



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 IV**

Outline of the Course: RJSPBOT401 and RJSPBOT402 are common papers for all specialisations

RJSPBOT401: Techniques and Instrumentation.

RJSPBOT402: Cell and Molecular Biology.

RJSPBOT403 and RJSPBOT404 are Optional Papers in any one of the following specialisations.

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

Theory – RJSPGBOT401	4 Credits
Theory – RJSPGBOT402	4 Credits
Theory – RJSPGBOTPPB403/ RJSPGBOTMCB403	4 Credits
Theory – RJSPGBOTPPB404/ RJSPGBOTMCB404	4 Credits
Practical's (based on all 4 courses) – RJSPBOTP401, RJSPBOTPPBP402/ RJSPGBOTMCBP402 PROJECT WORK (RJSPGBOTPPBP403&404/ RJSPGBOTMCBP403&404)	16 Credits

**M. Sc Botany Syllabus Semester IV****SEMESTER IV (Common Papers)**

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
RJSPGBOT401	Title of the Paper: TECHNIQUES AND INSTRUMENTATION			
	I	Centrifugation	4	1
	II	Nanotechnology		1
	III	Tracer technique		1
	IV	IPR		1
RJSPGBOT402	Title of the Paper: Molecular Biology			
	I	Gene Regulation I	4	1
	II	Gene Regulation II		1
	III	Gene Regulation III		1
	IV	Cell signalling		1

Practicals	1&2	Techniques and instrumentation and Molecular Biology		4
RJSPGBOT401				

**Specialization: Plant Physiology and Biochemistry**

RJSPGBOTPPB403	Title of the Paper: Plant Biochemistry		4
	I	Amino Acid Metabolism	1
	II	Cytosolic Carbon & Mitochondrial Metabolism	1
	III	Senescence	1
	IV	Sulphate metabolism	1
RJSPGBOTPPB404	Title of the Paper: Plant Physiology		4
	I	Stress Physiology – Biotic stress	1
	II	Metabolism of Secondary Metabolites I	1
	III	Metabolism of Secondary Metabolites II	1
	IV	Sensory photobiology	1

RJSPGBOTPPBP402	Plant Physiology		4
RJSPGBOTPPBP 403 & 404	Research project submission and presentation		8

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

RJSPGBOTMCB403	Title of the Paper: Plant Biotechnology			
	I	Downstream processing and techniques	4	1
	II	Industrial Biotechnology		1
	III	Environmental biotechnology		1
	IV	Food Biotechnology		1
RJSPGBOTMCB404	Title of the Paper: Molecular Biology and Cytogenetics			
	I	Plant Breeding, I	4	1
	II	Plant Breeding II		1
	III	Molecular plant Breeding		1
	IV	Plant Genetic Engineering		1
RJSPGBOTMCBPP402	Plant Biotechnology		4	
RJSPGBOTMCBPP 403 & 404	Research project submission and presentation		8	

**SEMESTER IV (General Papers)**

Course Code	Topic	Credits
RJSPGBOT401	TECHNIQUES AND INSTRUMENTATION	4
UNIT I: Centrifugation		1
<ul style="list-style-type: none"> <li>➤ Basics principle of Sedimentation.</li> <li>➤ Types of rotors.</li> <li>➤ Differential &amp; density gradient centrifugation.</li> <li>➤ Preparative centrifugation &amp; Applications; Analytical centrifugation &amp; application.</li> </ul>		
<u>Unit II:</u> Nanotechnology		1
<ul style="list-style-type: none"> <li>➤ Synthesis of nanoparticles using biological samples.</li> <li>➤ Characterization of nanoparticles (FTIR, SEM, TEM, STEM, Scanning Tunneling Microscope, Atomic Force Microscope, UV-Visible Spectrophotometer).</li> </ul>		
<u>Unit III:</u> Tracer techniques		1
<ul style="list-style-type: none"> <li>➤ Pattern and rate of radioactive decay, Units of radioactivity, Stable Isotopes</li> <li>➤ Principle, instrumentation &amp; technique: Geiger-Muller counter, Liquid scintillation counters &amp; Autoradiography.</li> <li>➤ Applications of isotopes in biology: Tracer techniques &amp; Autoradiography.</li> </ul>		
<u>Unit IV:</u> IPR		1
<ul style="list-style-type: none"> <li>➤ Introduction to intellectual property right (IPR)</li> <li>➤ Concept and kinds. IPR in India and world</li> <li>➤ Patents Objectives, Rights, Patent Act 1970 and its amendments.</li> <li>➤ Information Technology Related Intellectual Property Rights; Computer Software and Intellectual Property</li> </ul>		

