



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College
of Arts, Science & Commerce
(Autonomous College)



Affiliated to
UNIVERSITY OF MUMBAI

Syllabus for the T.Y.B.Sc.

Program: B.Sc. BIOTECHNOLOGY

Program Code: RJSUBT

(CBCS 2019-20)

PROGRAM OUTCOMES FOR UNDERGRADUATE 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 GAT-B, IIT-JAM, CUTE, TIFR, 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 microbiology, 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 BSc BIOTECHNOLOGY

Sr. No	A Student Specific completing B.Sc. Biotechnology will be able to :
PSO1	Understand the concepts of cell cycle, its phases, mechanisms of apoptosis and pathways involved.
PSO2	Understand the general principles of cell communication, role of gap junction in signaling responses to multicellular signal molecules. Also understand the role of secondary messengers.
PSO3	Gain insight about human embryonic development and post fertilization events.
PSO4	Understand the concepts of cancer biology, gaining insights on the characteristics of cancer cells, its types, genes involved in cancer, the process of angiogenesis, invasion and metastasis.
PSO5	To understand the concepts of fundamentals of virology, virus purification and assays involved.
PSO6	Gain an understanding about chemotherapeutic drugs and bioanalytical techniques including spectroscopy.
PSO7	Understand the concepts related to tools used in molecular biology, gene sequencing and editing, transgenic animals and plants.
PSO8	Gain an understanding of the basic concepts of marine biotechnology & cosmetics, food technology, plant biotechnology and Patents including IPR.
PSO9	Understand the fundamentals of bacteriology, mycology, parasitology, hematology and clinical pathology.
PSO10	Understanding of biochemistry of carbohydrate, lipid metabolism and gaining insights related to endocrinology and nutrition.
PSO11	Gain an understanding of the basic concepts of industrial microbiology, environmental biotechnology, pharmacology and neurochemistry..
PSO12	Gain insight about the techniques and automation in medical lab technology.

DISTRIBUTION OF TOPICS AND CREDITS
T.Y.B.Sc. BIOTECHNOLOGY SEMESTER V

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT501	Paper - Embryology and cancer Biology			60 hours
	I	Cell Cycle	3	
	II	Cell Signaling		
	III	Developmental Biology		
	IV	Cancer Biology		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT502	Paper - Virology and Bioanalytical techniques			60 hours
	I	Virology	3	
	II	Chemotherapeutic Drugs		
	III	Spectroscopy		
	IV	Bioanalytical techniques		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT503	Paper -Molecular Biology			60 hours
	I	Tools in Molecular Biology	3	
	II	Gene sequencing and editing		
	III	Transgenic animals		
	IV	Transgenic plants		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT504	Paper - Applied Biotechnology			60 hours
	I	Marine biotechnology & Cosmetics	3	
	II	Food biotechnology		
	III	Plant biotechnology		
	IV	Patent & IPR		

Ability enhancement course

Course Code	Unit	Topic Headings	Credits	Duration
RJSUACMT501	Paper - Microbiology, Hematology and Clinical Pathology			60 hours
	I	Bacteriology	3	
	II	Mycology and Parasitology		
	III	Hematology		
	IV	Clinical Pathology		

Core subject Practicals

Course Code	Topic Headings	Credits	Duration
RJSUBTP501	Practicals of RJSUBT501 & RJSUBTP502	3	45 hours
RJSUBTP502	Practicals of RJSUBT503 & RJSUBTP504	3	45 hours

Ability enhancement course - Practicals

Course Code	Topic Headings	Credits	Duration
RJSUACMTP501	Practicals of RJSUACMT501	2	45 hours

DISTRIBUTION OF TOPICS AND CREDITS
T.Y.B.Sc. BIOTECHNOLOGY SEMESTER VI

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT601	Paper - Biochemistry			60 hours
	I	Carbohydrate metabolism	3	
	II	Lipid metabolism		
	III	Endocrinology		
	IV	Nutrition		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT602	Paper - Industrial microbiology			60 hours
	I	Milk and milk products	3	
	II	Fermentation process		
	III	Downstream processing		
	IV	QA-QC		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT603	Paper -Pharmacology and Neurochemistry			60 hours
	I	Principles of Pharmacology	3	
	II	Drug Absorption and Distribution		
	III	Toxicology		
	IV	Neurochemistry		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT604	Paper - Environmental Biotechnology			60 hours
	I	Industrial effluent treatment	3	
	II	Solid waste treatment		
	III	Wastewater treatment		
	IV	Hazardous waste management		

Ability enhancement course

Course Code	Unit	Topic Headings	Credits	Duration
RJSUACMT601	Paper - Techniques and Automation in MLT			60 hours
	I	Diagnostic microbiology	3	
	II	Automation and newer approaches in MLT		
	III	Clinical Biochemistry		
	IV	Organ Function Tests		

Core subject Practicals

Course Code	Topic Headings	Credits	Duration
RJSUBTP601	Practicals of RJSUBT601 & RJSUBTP602	3	45 hours
RJSUBTP602	Practicals of RJSUBT603 & RJSUBTP604	3	45 hours

Discipline Specific Elective

Course Code	Topic Headings	Credits	Duration
RJSUACMTP601	Practicals of RJSUACMT601	2	45 hours

