



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the B.Sc.

Program: B.Sc. BIOTECHNOLOGY

Program Code: RJSUBT

SEMESTER V

Vertical Under NEP: Major

Course Code : RJDSCBT351

**(REVISED in 2025-26 in alignment with National Education Policy (NEP 2020) facilitating
the inter and multidisciplinary learning and multiple entry and exit of the students)**

Level 5.5

(CBCS 2025-2026)

THE PREAMBLE

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 encompasses the study of all living beings including bacteria, archaebacteria, fungi, algae, protozoa, helminths, plants, animals and viruses. It includes the basic understanding of each type of cell - prokaryotic, eukaryotic, viral particles along with their intracellular architecture, their anatomical features, their physiological and biochemical process and their molecular mechanisms of inheritance right from chromosomes, genes to the nucleic acids. 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 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. Individualized and personal training is given to every student for various microbiology, molecular biology, biochemistry and medical diagnostics techniques that are a part of our extensive and inclusive UG and PG curriculum. Under autonomy, the department has made curriculum more robust by incorporating skill-based learning and Value Added Courses (VACs) such as Fermented Foods and Beverages, Clinical Research etc, that impart practical knowledge of the subject to the students. These value added courses are offered to students without any additional charge, from other subjects as well likewise Biotech students can complete VACs offered by other departments. These VACs, mini projects, internships and other co- curricular courses

completed by the students help them to earn extra credits every year along with the credits earned by successfully completing the prescribed course work. The department organizes talks titled 'Gyan-Vigyan' 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 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. In 2019 the department has earned DBT Star college grant which is being used to procure more equipment and instruments so that each student can carry out the molecular biology and other such advanced experiments on an individual basis.

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 JAM, GATE, CSIR-NET, SET, PET which the students can borrow and make the most of the resources and time available.

The department hosts its own [Webpage](#), RJBT, showcasing various departmental activities such as competitions, field trips, festivals, popular lecture series by eminent personalities, workshops and research projects. The department has its presence on various social media platforms such as **Facebook** and **Instagram**, this helps in interaction between our current students and alumni. We also have our official **YouTube** channel showcasing various practical techniques, students' videos and eminent talks. 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, IIT, IISC, BHU and companies such as Biocon Ltd, Reliance Life Sciences to name a few.

PROGRAM OUTCOMES FOR UNDERGRADUATE DEGREE PROGRAMS IN BIOTECHNOLOGY

The undergraduate program in Biotechnology has been designed to empower students to obtain domain knowledge, analyze, apply and innovate. 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 GAT B, IIT JAM, JNU, CUET PG, etc.

Some basic attributes which a student would acquire after completion of undergraduate 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 by way of organizing academic events, projects and going on field trips which will build team spirit. Thus the course will help learners to 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 social and 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 identify and 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

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NEP - T.Y.B.Sc Biotechnology Syllabus Semester V & VI 2025-26

Sr. No.	A student completing B.Sc. Biotechnology will be able to:
PSO1	Understand concepts in Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology and molecular biology.
PSO2	Demonstrate the laboratory skills in cell biology, basic and applied microbiology with an emphasis on technological aspects.
PSO3	Competent to apply the knowledge and skills gained in the fields of Plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.
PSO4	Critically analyze the environmental issues and apply the knowledge gained in biotechnology for conserving the environment and resolving the problems.
PSO5	Demonstrate comprehensive innovations and skills in the field of biomolecules, cell biology, molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.
PSO6	Critically analyze, interpret data, and apply tools of bioinformatics in various sectors of biotechnology including health and food.
PSO7	Learn and practice professional skills in handling microbes, animals and plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animal handling, intellectual property rights, biosafety, and biohazards.
PSO8	Explore the biotechnological practices and demonstrate innovative thinking in addressing the current day and future challenges with respect to food, health, and environment.
PSO9	Gain thorough knowledge and apply good laboratory and good manufacturing practices in biotech industries.
PSO10	Understand and apply molecular biology techniques and principles in forensic and clinical biotechnology.
PSO11	Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of small-scale enterprises.
PSO12	Understand concepts, importance of Biostatistics and to comprehend the principles behind various statistical analytical methods and their uses in biotechnology for data analysis.
PSO13	To develop a deep understanding of the immune system's functions and mechanisms.
PSO14	Gain proficiency in applying immunological techniques for research, diagnostics, and therapeutic innovations.
PSO15	Will be able to apply their knowledge to address emerging infectious diseases and contribute to global immunization strategies.
PSO16	Design, optimize, and scale microbial processes for the efficient production of bio-based products in industrial settings
PSO17	Apply cell biology concepts to analyze cellular structures, functions, and processes, and understand their roles in health, disease, and biotechnology.
PSO18	Apply principles of developmental biology to analyze the genetic, molecular, and