**M. Sc Botany Syllabus Semester IV**

M.Sc.	Semester IV Theory
RJSPGBOT401 Paper I Techniques and instrumentation	<p>Course Outcome 4.1:</p> <ol style="list-style-type: none"><li>1. Detailed study and application of centrifugation and analysis of Differential &amp; density gradient solution.</li><li>2. Detailed study of all type of chromatography techniques and its applications.</li><li>3. Study of tracer techniques with applications of isotopes in biology</li><li>4. Synthesis of nanoparticles using biological samples</li><li>5. Detailed study of IPR: Outcomes, process &amp; scope.</li></ol> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Knowing the working and application of centrifugation</li><li>➤ Mechanism of all different types of chromatography techniques</li><li>➤ Learning the tracer techniques &amp; PCR with applications</li><li>➤ Understanding the application of IPR</li></ul>

**M. Sc Botany Syllabus Semester IV**

Course Code	Topic	Credits
RJSPGBOT402	Molecular Biology	4
<u>UNIT I: Gene Regulation I</u> <ul style="list-style-type: none"> <li>➤ Regulations of gene expression in bacteria – TRP operon, ARA operon, Histidine operon.</li> <li>➤ Regulation of gene expression in bacteriophage <math>\lambda</math>.</li> </ul>		1
<u>Unit II: Gene Regulation II</u> <ul style="list-style-type: none"> <li>➤ Control of gene expression in eukaryotes, Transcriptional control, RNA processing control, mRNA translocation control, mRNA degradation control, protein degradation control.</li> </ul>		1
<u>Unit III: Gene Regulation III</u> <ul style="list-style-type: none"> <li>➤ Genetic regulation of development in <i>Drosophila</i>.</li> <li>➤ Developmental stages in <i>Drosophila</i> – embryonic development, imaginal discs, homeotic genes.</li> </ul>		1
<u>Unit IV: Cell signaling.</u> <ul style="list-style-type: none"> <li>➤ Hormones and their receptors, cell surface receptor, intracellular receptor, signaling through G-protein coupled receptors, signal relay pathways-signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.</li> <li>➤ Forms of signaling (paracrine, synaptic, autocrine, endocrine, cell to cell contact).</li> </ul>		1

**M. Sc Botany Syllabus Semester IV**

M.Sc.	Semester IV Theory
RJSPGBOT402  Paper II  Molecular Biology	<p>Course Outcome 4.2:</p> <ol style="list-style-type: none"><li>1. Detailed study of Regulations of gene expression in bacteria and bacteriophage <math>\lambda</math>.</li><li>2. Mechanism of gene expression in transcription, RNA processing and post translation modification in eukaryotes.</li><li>3. Genetic regulation of development stages in <i>Drosophila</i>.</li><li>4. Study of mechanism and types of cell signaling.</li></ol> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Understanding concept of Regulations of gene expressions</li><li>➤ Learning mechanism and types of cell signaling with its application</li></ul>

RJSPGBOTP401	TECHNIQUES AND INSTRUMENTATION MOLECULAR BIOLOGY	2	4
<ul style="list-style-type: none"><li>➤ Purification of chloroplast using density gradient centrifugation</li><li>➤ Isolation of mitochondria</li><li>➤ Synthesis of nanoparticles.</li><li>➤ Characterization of nanoparticles by UV spectroscopy.</li><li>➤ Project based on IPR</li><li>➤ Isolation of plasmid DNA.</li><li>➤ Quantification of plasmid DNA.</li><li>➤ Agarose gel electrophoresis separation of plasmid DNA.</li><li>➤ Restriction enzyme digestion and separation of fragments.</li><li>➤ Southern blot transfer technique.</li><li>➤ Transformation of <i>E. coli</i> cell by plasmid DNA.</li><li>➤ <math>\beta</math>-galactosidase expression and assay.</li></ul>			