YEAR	SEMESTER	CORE SUBJECT						APPLIED COMPO NENT	ABILITY ENHANC EMENT COURSE	SKILL ENHAN CEMEN T COURS E (SEC)	DISCIP LINE SPECIF IC ELECT IVE (DSE)	PRAC TICA LS	TOTAL
FY	I	2	2	2	2	2	2	-	3	-	-	6	21
	II	2	2	2	2	2	2	-	3	-	-	6	21
TOTAL		4	4	4	4	4	4	-	6	-	-	12	42
SY	III	2	2	2	2	2	-	-	2	2	-	6	22
	IV	2	2	2	2	2	-	-	2	2	-	6	22
TOTAL		4	4	4	4	4	-	-	4	4	-	12	40
TY	V	3	3	3	3	-	-	3	-	-	-	8	23
	VI	3	3	3	3	-	-	3	-	-	-	8	23
TOTAL		6	6	6	6	-	-	6	-	-	-	16	46

COURSE OUTCOMES (COs) B. Sc. BIOTECHNOLOGY

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	EMBRYOLOGY AND CANCER BIOLOGY
COURSE CODE	:	RJSUBT501
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Understand the molecules involved in cell signaling.
2	Gain an understanding of the basic concepts of events during fertilization and early embryonic development.
3	Gain insight into the biology of cancer cells.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Introduction to cell cycle and its phases. Role and importance of checkpoints in phases of cell cycle. Introduction to Apoptosis and types of apoptotic pathways. Factors involved in regulating apoptosis processes.	1	BT levels 1,2 & 3
CO2	Introduction to cell signaling, forms of intracellular signaling and types of extracellular signaling molecules.	2	BT levels 1,2 & 3
CO3	Introduction to human embryonic development stages and post fertilization events.	3	BT levels 1,2 & 3

CO4	Introduction to cancer biology, types of cancer, genes involved and preventive measures.	4	BT levels 1,2 & 3
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Paper Code: RJSUBT501	Paper-I: Embryology and cancer biology	Credits 3
Unit I	Cell Cycle	15 hrs
	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.	
Unit II	Cell Signaling	15 hrs
	General Principles of cell communication: Introduction, Extracellular signal molecules binding to receptors, Forms of intercellular signaling - Autocrine, Contact dependent, Paracrine, Synaptic and Endocrine. Role of gap junction in signaling response to multiple extracellular signal molecules; Morphogens, Lifetime of intracellular molecule, Role of Nitric oxide and nuclear receptors Binding reaction and role of Kd, Extracellular messengers and their receptors, GPCRs RTKs, Second messengers, Role of Calcium, Calcium binding proteins.	
Unit III	Developmental Biology	15 hrs
	Human Embryonic development: Events during fertilization, <i>in-vitro</i> 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.	
Unit IV	Cancer Biology	15 hrs
	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	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	VIROLOGY AND BIOANALYTICAL TECHNIQUES
COURSE CODE	:	RJSUBT502
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Learn the different type of virus cultivation and enumeration
2	Understand the development and mode of action of antimicrobial, antifungal and antiviral drugs.
3	Get an insight into the various spectroscopic methods used in biological studies.
4	Understand the principle and applications of chromatographic and tracer techniques.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	The course will give an overview of medically important virus families and their replication strategies, Lytic and lysogenic pathways, relation between virus and cancer. The students will learn methods and strategies for viral purification and assay, cultivation and enumeration.	5	BT levels 1,2 & 3
CO2	The course will help in understanding the mechanisms of action of various antibacterial, antifungal, antiviral drugs and also the mechanism of drug resistance	5	BT levels 1,2 & 3

CO3	The primary objective of this course is to develop the skills to understand the principle and application of bioanalytical techniques in analysis of biological samples.	6	BT levels 1,2 & 3
CO4	To provide scientific understanding of analytical techniques involving separation of macromolecules and detailed interpretation of results.	6	BT levels 1,2 & 3

Paper Code: RJSUBT502	Paper-II: Virology and bioanalytical techniques	Credits 3
Unit I	Virology	15 hrs
	Cultivation of dsDNA, ssDNA and RNA viruses, animal viruses and plant (TMV) viruses. Virus purification and assays, Cytocidal infections and cell damage -Viroids and Prions.	
Unit II	Chemotherapeutic Drugs	15 hrs
	Development of chemotherapy, General characteristics of antimicrobial drugs, determination level of antimicrobial activity, mechanism of action of antimicrobial drugs. Factors influencing effectiveness of antimicrobial drugs, antibacterial drugs, drug resistance, antifungal and antiviral drugs.	
Unit III	Spectroscopy	15 hrs
	Principle, instrumentation, working and applications of: Fluorescence Spectroscopy, Luminometry, Light scattering spectroscopy, Infrared Spectroscopy, Mass spectroscopy.	
Unit IV	Bioanalytical techniques	15 hrs
	Principle, working and applications of: Affinity chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, HPLC, GC. Isotopes in Biology - Nature of radioactivity; Detection Techniques using GM counter, Scintillation counter, autoradiograph; Applications of Tracer techniques in Biology.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	MOLECULAR BIOLOGY
COURSE CODE	:	RJSUBT503
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Use molecular biology tools and techniques in the field of biotechnology.
2	Gain knowledge regarding recent developments in genome sequencing and editing.
3	Understand the basis of gene cloning and development of transgenic animals and plants.
4	Understand more about the science that underlies the methods of gene transfer and development of genetically modified organisms.
5	To know something of the potential benefits and uncertainties associated with gene transfer and the high levels of technical ingenuity involved
6	Understand more the science that underpins the development of Golden Rice and understand why the usefulness of this product has proved so contentious