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NEP - T.Y.B.Sc Biotechnology Syllabus Semester V & VI 2025-26

Sr. No.	A student completing B.Sc. Biotechnology will be able to:
	environmental factors that drive organismal development and contribute to understanding developmental disorders.
PSO19	Gain proficiency in ability to accurately identify microorganisms using various laboratory techniques, interpret diagnostic results for infection control, and apply principles of microbiology to clinical practice to support patient care and treatment.
PSO20	Gain knowledge of blood collection, blood cell analysis, and blood disorders like anemia. Learn about blood group systems and the process of blood transfusion
PSO21	Understand the importance of organ function tests in assessing the health of vital organs, as well as their role in the detection, diagnosis, and monitoring of diseases.
PSO22	Understand the clinical significance of using urine, stool, semen, and CSF samples, along with cancer markers, in the detection and diagnosis of diseases.

Progressive Certificate, Diploma, Bachelor's Degree or Bachelor's Degree with Honors provided at the end of each year of exit of the four-years Undergraduate Programme.

	Exit options	Credit Required
1.	Certificate upon the successful completion of the First Year (Two Semesters) of the multidisciplinary Four-years Undergraduate Programme/ Five- years Integrated Master's Degree Programme.	44
2.	Diploma upon the successful completion of the Second Year (Four Semesters) of the multidisciplinary Four-years Undergraduate Programme/ Five- years Integrated Master's Degree Programme.	88
3.	Basic Bachelor's Degree upon the successful completion of the Third Year (Six Semesters) of the multidisciplinary Four-years Undergraduate Programme/ Five- years Integrated Master's Degree Programme.	132
4.	Bachelor's Degree with Honors in a Discipline at the successful completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-years Undergraduate Programme/ Five- years Integrated Master's Degree Programme.	176

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NEP - T.Y.B.Sc Biotechnology Syllabus Semester V & VI 2025-26

UGC GRID UNDER NEP 2020

YEAR & LEVEL	SEMESTER	MAJOR		MINOR	VSEC		OE	IKS/AEC/VEC			OJT/FP/CEP/CC/RP				TOTAL
		DSC	DSE		VSC	SEC		IKS	AEC	VEC	CC	CEP	FP	OJT	
FY 4.5	I	6	-	6	2	-	2	2	-	2	2	-	-	-	22
	II	6	-	6		2	2	-	2	2	2	-	-	-	22
TOTAL	FY	12	0	12	2	2	4	2	2	4	4	0	0	0	44
SY 5.0	III	6	-	3	-	2	3	-	4	-	2	-	2	-	22
	IV	6	-	3	2	2	3	-	2	-	2	2	-	-	22
TOTAL	SY	12	0	6	2	4	6	0	6	0	4	2	2	0	44
TY 5.5	V	12	4	-	4	-	-	-	-	-	-	-	2	-	22
	VI	12	4	-	2	-	-	-	-	-	-	-	-	4	22
TOTAL	TY	24	8	0	6	0	0	0	0	0	0	0	2	4	44
GRAND TOTAL		48	8	18	10	6	10	2	8	4	8	2	4	4	
		56		18	16		10	14			18				132

IMPLEMENTED FROM ACADEMIC YEAR 2023-24

Key:

FY = First Year BSc

SY = Second Year BSc

TY = Third Year BSc

DSC= Discipline Specific Course

DSE= Discipline Specific Elective

VSEC = Vocational Skill Enhancement Course

VSC= Vocational Skill Course

SEC = Skill enhancement course

OE = Open Elective

IKS - Indian Knowledge System

AEC = Ability enhancement Course

VEC = Value education Course

CC = Co-Curricular

CEP = Community Engagement Program

FP = Field Project

OJT = On Job Training

THIRD YEAR BACHELOR OF SCIENCE IN BIOTECHNOLOGY

SEMESTER V			
Courses	Credits	Course Titles	Course code
Discipline Specific Course I	4	Immunology and developmental biology	RJDSCBT351
Discipline Specific Course II	4	Microbial Production Technology	RJDSCBT352
Discipline Specific Course Practical	4	Product purification, assays and analysis - Practicals	RJDSCBTP351
Discipline Specific Elective	3	Diagnostic Microbiology	RJDSEBT351
Discipline Specific Elective Practical	1	Diagnostic Microbiology - Practicals	RJDSEBTP351
Vocational Skill Course	4	Industrial Processes	RJVSCBT351
Field Project/ Community Engagement Program	2	Field Project / Community Engagement Program	RJFPBT351/ RJCEP351
Total Credits	22		

