



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 II
Program: M.Sc. BIOTECHNOLOGY
Program Code: RJSPBT

(CBCS 2019-2020)

**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	To study genetic engineering of plants, transgenic plant technology, the fundamentals of animal cell culturing, and advanced cell culture techniques
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	To study synthesis and characteristics of nanomaterials, apply nanorobotics in various contexts, utilize nanomedicine for healthcare advancements
PSO6	To understand new drug discovery process, preclinical toxicology studies and the intricacies of clinical trials
PSO7	Understanding phylogenetics, proteomics, genomics, and drug discovery, enabling them to make significant contributions to the field of life sciences and biomedical research
PSO8	Understanding application of central tendency, non-parametric tests, statistical tests, and ANOVA techniques effectively in various statistical analyses
PSO9	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
PSO10	Gain critical thinking, and analytical skills, enabling them to make significant contributions to Biotechnology field
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 - 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

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
RJSPBTP301	Practicals of RJSPBT301,RJSPBT302,RJSPBT303 & RJSPBT304	4	60 hours
RJSPBTP302	Skill based project	4	60 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 - Biostatistics			60 hours
	I	Central Tendency	4	
	II	Non-parametric tests		
	III	Statistical tests		
	IV	ANOVA		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSPBTP401	Practicals of RJSPBT401 & RJSPBT404	4	60 hours
RJSPBTP402	Practicals of RJSPBT402 & RJSPBT403	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	:	PLANT AND ANIMAL TISSUE CULTURE
COURSE CODE	:	RJSPBT301
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.	1	BT levels 1,2 & 3
CO2	Understand the types, isolation and culturing of animal cells.	1	BT levels 1,2 & 3

Paper Code: RJSPBT301	Paper-I: 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	:	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, <i>S aureus</i> 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
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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
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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, <i>in vitro</i> fertilization, embryo cloning. Manipulation of reproduction in humans - Causes of infertility, intrauterine insemination, <i>in vitro</i> 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	:	BIOSTATISTICS
COURSE CODE	:	RJSPBT404
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	8	BT levels 1,2 & 3
CO2	Understanding of the concepts of Gaussian distribution, Hypothesis testing	8	BT levels 1,2 & 3
CO3	Understand the concept of correlation and regression.	8	BT levels 1,2 & 3

Paper Code: RJSPBT404	Paper-IV: 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	:	Practicals of RJSPBT301, RJSPBT302, RJSPBT303 & RJSPBT304
COURSE CODE	:	RJSPBTP301
CREDITS	:	4
DURATION	:	60 hours

LEARNING OBJECTIVES	
1	Concepts of PTC and hairy root culture
2	Observation and analysis of effect of abiotic stress on plants
3	Working and requirements of an ATC lab & ex vivo culturing of cells freshly obtained from a multicellular organism.
4	Free radicals, role of antioxidants as scavengers in ATC
5	Characterization and identification of pathogen
6	Concept of quorum and significance of biofilm
7	Rickettsial infections and their diagnosis
8	Stages of Chick embryo development
9	Use of microorganisms in bioremediation
10	Significance of validation methods in regulation GMOs
11	Characterization of compost by chemical and physical parameters

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.	9	BT levels 2, 3 & 4
CO2	Growth of seeds under stress, and use of proline estimation for analysis of effect of stress on seed germination.	9	BT levels 2, 3 & 4
CO3	Tissue Disintegration methods, preparation of ATC media and cells culturing.	9	BT levels 2, 3 & 4
CO4	Use of DPPH in scavenger activity assay	9	BT levels 2, 3 & 4
CO5	Use of culture methods, biochemical tests and direct microscopic examination for characterization of the pathogen	9	BT levels 2, 3 & 4
CO6	Use of cross reactivity in presumptive diagnosis of rickettsial infection	9	BT levels 2, 3 & 4

CO7	Use of growth curve and generation time in isolation of metal tolerant organisms	9	BT levels 2, 3 & 4
CO8	Principle of various methods for validation of GMOs	9	BT levels 2, 3 & 4
CO9	Principle of methods used for estimation of carbon, phosphorus, and calcium and physical parameters of a compost.	9	BT levels 2, 3 & 4
CO10	Use of candling in study of embryo developmentUse of culture methods, biochemical tests and direct microscopic examination for characterization of the pathogen	9	BT levels 2, 3 & 4