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	This course is designed to provide a contextual and inquiry based learning of modern day advances in the field of recombinant DNA technology.	7	BT levels 1,2 & 3
CO2	It will elucidate various gene editing and sequencing techniques used for assigning functions to various genes and manipulating them for diagnostics or treatment purposes.	7	BT levels 1,2 & 3

CO3	This course would provide an insight into the strategies used for creating transgenic animals and their need and applications in research and farming.	7	
CO4	This course would provide students with an understanding of concepts and methods associated with development and analysis of transgenic plants, and their applications in basic and applied research.	7	BT levels 1,2 & 3

Paper Code: RJSUBT503	Paper-III: Molecular biology	Credits 3
Unit I	Tools in Molecular Biology	15 hrs
	<p>Cloning and Expression vectors - pUC series plasmid, Cosmids, phagemids, M13, Shuttle vectors, YAC vectors, pET vectors. Enzymes in genetic engineering – Restriction endonucleases, Ligases, Alkaline phosphatase, Polynucleotide kinase, Terminal dideoxy transferase, DNA polymerase, Reverse transcriptase, S1 nuclease.</p> <p>Gene cloning – Steps in gene cloning, Isolation and purification of DNA; Isolation of gene of interest, restriction digestion, Blotting techniques, insertion of DNA in vector. Expression of cloned DNA molecules and maximization of expression. DNA libraries – Genomic library, chromosome walking and jumping, cDNA libraries.</p>	
Unit II	Gene sequencing and editing	15 hrs
	<p>Selection of recombinant clones – Selection of clones containing recombinant vectors, Selection of the clone containing a specific DNA insert, Hybrid arrest translation (HART), Hybrid release translation (HRT).</p> <p>Sequencing methods - Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing; Genome editing - RNAi, ZNF (Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases), CRISPR/Cas system (Clustered Regularly Interspersed Repeats)</p>	
Unit III	Transgenic animals	15 hrs
	<p>Transgenic mice- Methodology- retroviral method, DNA microinjection, ES method, Applications of transgenic mice. The Cre-loxP recombination system, Transgenesis with High – Capacity Vectors. Applications of Transgenic Mice.</p> <p>Cloning livestock by nuclear transfer. Transgenic Livestock. Transgenic Poultry and Transgenic Fish.</p>	
Unit IV	Transgenic plants	15 hrs

	<p>Applications of transgenic plants, Gene constructs, Vectors for production of transgenic plants, Transformation techniques – <i>Agrobacterium</i> mediated gene transfer, Agroinfection, Direct gene transfers.</p> <p>Examples of useful gene transfers – Insect resistant plant, virus resistant plants, herbicide resistant plant, stress and senescence tolerant plants, Golden rice, Edible vaccines.</p>	
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SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	APPLIED BIOTECHNOLOGY
COURSE CODE	:	RJSUBT504
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Gain insight in the field of marine biotechnology.
2	Gain knowledge regarding traditional fermentation processes in the fields of food and beverage production.
3	Get an insight in the field of plant biotechnology and its applications.
4	Get an understanding of laws that govern Patent and Intellectual property rights.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	This course introduces the students to different fields of biotechnology and their products that have commercial significance.	8	BT levels 1,2 & 3
CO2	This course will provide an understanding about concepts of bioprospecting from marine sources using biotechnology, Applications of biomolecules obtained from marine sources as functional food, antimicrobials, nutraceuticals and cosmeceuticals.	8	BT levels 1,2 & 3
CO3	This course will provide an insight on the principles of Beer, Wine and	8	BT levels 1,2 & 3

	vinegar fermentation process. Its application in the food industry.		
CO4	It will elucidate the importance of intellectual property rights and patents in industries. It will also give a broad view of the concepts involved related to intellectual property rights.	8	BT levels 1,2 & 3

Paper Code: RJSUBT504	Paper-IV: Applied biotechnology	Credits 3
Unit I	Marine Biotechnology & cosmetics	15 hrs
	<p>Introduction to Marine Biotechnology</p> <p>Bioprospecting- Methods for bioprospecting in marine environments. Drugs from marine organisms; Pharmaceutical compounds- Marine toxins, antiviral and antimicrobial agents. Approved marine drugs; Marine natural products and its challenges. Marine sources as healthy food or reservoirs of functional ingredients. Marine bioactive as potential Nutraceuticals, Fish collagen and Gelatin, Marine probiotics. Cosmetics – Definition and regulations, Cosmeceuticals, target organs and cosmetics delivery systems. Major functions of some marine components in cosmetics and Cosmeceuticals.</p>	
Unit II	Food technology	15 hrs
	<p>Fermentation of - Beer; Wine; Vinegar.</p> <p>Brewer's and Baker's yeast, Fungal amylase by solid substrate fermentation; Vitamin B12, SCP.</p>	
Unit III	Plant Biotechnology	15 hrs
	<p>Secondary metabolites in plant culture - production and its applications, immobilization, hairy root culture, elicitors, induced production of secondary metabolites.</p> <p>Effect of environmental factors, biotransformation, protoplast culture and somatic hybridization, cybrids. Applications and limitations of somatic hybridization.</p>	
Unit IV	Patent and IPR	15 hrs
	<p>Patent: Process of patenting; patenting microorganisms, genes; plant breeder's rights; patenting and biotechnology research.</p> <p>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.</p>	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	ABILITY ENHANCEMENT COURSE
COURSE CODE	:	RJSUACMT501
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	List the factors playing a role in causing a disease.
2	Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and prophylaxis.
3	Gain the technical capability of handling, isolating and identifying various Bacteria.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To understand sample collection, processing and diagnosis of bacteriological infections.	9	BT levels 1,2 & 3
CO2	To understand sample collection, processing and diagnosis of fungal and parasitic infections and also to understand the life cycle of different human parasites.	9	BT levels 1,2 & 3
CO3	It explains the importance of hematology and pathologically significant findings related to them.	9	BT levels 1,2 & 3
CO4	It gives the significance of clinical pathology and routine analysis of the different body secretions/fluids in diagnosis and prognosis.	9	BT levels 1,2 & 3