SEMESTER VI			
Courses	Credits	Course Titles	Course code
Discipline Specific Course I	4	Cancer biology, Immunotechnology and Pharmacology	RJDSCBT361
Discipline Specific Course II	4	Genetic engineering & Ethics	RJDSCBT362
Discipline Specific Course Practical	4	Immunological and pharmacological techniques - practicals	RJDSCBTP361
Discipline Specific Elective	3	Clinical pathology	RJDSEBT361
Discipline Specific Elective Practical	1	Clinical pathology - Practicals	RJDSEBTP361
Vocational Skill Course	2	Tissue Culture	RJVSCBT361
OJT	4	On-Job Training/ On -Field Training	RJOJTBT361
Total Credits	22		

Course	Course Code	Unit	Topic Headings	Credits	Duration
Discipline Specific Course I	RJDSCBT351	Paper Title : Immunology & Developmental Biology			
		I	Basics of Immunology	4	60
		II	Components of Immune System		
		III	Cell surface Receptors		
		IV	Developmental Biology		

Course	Course Code	Unit	Topic Headings	Credits	Duration
Discipline Specific Course II	RJDSCBT352	Paper Title : Microbial Production Technology			
		I	Downstream processing	4	60
		II	Bioanalytical techniques		
		III	Quality control and Effluent Treatment		
		IV	Biofertilizers, biopesticides, & biofuel		

Course	Course Code	Topic Headings	Credits	Duration
Discipline Specific Course Practical	RJDSCBTP351	Product purification, assays and analysis - Practicals	4	120

SEMESTER	:	V
TITLE	:	DISCIPLINE SPECIFIC COURSE 1
TITLE OF THE SUBJECT/COURSE	:	BASIC IMMUNOLOGY & DEVELOPMENTAL BIOLOGY
COURSE CODE	:	RJDSCBT351
CREDITS	:	04
DURATION	:	60 hrs

LEARNING OBJECTIVES	
1	Understand the body's first line of defense against pathogens through nonspecific mechanisms.
2	Explore how the immune system develops specific responses to pathogens via memory and adaptive mechanisms.
3	Understand how antibodies specifically bind to antigens to neutralize or eliminate pathogens.
4	To comprehend the molecular mechanisms of cell signaling and their impact on cellular processes and overall organismal function.
5	Understand the molecular, genetic, and environmental factors that regulate organismal development from fertilization to differentiation.

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Understand the working of the immune system through both nonspecific and specific defense mechanisms to protect the body.	PSO13	I, II, III
CO2	Understand the principles of immune recognition and how antibodies bind to antigens to initiate immune responses.	PSO13	I, II, III
CO3	Gain the ability to analyze and interpret cell signaling pathways and their roles in regulating cellular activities and disease processes.	PSO17	I, II, III
CO4	Gain the ability to analyze the molecular and genetic mechanisms underlying development and their	PSO18	I, II, III

	applications in health and disease.		
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SEMESTER V			
Course Code: RJDSGBT351		Course Title: Immunology & Developmental Biology	Credits
Unit	Unit Name	Topic	4
I	Basics of Immunology	Innate immunity, Acquired immunity, Humoral and Cellular immunity, Local and Herd Immunity, Hematopoiesis; Cell and Organs of the immune system.	1
II	Components of Immune System	Antigens – Types, General properties of antigens, Haptens and Superantigens Antibody: Structure Classes and functions of immunoglobulins. Complement System- Classical, Alternate and Lectin; Regulation and Biological Effects of Complement System; Deficiencies of Complement System	1
III	Cell surface Receptors	MHC Classes - Structures and Peptide Interactions, Antigen Presentation -Endocytic and Exocytic Pathways; MHC Restriction. T-cell Receptor and B-cell Receptor: Structure and function	1
IV	Developmental Biology	Human Embryonic development: Events during fertilization, in-vitro fertilization, Zona pellucida, glycoprotein, Oolemma protein and their role in fertilization, Molecular and biochemical events during sperm function. Post fertilization events: early embryonic development, establishing multicellularity, formation of blastula, embryonic germ layer	1
References: 1. Immunology 5th ed Janis Kuby, W.H. Freeman & Co Ltd; 5th Revised edition. 2. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA 3. Gilbert S. (2006) Developmental Biology (8th edition), Sinauer Associates Inc.			

SEMESTER	:	V
TITLE	:	DISCIPLINE SPECIFIC COURSE 2
TITLE OF THE SUBJECT/COURSE	:	MICROBIAL PRODUCTION TECHNOLOGY
COURSE CODE	:	RJDSCBT352
CREDITS	:	04
DURATION	:	60 hrs

LEARNING OBJECTIVES

1	Learn downstream processes and understand the techniques such as solvent extraction, chromatography, drying, crystallization, and whole broth processing for biomolecule purification
2	Understand the principles, instrumentation, and applications of affinity, ion-exchange, size exclusion chromatography, HPLC, GC, fluorescence, light scattering, infrared and mass spec.
3	Understand GMP, its implementation, regulatory certification, and quality control/assurance. Learn biological processes for industrial effluent treatment, including aerobic and anaerobic methods.
4	Understand the concepts, types, and applications of biofertilizers, biopesticides, bioherbicides, and biofuels, including their advantages and limitations. Analyze the role of bio-based agricultural inputs and renewable energy sources in promoting sustainability.