M.Sc.	Semester IV Practical
RJSPGBOTP401 Practical I Techniques and instrumentation Molecular Biology	<p>Course Outcome:</p> <ol style="list-style-type: none"><li>1. Centrifugation techniques</li><li>2. Molecular biology techniques</li><li>3. Synthesis and characterization of nanoparticles.</li><li>4. Industrial visit and report submission.</li></ol> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Knowing the application of centrifugation</li><li>➤ Knowing the application of molecular biology</li><li>➤ Understanding the application of nanoparticles</li></ul>

**Specialization: Plant Physiology and Biochemistry (PPB)**

Course Code	Topic	CREDITS
RJSPGBOTPPB403	Plant Biochemistry	4
<u>Unit I:</u> Amino acid metabolism.		1
<ul style="list-style-type: none"> <li>➤ Biosynthesis of Amino Acids (Proline, Glycine, Asparagine, Tryptophan, Phenylalanine, Glutamate),</li> <li>➤ Regulation of amino acid biosynthesis.</li> </ul>		
<u>Unit II:</u> Cytosolic carbon and Mitochondrial metabolism		1
<ul style="list-style-type: none"> <li>➤ Central role of Hexose Phosphate, Oxidative pentose phosphate pathway, regulation of Glycolysis and Gluconeogenesis.</li> <li>➤ Catabolic role of the TCA cycle, Anabolic role of the TCA cycle intermediates, Anapleurotic CO<sub>2</sub> fixation, provision of acetyl CoA for biosynthesis, Regulation of TCA.</li> </ul>		
<u>Unit III:</u> Senescence.		1
<ul style="list-style-type: none"> <li>➤ Pigment Metabolism, Protein metabolism and Oxidative metabolism during senescence.</li> <li>➤ Programmed cell death (PCD) an overview.</li> </ul>		
<u>Unit IV:</u> Sulphate Metabolism		1
<ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ Uptake and transport</li> <li>➤ Reductive sulphate pathway</li> </ul>		

M.Sc. (PPB)	Semester IV Theory
RJSPGBOTPPB403  Paper-III  Plant Biochemistry	<p>Course Outcome 4.3:</p> <ol style="list-style-type: none"><li>1. Study of lipid metabolism synthesis and function of membrane, structural &amp; storage lipids</li><li>2. Detailed study biosynthesis and regulation of amino acids</li><li>3. Study of the cytosolic carbon and mitochondrial metabolism.</li><li>4. Study of pigment, protein and oxidative metabolism during senescence.</li></ol> <p>Learning outcome:</p> <ul style="list-style-type: none"><li>➤ Understanding the lipid and amino acids synthesis and regulation</li><li>➤ Learning the importance cytosolic carbon and mitochondrial metabolism.</li><li>➤ Understanding the senescence regulation</li></ul>

Course Code	Topic	Credits
RJSPGBOTPPB404	Plant Physiology	4
<u>Unit I:</u> Stress Physiology – Biotic stress		1
<ul style="list-style-type: none"> <li>➤ Responses – Plant Pathogens</li> <li>➤ Biochemistry of plant defense mechanism</li> </ul>		
<u>Unit II:</u> Metabolism of Secondary metabolites I		1
<ul style="list-style-type: none"> <li>➤ General pathway, Classification and importance – Terpenoids, Alkaloids, Flavonoids</li> </ul>		
<u>Unit III:</u> Metabolism of Secondary metabolites I		
<ul style="list-style-type: none"> <li>➤ General pathway, Classification and importance – Phenylpropanoids, Lignins, Coumarins, Phenolic compounds</li> </ul>		
<u>Unit IV:</u> Sensory Photobiology		1
<ul style="list-style-type: none"> <li>➤ Structure, function and mechanism of phytochromes, Cryptochromes and Phototropins,</li> <li>➤ Phytochrome induced whole plant response, Molecular basis of flower organization: MADS box genes and their expression. Problems based on ABC model for flower organization.</li> </ul>		