Paper Code: RJSUACM T501	Applied component: Microbiology, Hematology and Clinical Pathology	Credits 3
Unit I	Bacteriology	15 hrs
	Guidelines for collection, transport, processing, analysis and reporting of cultures from specific specimen sources for - Infections of the respiratory tract, gastrointestinal tract, Urinary tract, genital tract, bones and joints, CNS, Wounds, abscesses and cellulites, Eye and Infections of the blood.	
Unit II	Mycology & Parasitology	15 hrs
	Mycology: Laboratory approach for diagnosis of fungal Infections- Specimen collection and transport, processing, direct examination, preparation of mounts for study, selection and inoculation of culture media, incubation of fungal cultures; Identification of <i>Candida</i> . Parasitology: Overview of life cycles of parasites. (<i>Entamoeba histolytica</i> , <i>Ascaris</i> , <i>Plasmodium spp</i> , <i>Giardia lamblia</i>) Collection, transport and processing of specimens.	
Unit III	Hematology	15 hrs
	Collection of blood, Anticoagulants, Structure, function and life span of blood cells; Abnormal forms of RBC; Abnormalities of WBC's; Hemoglobin: types-normal & abnormal, Types of anemia. Blood bank: human blood group system, Rhesus blood group system and immune antibodies, clinical significance of blood transfusion,; collection and processing of blood for transfusion.	
Unit IV	Clinical Pathology	15 hrs
	Routine urine analysis - composition of normal urine, routine examination of urine. Routine stool analysis – Importance of stool examination, collection of fecal specimen, physical examination Specimen collection, lab examination and clinical significance of CSF and gastric juice. Semen analysis, clinical significance, specimen collection, physical	

	examination, microscopic examination, sperm morphology – normal & abnormal, chemical examination. Examination of sputum – Collection, examination – physical, chemical and microscopic.	
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SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOCHEMISTRY
COURSE CODE	:	RJSUBT601
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Understand the biosynthetic pathways and regulation of biomolecules like carbohydrates and lipids.
2	Learn the various functions of endocrine gland secretions with their associated disorders.
3	Understand the functioning of vitamins and minerals in the body and gain an insight in the concept of nutrition.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To explain in detail various metabolic pathways, fate and energy production efficiency of carbohydrate and lipid metabolism.	10	BT levels 1,2 & 3
CO2	To understand the mechanism of action of various hormones, their synthesis, storage, release and associated disorders.	10	BT levels 1,2 & 3
CO3	The importance of vitamins, their sources, functions, bioactivity and associated disorders.	10	BT levels 1,2 & 3

Paper Code: RJSUBT601	Paper-I: Biochemistry	Credits 3
Unit I	Carbohydrate metabolism	15 hrs
	Biosynthesis and its regulation of Peptidoglycan in Bacteria. Biosynthesis and its regulation of Starch and sucrose in Plants; Glycogen in Animals.	
Unit II	Lipid metabolism	15 hrs
	Biosynthesis and regulation of fatty acids, triacylglycerol, membrane phospholipids and Cholesterol.	
Unit III	Endocrinology	15 hrs
	Mechanism of action of group I and II hormones. Biosynthesis, storage, release, transport, biochemical functions and disorders associated with hormones secreted by: Hypothalamus, Pituitary gland, Thyroid gland, Adrenal gland, Pancreas, Gonads and Placenta.	
Unit IV	Nutrition	15 hrs
	Dietary sources, bioactive form, functions and disorders associated with fat soluble and water soluble vitamins. Minerals - physiological and biochemical functions of principal and trace elements; Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus)	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	INDUSTRIAL MICROBIOLOGY
COURSE CODE	:	RJSUBT602
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Gain insight in the various processes involved in production of commercially available dairy products.
2	Have an in-depth understanding of downstream processes.
3	Understand and gain insight in the various processes involved in production of commercial products.
4	Understand the importance of GMP and its relevance in bioprocesses.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	This course introduces the students to various downstream processing technologies for extraction and purification of biological products produced using Bioprocess technology.	11	BT levels 1,2 & 3
CO2	It elaborates on the concept of GMP, implementation, Regulatory certification and SOPs used during QC and QA implementation.	11	BT levels 1,2 & 3

Paper Code: RJSUBT602	Paper-II: Industrial Microbiology	Credits 3
Unit I	Milk and milk products	15 hrs
	Milk: Normal flora, changes in raw milk; Enumeration; Factors affecting bacteriological quality; Preservation methods; Starter Cultures. Fermented products – Cheese, Butter; Yogurt and Buttermilk (Production process and spoilage)	
Unit II	Fermentation process	15 hrs
	Production of Streptomycin, Semi-synthetic Penicillin, Protease; Mushroom, citric acid, Glutamic acid, Lysine, monoclonal antibodies, Biotransformation.	
Unit III	Downstream processing	15 hrs
	Separation of cells from spent media; Cell disruption- physical and chemical methods; solvent extraction. Chromatography in DSP, Membrane processes; Drying; Crystallization and Whole broth processing.	
Unit IV	QA-QC	15 hrs
	Concept of GMP, implementation, Regulatory certification. Quality Control and quality assurance- Concepts, Requirements for implementing.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PHARMACOLOGY AND NEUROCHEMISTRY
COURSE CODE	:	RJSUBT603
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Understand the mechanisms of drug delivery and action in the body.
2	Get an understanding of the concepts of bioavailability and distribution.
3	In depth knowledge on toxic substances and poisons
4	Understand the biochemistry of nerve impulses and brain functioning.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To understand principles of pharmacology and its role related to biological activity of drugs in the system.	11	BT levels 1,2 & 3
CO2	To study the significance of drug absorption and distribution in the system, mode of administration of drugs and factors influencing drug absorptivity.	11	BT levels 1,2 & 3
CO3	To understand the effect of allergen, pesticide on systemic physiological functions. Also to discuss steps to be taken in case of nonmedical misuses of chemicals and bioterrorism.	11	BT levels 1,2 & 3