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Acquire knowledge about the downstream processes and the techniques involved for extraction, purification and optimal bio-product recovery.	PSO16	I, II, III
CO2	Understand the principles, instrumentation, working, and applications of affinity, ion-exchange, size exclusion chromatography, HPLC, and GC. Describe the principles, working, and applications of various spectroscopy techniques.	PSO16	I, II, III
CO3	Understand GMP concepts, implementation, and regulatory certification, Comprehend quality control/assurance principles and implementation and describe aerobic and anaerobic biological processes for industrial effluent treatment	PSO16	I, II, III

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CO4	Understand biofertilizers, biopesticides, bioherbicides, and biofuels, comparing them with conventional alternatives. Assess the role of bio-based solutions in sustainable agriculture and energy.	PSO16	I, II, III
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SEMESTER V			
Course Code: RJDSCBT352		Course Title: Microbial Production Technology	Credits
Unit	Unit Name	Topic	4
I	Downstream processing	Separation of cells from spent media; Cell disruption- physical and chemical methods; solvent extraction. Chromatography in DSP; Drying; Crystallization ; Whole broth processing.	1
II	Bioanalytical techniques	Principle, instrumentation, working and applications of - Affinity chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, HPLC, GC, Fluorescence Spectroscopy, Light scattering spectroscopy, Infrared Spectroscopy, Mass spectroscopy.	1
III	Quality control and Effluent Treatment	Concept of GMP, Implementation of GMP, Regulatory certification. Quality Control and quality assurance- Concepts, Requirements for implementing. Biological processes for industrial effluent treatment, Aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes , Biological filters, RBC. Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB, FBR	1
IV	Biofertilizers, biopesticides, & biofuel	Biofertilizers -Types of Biofertilizers, Bacteria and Mycorrhiza as Biofertilizers. Biopesticides - Types, Benefits and Applications Bioherbicides - Advantages and limitations, comparison between chemical and biological pesticide. Energy crops, Biogas, Bioethanol, Biohydrogen	1
References: - Stanbury P. F., Whitaker A. & Hall--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi. - Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press - Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific. - Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services			

5. Environmental biotechnology by Monika Jain
6. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur. .
7. Biotechnology, B.D.Singh, 6th Edition, MedTechScience press

SEMESTER	:	V
TITLE	:	DISCIPLINE SPECIFIC COURSE PRACTICALS
TITLE OF THE SUBJECT/COURSE	:	PRODUCT PURIFICATION, ASSAYS AND ANALYSIS - PRACTICALS
COURSE CODE	:	RJDSCBTP351
CREDITS	:	04
DURATION	:	120 hrs

LEARNING OBJECTIVES

1	Master techniques for protein purification, quantification, and characterization using precipitation and electrophoresis.
2	Understand protein separation using Affinity, Ion Exchange, and Size Exclusion Chromatography.
3	Gain proficiency in immunological assays for antigen-antibody detection and interactions, disease diagnosis, and serological testing such as Ouchterlony, Mancini, Widal, ELISA, Western Blot, CFT, VDRL, RA Test, Blood Typing.
4	Explore biotechnological applications in biofertilizer production (Rhizobium, Azotobacter) and vaccine development (TAB), including sterility validation and thermal resistance studies.

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Demonstrate competence in protein purification, quantification, and characterization using precipitation and electrophoresis techniques.	PSO7, PSO9	I, II, III, IV
CO2	Apply principles of chromatographic separation to isolate and purify biomolecules using Affinity, Ion Exchange, and Size Exclusion Chromatography.	PSO7, PSO9	I, II, III, IV
CO3	Analyze antigen-antibody interactions through	PSO7,	I, II, III, IV

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	immunological assays, enhancing diagnostic and serological testing proficiency.	PSO9	
CO4	Utilize biotechnological approaches for biofertilizer production and vaccine development, ensuring sterility and thermal stability.	PSO7, PSO9	I, II, III, IV