**M. Sc Botany Syllabus Semester IV**

M.Sc. (PPB)	Semester IV Theory
RJSPGBOTPPB404	Course outcome 4.4:
Paper-IV	1. Physiology of plants under stress
Plant Physiology	2. Secondary metabolites and their biosynthesis
	3. Understanding the mechanism of sensory photobiology and molecular basis of flower organization.
	4. Detailed study of biosynthetic pathways and biosynthesis of secondary metabolites
	Learning outcome:
	➤ Understanding the role of secondary metabolites
	➤ Application of phytochrome for desired designed plants
	➤ Commercial application and use of secondary metabolites

RJSPGBOTPPBP402	Plant Biochemistry	4
<ul style="list-style-type: none"> <li>➤ Estimation of Tryptophan.</li> <li>➤ Estimation of polyphenols from Tea and Amla</li> <li>➤ Extraction &amp; separation of Glucosinolates from Mustard.</li> <li>➤ Extraction &amp; separation of Piperine from <i>Piper</i>.</li> <li>➤ Extraction &amp; separation of lycopene from <i>Lycopersicum</i>.</li> <li>➤ Comparative assay of PAL from healthy and diseased plants</li> <li>➤ Study of enzyme glutathione reductase</li> <li>➤ Study of enzyme GDH</li> </ul>		

**M. Sc Botany Syllabus Semester IV**

M.Sc.	Semester IV Practical
RJSPGBOTPPBP403 Practical III Plant Physiology	<p>Course Outcomes</p> <ol style="list-style-type: none"> <li>1. Estimation of tryptophan and polyphenols.</li> <li>2. Study of enzymes SDH and effect of inhibitors on its activity.</li> <li>3. Extraction &amp; separation of Glucosinolates from Mustard, Piperine from <i>Piper</i> and lycopene from <i>Lycopersicum</i>.</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Know the importance and use of fats and oil, chlorophylls, tryptophan and polyphenols in plants.</li> <li>➤ Understanding the biosynthesis and storage of secondary metabolite in plant cell and its commercial application</li> </ul>

RJSPGBOTPPBP403 & 404	Plant Physiology	8
➤ Project submission		

M.Sc.	Semester IV Practical
RJSPGBOTPPBP403 & 404 Practical IV Plant Physiology	<p>Course Outcome:</p> <p>Research methodology will be discussed and well-defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany.</p> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Application of all knowledge and interpretation</li> </ul>

**Specialization: Molecular Biology, Cytogenetics and Biotechnology (MCB)**

Course Code	Topic	Credits
RJSPGBOTMCB403	Plant Biotechnology	4
<b>Unit I: Down Stream Processing and Techniques</b> <ul style="list-style-type: none"> <li>➤ Distillation</li> <li>➤ Floatation</li> <li>➤ Filtration</li> <li>➤ Centrifugation</li> <li>➤ Extraction methods: Solvent, absorption chromatography, gel filtration</li> </ul>		1
<b>Unit II: Industrial Biotechnology</b> <ul style="list-style-type: none"> <li>➤ General types of Industrial processes, list of antibiotic produced by fungi. Industrial production of penicillin</li> <li>➤ Industrial enzymes, Pectinase production as a case study</li> <li>➤ Single Cell Protein</li> </ul>		1
<ul style="list-style-type: none"> <li>➤ <b>Unit III: Environmental Biotechnology</b></li> <li>➤ Solid waste management by fungi and treatment of industrial effluents – dyes by laccases and peroxidases</li> <li>➤ Biomass for energy: Sources of biomass, advantages &amp;disadvantages, uses of biomass.</li> <li>➤ Biofuels: Gaseous forms of biofuels Biohydrogen and biomethane</li> <li>➤ Gasohol: Conversion of sugar to alcohol</li> <li>➤ Risks of GMO</li> </ul>		1

**M. Sc Botany Syllabus Semester IV**

<u>Unit IV: Food Biotechnology.</u> <ul style="list-style-type: none"> <li>➤ Fermentation: Production of yeast, Beer and Wine</li> <li>➤ Factors affecting spoilage. Food borne pathogen detection</li> <li>➤ Functional food</li> <li>➤ Quality control of food.</li> </ul>	1
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M.Sc. (MCB)	Semester IV Theory
RJSPGBOTMCB403  Paper-III  Plant Biotechnology	Course Outcome 4.3:  1. Students will learn industrial processes of recovery important products by various processes.  2. Study of Food Biotechnology and its application for Quality control of food  3. Environmental issues like solid waste management and green fuel technology  Learning outcome:  ➤ Industrial Biotechnology will enable students to learn the practical application of the subject.  ➤ Learning the importance of Quality control of food