CO4	To study in details the structure and functions of neurons and glial cells, mechanism of action potential, role of various channels , and effects of neurotransmitters and neurotoxins	11	BT levels 1,2 & 3
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Paper Code: RJSUBT603	Paper-III: Pharmacology & Neurochemistry	Credits 3
Unit I	Principles of Pharmacology	15 hrs
	Mechanism of drug action; drug receptors and biological responses; second-messenger systems; dose–response relationship: therapeutic index; ED, LD; Potency and Intrinsic Activity.	
Unit II	Drug Absorption and Distribution	15 hrs
	Absorption of drugs from the alimentary tract; factors affecting rate of gastrointestinal absorption; absorption of drugs after parenteral administration, factors influencing drug distribution; binding of drugs to plasma proteins; Physiological barriers to drug distribution	
Unit III	Toxicology	15 hrs
	Introduction of toxicology; herbicide and pesticide toxicity, Causes Allergy in response to drugs. Effects of prolonged administration. Adverse effects on reproduction, Specific poisoning. Nonmedical use of drugs, Deliberate and accidental self-poisoning, Principles of treatment, Bioterrorism	
Unit IV	Neurochemistry	15 hrs
	Anatomy and functioning of the brain; Propagation of nerve impulses; Neuronal excitation and inhibition; Synapses and gap junctions; Action of neurotransmitters.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	ENVIRONMENTAL BIOTECHNOLOGY
COURSE CODE	:	RJSUBT604
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Get an insight on the different traditional and new sources of renewable energy.
2	Understand the principles and practices involved in treatment of industrial effluent
3	Gain an insight in the management and treatment of wastewater.
4	Understand the disposal of waste from different industries.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To impart knowledge regarding management of industrial, storm and hazardous waste.	11	BT levels 1,2 & 3
CO2	To study biological processes used to treat effluent from industries.	11	BT levels 1,2 & 3
CO3	To study different methodologies to treat solid and liquid waste from different industries.	11	BT levels 1,2 & 3
CO4	To understand the importance of biofertilizers, its types, usage and applications in sustainable agriculture.	11	BT levels 1,2 & 3

Paper Code: RJSUBT604	Paper-IV: Environmental Biotechnology	Credits 3
Unit I	Industrial effluent treatment	15 hrs
	Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB.	
Unit II	Solid waste treatment	15 hrs
	Solid waste treatment; pollution indicators & biosensors; biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation; Use of immobilized enzymes or microbial cells for treatment	
Unit III	Wastewater treatment	
	Wastewater treatment- introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment; Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal.	
Unit IV	Hazardous waste management	15 hrs
	Biodegradation of waste from industry- Dairy; Distillery; Antibiotic industry	

SEMESTER	:	DISCIPLINE SPECIFIC ELECTIVE
TITLE OF THE SUBJECT/COURSE	:	TECHNIQUES AND AUTOMATION IN MLT
COURSE CODE	:	RJSUACMT601
CREDITS	:	3
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Gain an understanding of the basic principles used in disease diagnosis.
2	Gain critical thinking and analytical skills to understand new diagnostic Methods

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To gain knowledge about diagnostic microbiology, safety and special precautions in a clinical microbiology laboratory.	9	BT levels 1,2 & 3
CO2	To understand the role of automation in various areas like hematology, clinical biochemistry and upcoming approaches in automation.	9	BT levels 1,2 & 3
CO3	To understand the principle and significance of glucose tolerance test, thyroid function tests, hCG in pregnancy detection test and role of serum enzymes and cancer markers in diagnosis.	9	BT levels 1,2 & 3
CO4	To study and understand the significance of different organ	9	BT levels 1,2 & 3

	function tests like cardiac profile tests, Gastric function tests, Liver function tests and kidney function tests.		
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Paper Code: RJSUACM T601	Applied Component: Techniques and Automation in MLT	Credits 3
Unit I	Diagnostic Microbiology	15 hrs
	Safety and special precautions in clinical microbiology lab, Legislative and regulatory control, Infectious waste management, Methods of sterilization, Classification of biohazardous agents. Antimicrobial susceptibility testing: Selection of antimicrobial agents, Disc diffusion test, Dilution antimicrobial susceptibility test, E test, commercial systems.	
Unit II	Automation and newer approaches in MLT	15 hrs
	Automation: Semiautomated and automated identification systems for <i>Enterobacteriaceae</i> , Non fermenters, <i>Mycobacteria</i> , <i>Staphylococci</i> , Anaerobes. Automation in hematology: Automated full blood count impedance cell counters, optical cell counters, automated blood cell morphology. Automation in clinical biochemistry - Introduction, classification of automated systems, steps of automation in biochemical analysis. Commonly used automated analyzers of biochemical laboratories. Newer approaches: use of molecular techniques in diagnosis. Signal amplification methods – Nucleic acid probes, in situ hybridization; PCR and modifications of PCR; Post amplification analysis – DNA sequencing, microarray analysis; Strain typing – Pulse field gel electrophoresis, PCR- RFLP	
Unit III	Clinical Biochemistry	15 hrs
	Blood sugar level - Glucose tolerance curve and its interpretation. Evaluation methods of blood. Diabetes and its types. Enzymes in diagnostics. Thyroid tests : Introduction – determination of T-3, T-4, TSH. Cancer marker - Introduction, clinical application, enzymes as tumor markers ALP, CK, LDH, PAP, prostate specific antigens, hormones, oncofetal antigens, carbohydrates, bladder specific, breast tumor markers.	