SEMESTER V

Course Code: RJDSCTP351	PRACTICALS: Product purification, assays and analysis	Credits
Topic		4
1. To extract protein by ammonium sulphate precipitation. 2. Quantitative estimation of protein by Bradford Method. 3. Quantitative estimation of protein using UV spec. 4. Purity check of protein using PAGE. 5. Density gradient for purification of lymphocytes. 6. Blood grouping ABO and Rh typing 7. Separation of components from a mixture using Affinity chromatography. 8. Separation of components from a mixture using Ion exchange chromatography. 9. Separation of components from a mixture using Size exclusion chromatography. 10. Sterility testing of injectables. 11. Bioburden determination from air. 12. Microbial analysis of treated sewage by MPN method. 13. Determination of Total Solids from an effluent sample. 14. Study of physico-chemical parameters (pH, color, turbidity, BOD, COD) of an industrial effluent sample 15. Production of Biofertilizers (Rhizobium, Azotobacter) 16. Effect of Biofertilizers on plant growth 17. Study of Vesicular – Arbuscular Mycorrhiza 18. Study of Biogas production using organic waste		
References: ● Sharma, K. (2007). <i>Manual of Microbiology</i>. 2nd Edition, Ane Books Pvt Ltd., New Delhi ● Sawhney, S.K., & Singh, R. (2008). <i>Introductory Practical Biochemistry</i>. Narosa Publishing House. ● Cappuccino, J.G., & Sherman, N. (2004). <i>Microbiology: A Laboratory Manual</i> (6th ed.). Pearson. ● Farrell, S.O., & Ranallo, R.T. (2000). <i>Experimental Biochemistry: A Hands-on Approach</i>. Wadsworth Publishing. ● Plummer, D.T. (2001). <i>An Introduction to Practical Biochemistry</i> (3rd ed.). Tata McGraw Hill Education Pvt. Ltd., New Delhi, India. ● Sadashivam, S., & Manickam, A. (1995). <i>Biochemical Methods</i> (1st ed.). New Age		

International Publishers.

SEMESTER VI

Course	Course Code	Unit	Topic Headings	Credits	Duration
Discipline Specific Course I	RJDSCBT361	Paper Title : Cancer biology, Immunotechnology and Pharmacology			
		I	Cell cycle and cancer	4	60
		II	Cell signalling		
		III	Immunotechnology		
		IV	Pharmacology		

Course	Course Code	Unit	Topic Headings	Credits	Duration
Discipline Specific Course II	RJDSCBT362	Paper Title : Genetic engineering & Ethics			
		I	Gene sequencing and editing	4	60
		II	Transgenic plants		
		III	Transgenic animals		
		IV	Patent and IPR		

Course	Course Code	Topic Headings	Credits	Duration
Discipline Specific Course Practical	RJDSCBTP361	Immunological and pharmacological techniques - Practicals	4	120

SEMESTER	:	VI
TITLE	:	DISCIPLINE SPECIFIC COURSE 1
TITLE OF THE SUBJECT/COURSE	:	Cancer biology, Immunotechnology and Pharmacology
COURSE CODE	:	RJDSCBT361
CREDITS	:	04
DURATION	:	60 hrs

LEARNING OBJECTIVES	
1	Explore the molecular genetics of apoptosis and necrosis and examine the molecular and genetic foundations of cancer.
2	Analyze the general principles of cell communication including the various forms of intercellular and extracellular signaling mechanisms.
3	Apply various immuno-based techniques in diagnosis as well as evaluating cellular activity
4	Gain in-depth knowledge of various immunological assays
5	Comprehend the mechanism of drug action and examine the physiological processes involved in drug distribution and metabolism

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Describe the phases of cell cycle in a normal cell and explain the regulation of apoptosis and necrosis as well as identify the role of genetic factors in cancer progression	1, 5, 18	I, II, III, IV
CO2	Demonstrate cellular mechanisms like signalling, using immunotechniques and understand	1, 5,	I, II, III, IV
CO3	Analyze the mechanisms of drug-receptor interactions and apply knowledge of drug pharmacokinetics and dynamics to explain therapeutic actions, side effects, and drug resistance.	1, 5, 17	I, II, III, IV
CO4	Apply immunotechniques for studying cell	1, 5, 17	I, II, III, IV, V

