUMBAI**

**Syllabus for the M.Sc.**

**Program: M.Sc. BOTANY**

**Program Code: RJSPGBOT**

**(CBCS 2019-2020)**

**M.Sc Botany Semester III**

**Outline of the Course:** RJSPBOT301 and RJSPBOT302 are common papers for all specialisations

**RJSPGBOT301:** Techniques and Instrumentation.

**RJSPGBOT302:** Cell and Molecular Biology.

**RJSPGBOT303 and RJSPGBOT304 are Optional Papers in any one of the following specialisations.**

1. Plant Physiology and Biochemistry (PPB).
2. Molecular Biology, Cytogenetics and Biotechnology (MCB).

Theory - RJSPGBOT301	4 Credits
Theory - RJSPGBOT302	4 Credits
Theory – RJSPGBOTPPB303/ RJSPGBOTMCB303	4 Credits
Theory – RJSPGBOTPPB304/ RJSPGBOTMCB304	4 Credits
Practical's (based on all 4 courses) - RJSPGBOTP301, RJSPGBOTP302, RJSPGBOTP303, & RJSPGBOTP304	16 Credits

**SEMESTER III****Common Papers**

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
RJSPGBOT301	Title of the Paper: Research Methodology			
	I	Concept of Research	4	1
	II	Experiment design		1
	III	Statistical tools for data analysis		1
	IV	Computational tools		1
RJSPGBOT302	Title of the Paper: Molecular Biology			
	I	DNA replication.	4	1
	II	Transcription.		1
	III	RNA processing.		1
	IV	Translation.		1

**Specialization: Plant Physiology and Biochemistry**

RJSPGBOTPPB303	Title of the Paper: Plant Biochemistry.		4
	I.	Enzymes , Vitamins as Coenzymes.	1
	II.	Lipids metabolism II	1
	III	Plant proteins.	1
	IV	Nucleotide metabolism.	1
RJSPGBOTPPB304	Title of the Paper: Plant Physiology.		4
	I	Stress Physiology: Drought and Salinity	1
	II	Stress Physiology: Freezing, oxidative, temperature and oxygen.	1
	III.	Membrane transport I	1
	IV.	Membrane transport II	1
RJSPGBOTPPBP303	Plant Biochemistry.		4
RJSPGBOTPPBP304	Plant Physiology		4

**M. Sc Botany Syllabus Semester III****Specialization: Molecular Biology, Cytogenetics and Biotechnology (MCB)**

RJSPGBOTMCB303	Title of the Paper: Plant Biotechnology			
	I	Plant Tissue Culture I.	4	1
	II	Plant Tissue Culture II.		1
	III	Biotransformation.		1
	IV	Commercial aspects.		1
RJSPGBOTMCB304	Title of the Paper: Molecular Biology and Cytogenetics.			
	I	Cytology.	4	1
	II	Cancer Biology.		1
	III	Immune System.		1
	IV	Genetic Diseases.		1

RJSPGBOTMCBP303	Plant Biotechnology	4
RJSPGBOTMCBP304	Cytogenetics	4

**Detailed syllabus of Semester III General papers**

Course Code	Topic
RJSPGBOT301	Techniques and instrumentation
<u>Unit I: Concept of Research</u> <ul style="list-style-type: none"><li>➤ Why, What and How, Types and approach, Ethics, material collection – primary and secondary sources. Different resources – library, field and other</li></ul>	
<u>Unit II: Experimental design</u> <ul style="list-style-type: none"><li>➤ Method and standardisation</li><li>➤ Reproducibility of results</li></ul>	
<u>Unit III: Statistical tools for data analysis</u> <ul style="list-style-type: none"><li>➤ Mean, median and mode</li><li>➤ Standard deviation</li><li>➤ Coefficient of correlation</li><li>➤ t- test</li><li>➤ ANOVA and regression analysis</li><li>➤ RBD and Latin square</li></ul>	
<u>Unit IV: Computational tools for research</u> <ul style="list-style-type: none"><li>➤ Search engines</li><li>➤ Writing a Report</li><li>➤ Bibliography</li><li>➤ Ethics</li></ul>	