	Pregnancy test.	
Unit IV	Organ Function Tests	15 hrs
	Cardiac Profile Test –Ischemic heart diseases and their manifestation; Groups in CPT, Lipid profile tests. Gastric function Tests – gastric analysis, tests involved. Liver function tests – Types of jaundice; abnormalities of bile pigment and acid, change in enzyme and plasma proteins and their determination. Kidney function test –Groups in KFT; test to determine renal blood flow; clearance test; Diseases of kidney.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT501 & RJSUBT502
COURSE CODE	:	RJSUBTP501
CREDITS	:	3
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Different chromatography methods that are used in separation of specific biomolecules from a mixture.
2	Validation of instruments used in the laboratory.
3	MIC of antibiotics by broth dilution method and further estimating the MLC of the antibiotic under study.
4	Use of different antibiotic sensitivity tests depending on the nature of the samples under study.
5	Synergistic action of drugs.
6	Concept of chick embryo candling and methods of inoculation.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Separation of components from a mixture using different chromatography techniques like affinity chromatography, ion exchange chromatography and Size exclusion chromatography.	6	BT levels 2, 3 & 4
CO2	Validation of different instruments like micropipette, measuring cylinder weighing balance and	6	BT levels 2, 3 & 4

	colorimeter.		
CO3	Minimum Inhibitory concentration and minimum lethal concentration of antibiotics under study.	6	BT levels 2, 3 & 4
CO4	Antibiotic sensitivity test using agar cup method, disc diffusion method and ditch plate method.	6	BT levels 2, 3 & 4
CO5	To understand the concept of synergistic action of various drugs.	6	BT levels 2, 3 & 4
CO6	Chick embryo candling and inoculation methods	3	BT levels 2, 3 & 4

Paper Code: RJSUBTP501	Practical-I: Practicals based on RJSUBT501 and RJSUBT502	Credits 3
1	Separation of components from a mixture using Affinity chromatography	
2	Separation of components from a mixture using ion exchange chromatography	
3	Separation of components from a mixture using Size exclusion chromatography	
4	Validation of micropipette, measuring cylinder weighing balance and colorimeter.	
5	MIC and MLC of antibiotic	
6	Antibiotic sensitivity test using agar cup method	
7	Antibiotic sensitivity test using paper disc method	
8	Antibiotic sensitivity test using ditch method	
9	Synergistic action of drugs	
10	Chick embryo candling and inoculation methods	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT503 & RJSUBT504
COURSE CODE	:	RJSUBTP502
CREDITS	:	3
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Transformation and selection of transformants using blue white screening method.
2	Extraction of genomic DNA from bacteria, restriction enzyme digestion and ligation of NA samples.
3	Plant tissue culture in callus induction, isolation of protoplast and preparation of cell suspension.
4	Use of DPPH assay to estimate the antioxidants extracted from marine sources.
5	Extraction and estimation of Gelatin and Collagen from marine waste.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Transformation in <i>E.coli</i> and screening by blue-white selection method.	7	BT levels 2, 3 & 4
CO2	Restriction enzyme digestion and ligation of the samples.	7	BT levels 2, 3 & 4
CO3	Extraction of Genomic DNA from bacteria.	7	BT levels 2, 3 & 4
CO4	Concept of polymerase chain reaction.	7	BT levels 2, 3 & 4
CO5	Use of methods for immobilization of plant cells.	7	BT levels 2, 3 & 4

CO6	Use of plant tissue culture techniques for callus induction and preparation of cell suspension.	8	BT levels 2, 3 & 4
CO7	Isolation of Protoplast from the given plant sample.	8	BT levels 2, 3 & 4
CO8	To carry out a bioassay of vitamin B12.	8	BT levels 2, 3 & 4
CO9	Determine the acidity of the vinegar sample.	8	BT levels 2, 3 & 4
CO10	To perform DPPH assay to estimate the quantity of antioxidant extracted from marine algae	8	BT levels 2, 3 & 4
CO11	Extraction and estimation of Gelatin / Collagen from fish scales.	8	BT levels 2, 3 & 4

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Paper Code: RJSUBTP502	Practical-II: Practicals based on RJSUBT503 and RJSUBT504	Credits 3
1	Transformation in <i>E.coli</i> and screening by blue-white selection	
2	Restriction enzyme digestion and ligation	
3	Genomic DNA extraction from bacteria	
4	Polymerase chain reaction	
5	Immobilization of plant cells	
6	Callus induction and cell suspension	
7	Isolation of Protoplast	
8	Bioassay of vitamin B12	
9	Determination of acidity of vinegar	
10	DPPH assay for antioxidant extracted from marine algae	
11	Extraction and estimation of Gelatin / Collagen	