	communication to understand signaling pathways and drug-receptor interactions at the cellular level.		
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SEMESTER VI			
Course Code: RJDSGBT361		Course Title: Cancer biology, Immunotechnology and Pharmacology	Credits
Unit	Unit Name	Topic	4
I	Cell cycle and cancer	The Early Embryonic Cell Cycle and the Role of MPF Yeasts and the Molecular Genetics of Cell-Cycle Control, Apoptosis and necrosis. Caspases and target, factors that regulate apoptosis in normal cells Cancer: Definition, Characteristics of normal cell and cancerous cell. Tumor- Benign and malignant, types of cancer, oncogenes and tumor suppressor genes, invasion metastasis, angiogenesis, preventive measures for cancer	1
II	Cell signalling	General Principles of cell communication: Introduction Forms of Signaling: Autocrine Paracrine, Synaptic, and Endocrine Cellular Responses to Signaling Molecules Role of gap junction in signaling, Nitric oxide as signaling molecules. Intracellular receptor signaling, Types of Cell-Surface Receptors GPCRs, Second messengers, Role of Calcium, Calcium binding proteins, RTKs	1
III	Immunotechnology	Antigen-antibody reaction – features, antibody generation, Immunoprecipitation based techniques, Agglutination Reactions; Coomb's Test; Complement Fixation Tests; ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. Electron microscopy using labelled antibodies	1
IV	Pharmacology	Pharmacokinetics: Absorption, Distribution, Metabolism, Excretion; Route of administration Pharmacodynamics: Drug-receptor interactions (Agonist, Antagonist, Partial Agonist); Location of drug receptors, affinity and intrinsic activity, Potency and efficacy; Drugs acting on enzymes; Non-receptor mechanisms; Placebo effect; Therapeutic Index, Synergism, Antagonism Efficacy, Dose-Response curves, LD50, ED50	1
References: 1. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA 2. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA			

3. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
4. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
5. Textbook of Pharmacology, By Barar F.S.K.

SEMESTER	:	VI
TITLE	:	DISCIPLINE SPECIFIC COURSE 2
TITLE OF THE SUBJECT/COURSE	:	Genetic engineering & Ethics
COURSE CODE	:	RJDSCBT362
CREDITS	:	04
DURATION	:	60 hrs

LEARNING OBJECTIVES

1	Evaluate and compare various DNA sequencing methods
2	Demonstrate an understanding of genome editing technologies and their applications
3	Understand the methodologies and applications of transgenic plants and animals
4	Understand the process and significance of patenting in biotechnology

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Understand and apply key principles in gene cloning and vector construction	PSO10	I, II, III
CO2	Analyze sequencing methods and genome editing techniques	PSO7	I, II, III, IV
CO3	Analyze the role of transgenic organisms in biotechnology and biomedical research	PSO3	I, II, III, IV
CO4	Understand and Analyze the framework of Intellectual Property Rights (IPR) and its protection in India	PSO7	I, II, III, IV

SEMESTER VI			
Course Code: RJDSCBT362		Course Title: Genetic engineering & Ethics	Credits
Unit	Unit Name	Topic	4
I	Gene sequencing and editing	Cloning and Expression vectors - Properties of Host, Properties of Vectors, Types of Vectors, Enzymes in genetic engineering: Restriction endonucleases, Ligases, Alkaline phosphatase, Polynucleotide kinase, Terminal dideoxy transferase, DNA polymerase, Reverse transcriptase, S1 nuclease. Selection of recombinant clones, Selection of the clone containing a specific DNA insert; Gene cloning – Steps in gene cloning, Expression of cloned DNA molecules and maximization of expression DNA libraries – Genomic library, Chromosome walking and jumping, cDNA libraries Sequencing methods - Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing, Next Generation S.	1
II	Transgenic plants	Introduction, Gene constructs, Vectors for production of transgenic plants, Transformation techniques – Physical, chemical and biological, Applications of transgenic plants, Insect resistant plant- BT cotton, herbicide resistant plant- Glyphosate resistant crop, Biofortified Crop-Golden rice.	1
III	Transgenic animals	Introduction to Transgenic Animals: Methodologies to produce Transgenic mice, Detection of transgenic lines using PCR, Use of transgenic mice as a model for Alzheimer's Diseases, The Cre-loxP recombination system (Gene knockout), RNA interference. Transgenesis with High – Capacity Vectors. Applications of Transgenic Animal- Mice, livestock , fish, poultry	1
IV	Patent and IPR	Patent: Process of patenting; patenting microorganisms, genes; plant breeder's rights; patenting and biotechnology research. Intellectual property rights (IPR): Protection of IPR in India, terminology associated with IPR – copyright, trademark, design, geographical indications and trade secrets. Issue relating to IPR: Copyleft, traditional knowledge, biodiversity and biopiracy.	1
References: 1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell. 2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L. 3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.			

4. Biotechnology 3rd Edition S.S. Purohit.
5. Genomes 3rd Edition T.A. Brown.
6. Biotechnology B.D. Singh.
7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown. 8. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)
8. Plant Tissue Culture_ Theory and Practice, a Revised Edition, Bhojwani & Razdan.
9. Plant Cell Culture Protocols 2nd ed, Humana Press
10. IPR, Biosafety and Bioethics, Deepa Goel, Shomini Parashar -Pearson Education (2013)
11. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology- Padma Nambisan (Auth.) - Academic Press (2017)
12. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.