**M. Sc Botany Syllabus Semester IV**

Course Code	Topic	Credits
RJSPGBOTMCB404	Molecular Biology and Cytogenetics	4
<u>Unit I: Plant Breeding I</u> <ul style="list-style-type: none"> <li>➤ Aims and outcomes, plant introductions and acclimatization.</li> <li>➤ Selection – Mass, Pure line and Clonal.</li> <li>➤ Hybridization techniques, hybridization in self-pollinated and cross-pollinated plants.</li> <li>➤ Genetic control and manipulation of breeding systems including male sterility and apomixes.</li> </ul>		1
<u>Unit II: Plant Breeding II</u> <ul style="list-style-type: none"> <li>➤ Distant hybridization: In nature (plant breeding) – Barriers to the production of distant hybrids; Unreduced gametes in distant hybridization; Sterility in distant hybrids; Consequences of segregation in distant hybrids;</li> <li>➤ Applications and Achievements of distant hybridization in crop improvement; Limitations of distant hybrids.</li> </ul>		1
<u>Unit III: Molecular plant Breeding (Transgenic Crops)</u> <ul style="list-style-type: none"> <li>➤ Natural method of gene transfer (<i>Agrobacterium</i> and virus), selectable markers.</li> <li>➤ Artificial methods of gene transfer: Direct DNA uptake by protoplast, Electroporation, Liposome mediated and particle gun transformation</li> <li>➤ Production of Transgenic plants: Virus resistant &amp; Herbicide –resistant, plants, Bt Cotton, Golden rice.</li> </ul>		1
<u>Unit IV: Plant Genetic Engineering</u> <ul style="list-style-type: none"> <li>➤ Production of bio pharmaceuticals in transgenic plants.</li> <li>➤ Edible vaccines &amp; Plantibodies.</li> <li>➤ DNA-based molecular marker aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites.</li> </ul>		1

**M. Sc Botany Syllabus Semester IV**

M.Sc. (MCB)	Semester IV Theory
RJSPGBOTMCB404	Course outcome 4.4:
Paper-IV	1. Detailed study of plant breeding with hybridization techniques and its applications.
Molecular Biology	2. Mechanism of molecular plant breeding of transgenic crops
and Cytogenetics	3. Detailed study of plant genetic engineering
	Learning outcome:
	➤ Understanding the importance of plant breeding
	➤ Understanding detailed concept of molecular plant breeding of transgenic crops
	➤ Knowing the effect of plant genetic engineering and its applications

RJSPGBOTMCBP403	Plant Biotechnology	4
➤ Identify cultivars of any vegetable by Isoenzymes. ➤ Production of wine from different fruits and measurement of alcohol content ➤ Dye removal from water sample by laccase from suitable source ➤ Study of Mitotic Index. ➤ Culturing of <i>Drosophila</i> and study of genetic traits. ➤ Blood group testing ➤ Culturing of human blood cells and karyotyping ➤ Karyotypes of genetic disorders.		

**M. Sc Botany Syllabus Semester IV**

M.Sc.	Semester IV Practical
RJSPGBOTMCBP403 Practical III Plant Biotechnology	<p>Course Outcome:</p> <ol style="list-style-type: none"> <li>1. Identify cultivars of any vegetable by Isoenzymes.</li> <li>2. Study of Mitotic Index.</li> <li>3. Culturing of <i>Drosophila</i> for the study of genetic traits.</li> <li>4. Blood group testing, Karyotypes of genetic disorders.</li> </ol> <p>Learning outcome:</p> <ul style="list-style-type: none"> <li>➤ Understanding the importance and application of PTC</li> <li>➤ Skill development in PTC</li> <li>➤ Knowing the types of bioreactors and its commercial application</li> </ul>

RJSPGBOTMCBP404	Plant Biotechnology	8
➤ Project submission		

M.Sc.	Semester IV Practical
RJSPGBOTMCBP404 Practical IV Plant Biotechnology	<p>Course Outcome:</p> <p>Research methodology will be discussed and well-defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany.</p> <p>Learning outcome:</p> <p>Application of all knowledge and interpretation</p>

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