**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Theory
RJSPGBOT301 Paper I Techniques and instrumentation	<p>Course Outcome 3.1:</p> <ol style="list-style-type: none"><li>1. Data analysis and hypothesis testing using biostatistical tools.</li><li>2. Detailed study and analysis of bioinformatics tools.</li><li>3. Submission of a review paper written by the student</li></ol> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Knowing the application of biostatistics and bioinformatics tools depending on data with its interpretation</li><li>➤ Development of writing skills</li></ul>

**M. Sc Botany Syllabus Semester III**

Course Code	Topic
RJSPBOT302	Molecular Biology
<u>Unit I: DNA Replication</u> <ul style="list-style-type: none"><li>➤ Molecular details of DNA replication in prokaryotes and eukaryotes.</li><li>➤ Assembly of raw DNA into nucleosomes.</li><li>➤ DNA recombination, Holliday model for recombination.</li></ul>	
<u>Unit II: Transcription</u> <ul style="list-style-type: none"><li>➤ Transcription, RNA synthesis, classes of RNA and the genes that code for them.</li><li>➤ Transcription of protein coding genes, prokaryotes and eukaryotes, mRNA molecule.</li><li>➤ Transcription of other genes, ribosomal RNA, and ribosomes</li></ul>	
<u>Unit III: RNA processing</u> <ul style="list-style-type: none"><li>➤ Capping, polyadenylation, splicing, introns and exons.</li><li>➤ snRNA, Types of snRNA, snRNA in spliceosome, significance of snRNA</li><li>➤ Non-coding RNAs, ribozyme, riboswitches, RNA localization.</li></ul>	
<u>Unit IV: Translation</u> <ul style="list-style-type: none"><li>➤ Protein structure, nature of genetic code, translation of genetic message.</li><li>➤ Post translational modifications, localization, chaperons.</li></ul>	



**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Theory
RJSPGBOT302 Paper II Molecular Biology	<p>Course Outcome 3.2:</p> <ol style="list-style-type: none"> <li>1. Detailed study of Molecular details of DNA replication and recombination in prokaryotes and eukaryotes.</li> <li>2. Mechanism of transcription, RNA synthesis, protein coding genes and RNA processing post transcription in prokaryotes and eukaryotes.</li> <li>3. Translation and post translational modifications.</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding concept of molecular biology in detail</li> <li>➤ Learning the application of tools in molecular biology</li> </ul>

RJSPBOTP301	Techniques and instrumentation
<ul style="list-style-type: none"> <li>➤ Hypothesis testing, Normal deviate test.</li> <li>➤ ANOVA- one way &amp; two ways.</li> <li>➤ Randomized block Design and Latin square.</li> <li>➤ Multiple alignments.</li> <li>➤ Phylogenetic tree.</li> <li>➤ BLAST.</li> <li>➤ Motif finding.</li> <li>➤ Use of search engines</li> <li>➤ Presentation on a given research topic and submission of a review paper written by the student.</li> </ul>	

**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Practical
RJSPGBOTP301 Practical I Techniques and instrumentation	<p>Course Outcome:</p> <ol style="list-style-type: none"> <li>1. Biostats analysis of hypothesis testing, normal deviate test, ANOVA- one way &amp; two way.</li> <li>2. Construction of randomized block design and Latin square.</li> <li>3. Bioinformatics analysis for Multiple alignments, Phylogenetic tree, BLAST and Motif finding.</li> <li>4. Writing skills</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Knowing the application of biostatistics and bioinformatics tools depending on data with its interpretation</li> <li>➤ Development of application skills</li> </ul>

RJSPBOTP302	
	<ul style="list-style-type: none"> <li>➤ Aseptic techniques, safe handling of microorganisms.</li> <li>➤ Establishing pure cultures, Streak Plate method (T-streak and pentagon method), Pour plate, Spread plate.</li> <li>➤ Preparation of culture medium, stock solutions</li> <li>➤ Separation of seed proteins using PAGE.</li> <li>➤ Genomic DNA isolation and quantification.</li> </ul>