SEMESTER	:	VI
TITLE	:	DSC PRACTICALS
TITLE OF THE SUBJECT/COURSE	:	IMMUNOLOGICAL AND PHARMACOLOGICAL TECHNIQUES - PRACTICALS
COURSE CODE	:	RJDSCBTP361
CREDITS	:	04
DURATION	:	120 hrs

LEARNING OBJECTIVES	
1	Master molecular biology techniques such as determination of Purity of plasmid DNA using UV spectrophotometry, Ligation, Transformation, Gene Sequencing, Expression of recombinant protein
2	Understand Callus induction and cell suspension & Isolation of plant protoplast.
3	Gain proficiency in immunological assays for antigen-antibody detection and interactions, disease diagnosis, and serological testing such as Ouchterlony, Mancini, Widal, ELISA, Western Blot, CFT, VDRL, RA Test, Blood Typing.
4	Explore biotechnological applications in biofertilizer production (Rhizobium, Azotobacter) and vaccine development (TAB), including sterility validation and thermal resistance studies.
5.	Understand calculation of Pharmacokinetic Parameters

Course Outcome No.	On completing the course, the student will be able to:	PSO Addressed	Bloom's Levels
CO1	Demonstrate competence in plasmid quantification, Ligation, Transformation, Gene Sequencing, Expression of recombinant protein	PSO7, PSO9	I, II, III, IV
CO2	Apply principles of Callus induction and cell suspension & Isolation of plant protoplast	PSO7, PSO9	I, II, III, IV
CO3	Analyze antigen-antibody interactions through immunological assays, enhancing diagnostic and serological testing proficiency.	PSO7, PSO9	I, II, III, IV
CO4	Utilize biotechnological approaches for biofertilizer	PSO7,	I, II, III, IV

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	production and vaccine development, ensuring sterility and thermal stability.	PSO9	
CO5	Analyze Toxicity and Drug Properties	PSO7, 9	I, II, III, IV

SEMESTER VI		
Course Code: RJDSCBTP361	PRACTICALS: Immunological and pharmacological techniques	Credits
Topics		4
1. Determination of Purity of plasmid DNA using UV spectrophotometry 2. To prepare competent cells and transform with plasmid 3. Gene Sequencing 4. Expression of recombinant protein. 5. Determination of antigen identity interaction by Ouchterlony method 6. Determination of antigen concentration by Mancini method 7. Semi - Quantitative determination of enteric fever using Widal test 8. Quantitative determination of enteric fever using Widal test 9. Detection of syphilis using VDRL test 10. Detection of antibodies in serum using Complement Fixation Test (CFT). 11. To perform sandwich Dot ELISA test for antigen. 12. Detection of antigen/antibody using ELISA 13. DPPH assay 14. Determination of LC50 in <i>Chironomus larvae</i> 15. Calculation of Pharmacokinetic Parameters from a Given Data. 16. Determination of Partition coefficient for any two drugs 17. Drafting Patent Application 18. Patent Case Study		
References: ● Purifying Challenging Proteins Principles and Methods Handbooks from GE Healthcare ● Biotechnology Procedures and Experiments Handbook, S. Harisha, Infinity Science Press. ● Plant Cell Culture Protocols 2nd ed, Humana Press ● Research Handbook on the Protection of Intellectual Property under WTO Rules Intellectual Property in the WTO Volume I.		

THIRD YEAR BACHELOR OF SCIENCE IN BIOTECHNOLOGY

RULES AND REGULATIONS REGARDING ASSESSMENT AND EVALUATION

FOR TY UNDER NEP FROM A.Y, 2025-2026 ONWARDS:-

1 A learner appearing for a second year examination under NEP will have a maximum of **22 credits** and examinations will be of **maximum 550 marks**.

2. Courses having **2 credits, 3 credits and 4 credits** will have examinations of **50, 75, 100 marks** respectively.

3. With regard to Major Course, Minor Course and OEC:

Continuous evaluation of 40- 60 adopted under autonomy (2018) shall continue for all the courses, for the courses with 2 credits and 50 marks, Internal is of 20 marks (only one IA) and External 30 marks (SEE); while the courses with 3 credits and 75 marks, it is 25 marks (only one IA) and 50 marks (SEE). In the case of courses of 100 marks, the break up of marks will be 40 marks (IA) and 60 marks (SEE).

4. With regard to IKS, VSEC (VSC and SEC), AEC, VEC:

These will be of 2 Credits each and of 50 marks. Continuous evaluation of 40-60 wherein internal is of 20 marks and SEE of 30 marks or only one SEE of 50 marks or continuous evaluation of more than one test by the respective

Coordinating department or as directed by the EC

5. With regard to CC:

Vertical of CC shall also be more like a continuous evaluation where a student will be awarded marks on the basis of his/her participation in the co-curricular activities of the department/other departments/associations/extension activities/intercollegiate events and Jeevan Kaushal. A workbook will be provided to a student to keep a record of his/her participation and will be duly signed by the concerned teachers.