Paper Code: RJSPBT P301	Practical-II: Practicals of RJSPBT301, RJSPBT302, RJSPBT303 & RJSPBT304	Credits 4
1	Hairy root culture	
2	Abiotic stress tolerance	
3	Establishing primary culture (ATC)	
4	To assay the radical scavenging activity of a tissue hydrolysate –DPPH Method	
5	Medical diagnostic – S. aureus, Pseudomonas spp	
6	Staining of Biofilms	
7	Weil – Felix reactions	
8	Bioremediation- isolation of metal tolerant organisms & study their growth characteristics and pattern	
9	GMO – Validation – kit based/ demo	
10	Composting – physical & chemical parameters	
11	Candling, Observing chick embryo- stages of development	
12	Developmental Biology – Visit to laboratory/video lectures for latest developments in the field. To be documented.	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	SKILL BASED PROJECT
COURSE CODE	:	RJSPBTP302
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	10	BT levels 2, 3 & 4
CO2	Develop and refine skills	10	BT levels 2, 3 & 4
CO3	Explore a career path	10	BT levels 2, 3 & 4

Paper Code: RJSPBTP302	Practical-I:Skill based project	Credits4
1	Project /NPTEL Module	

COURSE OUTCOMES (COs) M. Sc. II BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Practicals of RJSPBT401 & RJSPBT404
COURSE CODE	:	RJSPBTP401
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Principle of biological synthesis of nanoparticles and parameters that can be used for their characterization
2	Potency of nanoparticle against bacteria and its potential application
3	How to use statistical tools to make decisions based on data, and make predictions.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of various plant leaves in synthesis of silver nanoparticles and their characterization using spectrophotometer and absorption spectrum	11	BT levels 2, 3 & 4
CO2	Use of agar well diffusion method to assess the antibacterial activity of synthesized nanoparticles against Gram negative and Gram positive bacteria.	11	BT levels 2, 3 & 4
CO3	Statistical population and use of various parametric and nonparametric tests to analyze the data.	11	BT levels 2, 3 & 4

Paper Code: RJSPBTP401	Practical-II:Practicals of RJSPBT401 & RJSPBT404	Credits 4
1	Nanoparticles – synthesis chemical and biological methods; Spectroscopic analysis	
2	Antibacterial effects of nanoparticle	
3	Biostatistics problems (theory and problem)	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	Practicals of RJSPBT402 & RJSPBT403
COURSE CODE	:	RJSPBTP402
CREDITS	:	4
DURATION	:	60

LEARNING OBJECTIVES	
1	Concept of sequence alignment and use of various bioinformatic tools in alignment
2	Use of BLAST in study of orthologs and paralogs, homologs
3	Use of bioinformatic tools in study of conserved sequence pattern
4	Use of KEGG for exploring advanced data analysis and inter-pathway dependence
5	Structural Classification of proteins using CATH and SCOP

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Deciphering a phylogenetic tree and understanding of evolutionary relationship based on it	11	BT levels 2, 3 & 4
CO2	Concepts of motifs and domains	11	BT levels 2, 3 & 4
CO3	Use of Integrated database Concept of hierarchical domain classification of protein structures	11	BT levels 2, 3 & 4

Paper Code: RJSPBTP401	Practical-II:Practicals of RJSPBT403 & RJSPBT404	Credits 4
1	Study and present published findings of any clinical trial	
2	Multiple alignment - Phylogenetic tree	
3	BLAST - orthologs and paralog, homologs	
4	Motif finding	
5	KEGG	
6	Structure of proteins - identification of chains, helices, special groups, metal ions etc. CATH / SCOP classification of a given protein / RASMOL	
7	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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18. Nano forms of carbon and its applications (2007), Prof. Maheshwar Sharon and Dr. Madhuri Sharon Manad Nanotech Pvt. Ltd.
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21. Textbook of Biotechnology (2005) R. C. Dubey S. Chand and Co.

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25. Clinical Pharmacokinetics, Krishna D.R & Klotz V., Springer Verlag
26. Remington Pharmaceutical sciences, Williams and Wilkins, Lippincott
27. Drug Interaction, Hamsten, Kven Stockley
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29. Basic Business Publ., Bombay
30. Practical Guide to clinical data management, Sussane Prokscha
31. Clinical pharmacology and Drug Therapy, Grahame smith & Aroson
32. Clinical Data Management, Richard Rondel, Wiley
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.
4. 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
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, RJSPBTP302; 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.

MSc Biotechnology Syllabus Semester III & IV

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	Plant and animal tissue culture	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 RJSPBTP302		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
	Biostatistics	RJSPBT404	Use of various biostatistics tools	Skill development, Employability in Pathology laboratory, R & D and epidemiology	Interpretation of data
	Practicals of	RJSPBTP401, RJSPBTP402		Experimental skills Observational skills Analytical skills Interpretation skills Experiment Planning and execution skills Writing skills	