**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Practical
RJSPGBOTP3 02 Practical II Molecular Biology	<p>Course Outcome:</p> <ul style="list-style-type: none"> <li>➤ Working on Aseptic techniques, safe handling of microorganisms and establishing pure cultures</li> <li>➤ Maintenance of cultures - Paraffin embedding, Lyophilisation.</li> <li>➤ Preparation of culture medium, stock solutions</li> <li>➤ Determination of cell number, viable count method (using pour plate and serial dilution technique).</li> <li>➤ Separation of seed proteins using PAGE and analysis of proteins by one and two-dimensional gel electrophoresis.</li> <li>➤ Genomic DNA isolation and quantification.</li> </ul> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding concept and handling of microbial culture</li> <li>➤ Learning the application of tools in molecular biology</li> <li>➤ Applications of gel electrophoresis</li> </ul>

**M. Sc Botany Syllabus Semester III****Specialization: Plant Physiology and Biochemistry (PPB)**

Course Code	Topic	Credits
RJSPGBOTPPB303	Plant Biochemistry	<b>4</b>
Unit I: Enzymes		
<ul style="list-style-type: none"> <li>➤ Purification and Isolation</li> <li>➤ Biochemical regulation</li> <li>➤ Isoenzymes</li> <li>➤ Vitamins – structure and Coenzyme activity</li> </ul>		1
Unit II: Lipid metabolism		1
<ul style="list-style-type: none"> <li>➤ Biosynthesis and degradation of odd carbon chain FA, structural and storage lipids</li> </ul>		
Unit III: Plant Proteins		1
<ul style="list-style-type: none"> <li>➤ Lectins and storage proteins in plants, transamination, oxidative deamination and Urea cycle.</li> </ul>		
Unit IV: Nucleotide Metabolism		1
<ul style="list-style-type: none"> <li>➤ Purine and Pyrimidine biosynthesis and regulation.</li> <li>➤ Recycling of Purine and Pyrimidine nucleotides by salvage pathways.</li> </ul>		

M.Sc. (PPB)	Semester III Theory
RJSPGBOTPPB303 Paper-III Plant Biochemistry	<p>Course Outcome 3.3:</p> <ol style="list-style-type: none"> <li>1. Study of Mechanism of all types of enzyme, catalyst, regulation and kinetics.</li> <li>2. Detailed study Vitamins and Coenzymes.</li> <li>3. Study the role of lectins (plant proteins).</li> <li>4. Detailed study of nucleotide metabolism and its synthesis.</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding the regulation of all types of enzymes</li> <li>➤ Learning the importance of Vitamins and Coenzymes.</li> <li>➤ Know the importance of plant lectins</li> <li>➤ Understanding the biosynthesis and regulation of nucleotide metabolism</li> </ul>

**M. Sc Botany Syllabus Semester III**

RJSPGBOTPPBP303	Plant Physiology practical	2	4
<ul style="list-style-type: none"> <li>➤ Study of enzyme SDH and effect of inhibitor on its activity</li> <li>➤ Isolation and estimation of DNA.</li> <li>➤ Estimation of RNA by Orcinol method.</li> <li>➤ Extraction and estimation of vitamin C from the given plant material</li> <li>➤ Estimation of activity of GOT from given plant material</li> <li>➤ Estimation of activity of GPT from given plant material</li> <li>➤ Extraction and purification of a lectin from red kidney beans and study of its phytohemagglutinin property</li> <li>➤ Experiment for PUFA</li> </ul>			

M.Sc.	Semester III Practical III
RJSPGBOTPPBP303 Practical III Plant Physiology	<p>Course Outcome:</p> <ol style="list-style-type: none"> <li>1. Study of various enzyme assays and interpretations</li> <li>2. Isolation and estimation of DNA and estimation of RNA by Orcinol method.</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding the regulation of all types of enzymes</li> <li>➤ Learning the isolation of DNA and RNA</li> </ul>