SEMESTER	:	SUBJECT SPECIFIC ELECTIVE
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUACMT501
COURSE CODE	:	RJSUACMTP501
CREDITS	:	2
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Germ tube test for identification of <i>Candida albicans</i> .
2	Staining of blood smears for presence of malarial parasitic form.
3	Media used for isolation of pathogenic organisms.
4	Growth characteristics of pathogenic organisms like <i>S. aureus</i> , <i>E.coli</i> , <i>K. pneumoniae</i> and <i>Pseudomonas spp</i>
5	Hematological parameters used in investigation of clinical conditions.
6	Physical, chemical and microscopic methods used for examination of urine for diagnosis.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of germ tube test in identification of <i>Candida albicans</i> .	12	BT levels 2, 3 & 4
CO2	Use of blood smears staining in identification of malarial parasites	12	BT levels 2, 3 & 4
CO3	Study of different types of media used in identification of pathogenic organisms and transport media used to transport specimens.	12	BT levels 2, 3 & 4

CO4	Isolation and characterization of bacterial pathogens like <i>S. aureus</i> , <i>E.coli</i> , <i>K. pneumoniae</i> and <i>Pseudomonas spp</i>	12	BT levels 2, 3 & 4
CO5	Different pathological tests like VDRL test, ESR, PCV, Blood grouping, Cross matching and Red cell indices.	12	BT levels 2, 3 & 4
CO6	Technique of Blood collection	12	BT levels 2, 3 & 4
CO7	Methods like acid hematin and drabkin's for estimation of Hemoglobin in a patient's blood sample.	12	BT levels 2, 3 & 4
CO8	Determination of total RBC & WBC count in blood.	12	BT levels 2, 3 & 4
CO9	Differential WBC count by field's staining.	12	BT levels 2, 3 & 4
CO10	Examination of urine by Physical, Chemical, Microscopic methods.	12	BT levels 2, 3 & 4

Paper Code: RJSUACMTP5 01	Practical III - Practicals of RJSUACMT501	Credits 2
1	Identification of <i>Candida albicans</i> .	
2	Identification of Malarial parasitic forms in blood smears	
3	Study of media used in identification of pathogenic organisms	
4	Study of transport media	
5	Isolation and characterization of bacterial pathogens- a. <i>S. aureus</i> b. <i>E.coli</i> c. <i>K. pneumoniae</i> d. <i>Pseudomonas spp</i>	
6	VDRL test	
7	Blood collection	
8	Hemoglobin estimation: acid hematin and drabkin's method	
9	Total RBC & WBC count	
10	Differential WBC count	
11	ESR and PCV	
12	Red cell indices	
13	Bleeding time & clotting time	
14	Blood grouping ABO and Rh typing	
15	Cross matching	
16	Physical, Chemical, Microscopic examination of Urine	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT601 & RJSUBT602
COURSE CODE	:	RJSUBTP601
CREDITS	:	3
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Pyne's method in estimating milk proteins.
2	MBRT, RRT, Phosphatase test for estimating the quality of milk.
3	Enumeration of normal flora from raw milk and curd.
4	p-dimethyl aminobenzaldehyde to detect urea as a milk adulterant.
5	Glucose oxidase -peroxidase for determination of blood glucose from patients blood sample.
6	DCPIP for estimation of Vitamin C from food samples

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Pyne's method for estimation of milk protein.	11	BT levels 2, 3 & 4
CO2	Microbial analysis of milk by MBRT, RRT and phosphatase test.	11	BT levels 2, 3 & 4
CO3	Microscopic count of milk samples.	11	BT levels 2, 3 & 4
CO4	Enumeration of normal flora from raw milk and curd.	11	BT levels 2, 3 & 4
CO5	Determination of milk adulterants like urea.	11	BT levels 2, 3 & 4

CO6	Detection of blood glucose level to detect diabetes mellitus.	10	BT levels 2, 3 & 4
CO7	Estimation of Vitamin C from food samples by DCPIP method.	10	BT levels 2, 3 & 4

Paper Code: RJSUBTP601	Practical-I: Practicals based on RJSUBT601 and RJSUBT602	Credits 3
1	Estimation of Milk protein by Pynes method	
2	Microbial analysis of Milk by MBRT and RRT	
3	Phosphatase test in Milk	
4	Direct microscopic count of milk sample	
5	Isolation and enumeration of Normal flora from Raw Milk and curd	
6	Detection of Urea as adulterant in Milk	
7	Determination of blood glucose levels for detection of diabetes mellitus	
8	Estimation vitamin C by DCPIP method from food samples	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT603 & RJSUBT604
COURSE CODE	:	RJSUBTP602
CREDITS	:	3
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	LC50 for the given chemical on the system of model organism
2	Use of different mediums to check the sterility of the injectables.
3	Influence of heavy metals on the growth of bacteria.
4	Different physico-chemical estimation methods to check the quality of industrial effluent samples.
5	MPN method for analyzing the quality of water samples.
6	Extraction method for biopolymers from bacterial source.
7	Effluent treatment in large scale in housing colonies or industries

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Determination of LC50 value for the given chemical / effluent using chironomus larvae/ Daphnia as model system	11	BT levels 2, 3 & 4
CO2	Sterility testing of injectables.	11	BT levels 2, 3 & 4
CO3	The effect of heavy metals on the growth pattern of bacteria Study of physico-chemical parameters (pH, color, turbidity,	11	BT levels 2, 3 & 4