6. Duration of examinations:

- An exam of 20/25 marks shall be of duration of 30 minutes.
- An SEE exam of 30 marks (offline) shall be of duration of 1 hour.
- An SEE exam of 50 marks (offline) shall be of duration of 1 1/2 hour
- An SEE exam of 50 marks (online MCQ) shall be of 60 minutes.
- An SEE exam of 60 marks (offline) shall be of duration of 2 hours.

7. There shall be **combined passing of Internals and SEE** in a given paper with a **minimum passing percentage of 40**.

8. **Appearing for SEE** for every paper is **compulsory** irrespective of the performance in the internals examinations. A student absent in SEE will be thus declared failing in a given subject.

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9. There shall be provision for supplementary examination for the benefit of students who miss their SEE on grounds of medical emergency or representing college at the national level event or any other equivalent event with a special permission granted by the Head of the institution.
10. There shall be no Additional Examinations for any of the Semesters except for the Semester V wherein one chance of credit improvement in Semester V shall be given before the Learner appears for the final Semester VI Examination.
11. A learner appearing for first year exam under NEP shall have an examination of maximum **550 marks** to which effect **ATKT** is allowed for **maximum of 200 marks** corresponding to **failing in 3/4 courses** but must have passed in at least one Theory course of Major/Minor.

Mapping of the course to Local/ Regional/National/International relevance & employability

Biotechnology applies biological and molecular processes to develop technologies that benefit health, industry, and the environment. It has long been used in food production, such as making bread and cheese. Modern biotechnology creates innovations to fight diseases, improve agriculture, reduce environmental impact, and enhance industrial processes. Studying biotechnology offers career opportunities in healthcare, agriculture, environmental conservation, and industry. It contributes to developing new drugs, increasing crop yields, producing biofuels, and addressing pollution. Additionally, it plays a vital role in understanding and treating diseases and genetic disorders, ultimately improving human health and sustainability.

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
TY Biotech	Immunology & Developmental Biology	RJDSCBT 351	It contributes to local healthcare, disease prevention, and personalized medicine advancements	Crucial for regional healthcare innovation, addressing local disease challenges and improving public health outcomes.	Plays a vital role in shaping national healthcare policies, advancing disease control, and supporting biomedical research for public health.	Key to global health advancements, driving international research collaborations and tackling worldwide diseases.
	Microbial Production technology	RJDSCBT 352	Benefits local communities by supporting eco-friendly manufacturing, enhancing food security, and promoting small-scale biotechnological innovations.	Drives regional economic development by fostering local biotechnology industries, creating jobs, and promoting sustainable practices.	Supports national industries by advancing biotechnology, enhancing sustainable production, and boosting economic growth through.	Essential for global sustainability, enabling the production of bio-based materials, medicines, and renewable energy worldwide.
	Product purification, assays and analysis	RJDSCBT P351	Ensures high-quality standards in industries like food, pharmaceuticals, and agriculture, boosting consumer safety and trust.	Vital for ensuring quality control, enhancing local manufacturing processes, and supporting regional biotechnology advancements.	Critical for maintaining regulatory standards, ensuring public safety, and supporting the growth of industries like healthcare and manufacturing.	Essential for global trade, ensuring product safety, quality, and compliance with international standards.

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
TY Biotech	Cancer biology & Pharmacology	RJDSC BT361	Early diagnosis and treatment, addressing rising cancer cases in local populations	Region-specific prevention and intervention strategies	Development of precision medicine, enabling tailored treatments based on genetic and molecular profiling	Advances in cancer pharmacology, drive global pharmaceutical breakthroughs and treatment efficacy.
	Genetic engineering & Ethics	RJDSC BT362	Local farmers benefit from GM crops that improve yield, resist pests etc, contributing to food security and economic stability.	Regional biotech industries develop gene therapies and genetically engineered drugs, for genetic disorders, cancer, and infectious diseases	Governments establish bioethics frameworks to regulate genetic engineering practices, ensuring public safety, and compliance with ethical standards in human gene editing and GMOs	Global discussions on the ethical implications of CRISPR and human genome editing, promoting international guidelines and preventing unethical genetic modifications.
	Immunological and Pharmacological techniques	RJDSC BTP361	Local healthcare centers use immunological techniques to detect infections and administer vaccines, improving community health.	Develop and manufacture monoclonal antibodies, vaccines, and immunosuppressive drugs to cater to the medical needs	National health agencies regulate immunological and pharmacological advancements, ensuring drug safety, & vaccine distribution	International bodies like WHO and CDC coordinate immunological research, vaccine development, and pharmacological advancements