**M. Sc Botany Syllabus Semester III**

Course Code	Topic	CREDITS
RJSPGBOTPPB304	Plant Physiology	4
<u>Unit I: Stress Physiology I – Abiotic stress</u> <ul style="list-style-type: none"><li>• Drought - Morphological and cellular adaptations, mechanism of drought tolerance, role of Proline, Glycine betaines, Mannitol, Pinitol and Osmotin in stress resistance.</li><li>• Salinity - Generic Pathway for Plant Response to stress effect of salt on metabolic processes, Mechanism of salt resistance- salt avoidance (exclusion, extrusion and dilution) and tolerance (Regulation of ion homeostasis by SOS pathway), Role of Glycine betaine and Proline in Salinity Stress, DEAD-Box Helicases in Salinity Stress Tolerance.</li></ul>		1
<u>Unit II: Stress Physiology II – Abiotic stress</u> <ul style="list-style-type: none"><li>• Freezing stress</li><li>• Oxygen stress and Flooding</li><li>• Oxidative stress</li><li>• Heat stress</li></ul>		1
<u>Unit III: Membrane transport I</u> <ul style="list-style-type: none"><li>• Overview</li><li>• Organisation of transport at plant membrane</li><li>• Pumps – Proton pump, H<sup>+</sup> ATPase and Ca<sup>+2</sup> ATPase</li></ul>		1
<u>Unit IV: Membrane transport II</u> <ul style="list-style-type: none"><li>• Carriers</li><li>• Ion Channels – K<sup>+</sup> and Ca<sup>+2</sup> channels</li><li>• Aquaporins</li></ul>		1

**M. Sc Botany Syllabus Semester III**

M.Sc. (PPB)	Semester III Theory
RJSPGBOTPPB304 Paper-IV Plant Physiology	<p>Course outcome 3.4:</p> <ol style="list-style-type: none"> <li>Detailed study of concept of water potential, transport and translocation in plants.</li> <li>Understanding the mechanism of adaptation of plants under stress conditions</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding the role of water, ions, solutes and macromolecules in transport and translocation in plants</li> <li>➤ Understanding detailed concept of stress metabolites their importance and applications</li> </ul>

RJSPGBOTPPBP304	Plant Physiology practical	4
	<ul style="list-style-type: none"> <li>➤ Preparation of acid extract from halophytes and estimation of Na and K content by flame photometer</li> <li>➤ Estimation of proline content from stressed and control plants.</li> <li>➤ Study of oxidative enzymes SOD, Catalase from plants subjected to stress</li> <li>➤ Study of chloride uptake from suitable plant material</li> <li>➤ Study of enzyme ATPases from suitable plant material</li> </ul>	

M.Sc.	Semester III Practical
RJSPGBOTPPBP304 Practical IV Plant Physiology	<p>Course Outcome</p> <p>Techniques of elemental analysis</p> <p>Dynamics of stress induced enzymes</p> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Application of what they have learnt and interpretation</li> </ul>

**M. Sc Botany Syllabus Semester III****Specialization: Molecular Biology, Cytogenetics and Biotechnology (MCB)**

Course Code	Topic	Credits
RJSPGBOTMCB303	Plant Biotechnology	4
<u>Unit I: Plant Tissue Culture I</u>		1
<ul style="list-style-type: none"> <li>➤ Micropropagation of floricultural and medicinal plants using organogenesis and embryogenesis.</li> <li>➤ Factors responsible for <i>in vitro</i> and <i>ex vitro</i> hardening.</li> <li>➤ Plant improvement through soma clonal variations.</li> </ul>		
<u>Unit II: Plant Tissue Culture II</u>		1
<ul style="list-style-type: none"> <li>➤ Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery.</li> <li>➤ Problems in plant tissue culture: Contamination, Phenolics and Recalcitrants.</li> </ul>		
<u>Unit III: Biotransformation</u>		1
<ul style="list-style-type: none"> <li>➤ Biotransformation using: Freely suspended plant cells and Immobilized plant cells.</li> <li>➤ Biotransformation for Vanillin production from Capsicum cell cultures.</li> <li>➤ In vitro storage of germplasm, Cryopreservation.</li> <li>➤ Studies on <i>Agrobacterium</i> mediated transformed root cultures.</li> </ul>		
<u>Unit IV: Commercial aspects</u>		1
<ul style="list-style-type: none"> <li>➤ The quest for commercial production from plant cell: scaling up of cell cultures,</li> <li>➤ Bioreactors: factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed-batch, semicontinuous, two stage operation, continuous cultivation.</li> <li>➤ Factors for growth in Bioreactors.</li> <li>➤ Shikonin production by <i>Lithospermum erythrorhizon</i> cell cultures.</li> <li>➤</li> </ul>		



**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Topic Plant Biotechnology
RJSPGBOTMCB303 Paper III Specialisation Plant Biotechnology	<p>Course Outcome</p> <ul style="list-style-type: none"><li>• Mass Propagation of plants using <i>in vitro</i> technique</li><li>• Industrial production of fine chemicals using plant cell cultures</li></ul> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Application of techniques of plant tissue culture</li><li>➤ To learn production of value added chemicals by using green techniques like Biotransformation</li></ul>

**M. Sc Botany Syllabus Semester III**

Course Code	Topic	Credits
RJSPGBOTMCB304	Molecular Biology and Cytogenetics	4
<u>Unit I: Cytology</u>		1
<ul style="list-style-type: none"> <li>➤ Cell membrane and permeability: Molecular models of cell membrane, cell permeability. Differentiation of cell membrane, intercellular communications and gap junctions. Cell coat and cell recognition, cell surface.</li> <li>➤ Cell Cycle and Apoptosis: Mechanism of Cell division; Regulation, Roles of Cyclins and Cyclin dependent kinases, Cell Plate formation, PCD.</li> <li>➤ Organization and function of mitochondrial and chloroplast genomes.</li> </ul>		
<u>Unit II: Cancer Biology</u>		1
<ul style="list-style-type: none"> <li>➤ Cancer cells: Characteristics, division, spread, treatment. Course of cancer cell formation, Carcinogens: radiations, chemicals, Oncogenic virus.</li> <li>➤ Cancer and mutations, reproductive properties of transformed animal cell in culture, oncogenes, proto oncogenes and their conversion. Oncogenes and growth factors.</li> </ul>		
<u>Unit III: Immune System</u>		1
<ul style="list-style-type: none"> <li>➤ Phylogeny of immune system, innate and acquired immunity, nature and biology of antigens, major histocompatibility, complex cells of immune system, regulation of immune responses. Production of antibodies by plant cells and organs.</li> <li>➤ Immunity in Health and Disease: Immunodeficiency and AIDS</li> </ul>		
<u>Unit IV: Genetic Diseases</u>		1
<ul style="list-style-type: none"> <li>➤ Genetic disorders, genetic counselling and gene therapy.</li> <li>➤ Biochemical disorders, sex linked disorders, cardiovascular disorders.</li> </ul>		

**M. Sc Botany Syllabus Semester III**

M.Sc.	Semester III Molecular Biology and Cytogenetics
RJSPGBOTMCB304 Paper IV Specialisation Molecular Biology, Cytogenetics	Course Outcome <ul style="list-style-type: none"><li>• Cell cycle, programmed cell death</li><li>• Organisation and functions of mitochondria and chloroplast genome</li></ul> Learning outcome: <ul style="list-style-type: none"><li>➤ Understanding the mechanism of cancer biology and immunology</li><li>➤ Application in diagnostics</li></ul>

**M. Sc Botany Syllabus Semester III**

	Plant Biotechnology	4
RJSPBOTMCBP303	<ul style="list-style-type: none"> <li>➤ Preparation of stock solutions and MS medium.</li> <li>➤ Callus induction and regeneration.</li> <li>➤ Isolation of bioactive compounds from callus and plant source using TLC.</li> <li>➤ Types of Bioreactors.</li> </ul>	2
RJSPBOTMCBP304	<ul style="list-style-type: none"> <li>➤ Microscopic identification of cancer cell</li> <li>➤ <i>Allium cepa</i> bioassay</li> <li>➤ ELISA</li> <li>➤ Genetic disorders</li> <li>➤ Flow cytometry</li> <li>➤ Visit to diagnostic centre and report writing</li> </ul>	2
M.Sc.	Semester III Molecular Biology and Cytogenetics	
RJSPGBOTMCB303 & R JSBOTMCB304 Practical Specialisation Plant biotechnology and Molecular Biology, Cytogenetics	<p>Course Outcome</p> <ul style="list-style-type: none"> <li>• Cell cycle, Programmed cell death</li> <li>• Organisation and functions of mitochondria and chloroplast genome</li> </ul> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding the mechanism of cancer biology and immunology</li> <li>➤ Diagnostic tools</li> </ul>	

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