	BOD, COD)and Total solids of an industrial effluent sample		
CO4	Microbial analysis of water by MPN method.	11	BT levels 2, 3 & 4
CO5	Encapsulation of yeast and estimation of invertase activity	11	BT levels 2, 3 & 4
CO6	Extraction of biopolymer from bacterial source.	11	BT levels 2, 3 & 4
CO7	Visit to ETP/ CETP	12	BT levels 2, 3 & 4

Paper Code: RJSUBTP602	Practical-II: Practicals based on RJSUBT603 and RJSUBT604	Credits 3
1	Evaluation of LD 50 and LC 50	
2	Sterility testing of injectables.	
3	Study the effect of heavy metals on the growth of bacteria	
4	Determination of Total Solids from an effluent sample	
5	Study of physico-chemical parameters (pH, color, turbidity, BOD, COD) of an industrial effluent sample	
6	Microbial analysis of water by MPN method	
7	Encapsulation of yeast and estimation of invertase activity	
9	Visit to ETP/ CETP	

SEMESTER	:	DISCIPLINE SPECIFIC ELECTIVE
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUACMT601
COURSE CODE	:	RJSUACMTP601
CREDITS	:	2
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Standard antimicrobial susceptibility test technique.
2	Broth dilution method to check the MIC of the antibiotics under study.
3	Tests like SGOT, SGPT and total bilirubin to determine the functioning of the liver.
4	hCG as a marker to detect early pregnancy.
5	Glucose oxidase- peroxidase method to estimate the blood glucose level.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Antibiotic sensitivity testing by paper disc method	6	BT levels 2, 3 & 4
CO2	Minimal inhibitory concentration of the drug/ antibiotic under study.	5	BT levels 2, 3 & 4
CO3	Determine the normal functioning of the liver using serum transaminases-SGPT and SGOT.	10, 12	BT levels 2, 3 & 4
CO4	Estimate the serum and urine creatinine level in determining the normal renal function.	10, 12	BT levels 2, 3 & 4
CO5	Estimate the total bilirubin level in determining the normal functioning of the liver.	10, 12	BT levels 2, 3 & 4

CO6	Detection of pregnancy using Human chorionic gonadotropin (hCG) in urine.	10, 12	BT levels 2, 3 & 4
CO7	Determine the glucose in blood by glucose oxidase- peroxidase test.	10, 12	BT levels 2, 3 & 4
CO8	Estimation of serum cholesterol by Wybenga and Pileggi method.	10, 12	BT levels 2, 3 & 4

Paper Code: RJSUACMT60 1	Practical-: Practicals based on RJSUACMT601	Credits 2
1	Antibiotic sensitivity testing by paper disc	
2	MIC of antibiotic	
3	Estimation of SGPT	
4	Estimation of SGOT	
5	Estimation of creatinine	
6	Estimation of total bilirubin	
7	Detection of hCG in urine	
8	Estimation of blood glucose	
9	Estimation of serum cholesterol	
10	Visit to pathology laboratory	
11	Field Project	

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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 hours.
3. Students must appear for at least one of the two Internal Tests to be eligible for the Semester End Examination.
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 3 practical papers
5. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of T.Y.B.Sc. Biotechnology or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of T.Y.B.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 combined in each paper) and in 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: Written test -20 marks
 - IA 2: Written Test / Assignment / Field Trip/mini project/ & Report -20 marks
- **Semester End Examination – 60 marks**
 - Question paper covering all units
- **Course Semester End Examination in Semester V -Paper I to V (RJSUBT501 to RJSUBT504 & RJSUACMT501) and Semester VI - Paper I to V (RJSUBT601 to RJSUBT604 & RJSUACMT601)**

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
Unit 4	08	03	04	15
-TOTAL- Per objective	32	12	16	60
% WEIGHTAGE	53	20	27	100%

- **Evaluation of Practicals 300 marks with individual paper passing**
- **100 marks for each practical Sem V - RJSUBTP501, RJSUBTP502 & RJSUACMT501; Sem VI - RJSUBTP601, RJSUBTP602 & RJSUACMT601**
- 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.

T.Y.B.Sc. BIOTECHNOLOGY SEM V**Mapping of the course to employability/ Entrepreneurship/skill development**

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/ skill development	Employability/ Entrepreneurship /Skill development	Specific activity
TYBSc Biotechnology	Embryology and cancer biology	RJSUBT501	Cell Cycle, Cell Signaling, Developmental Biology, Cancer Biology	Skill development & Employability in R&D (medicine) and pathology Lab	Cell cycle phases, Cell signaling, Biology of Cancer cells
	Virology and bioanalytical techniques	RJSUBT502	Virology, Chemotherapeutic Drugs, Spectroscopy, Bioanalytical techniques	Skill development & Employability in sales and marketing, Pathology Lab, R&D	Virus cultivation, antiviral drugs, Spectroscopic, Chromatographic techniques.
	Molecular Biology	RJSUBT503	Tools in molecular biology, Gene sequencing and editing, Transgenic animals, Transgenic plants	Skill development, entrepreneurship & Employability in R&D	Genome sequencing and editing. Transgenic plants and animals.
	Applied biotechnology	RJSUBT504	Marine biotechnology & Cosmetics, Food biotechnology, Plant biotechnology, Patent and IPR	Skill development, entrepreneurship & Employability in fermentation industry and regulatory affairs, R&D	Marine and food biotechnology.
	Microbiology, Hematology and Clinical Pathology	RJSUACMT501	Bacteriology, Mycology and Parasitology, Hematology, Clinical Pathology	Skill development & Employability in path lab, epidemiology and R&D	Systemic Infections
	Practicals of	RJSUBTP501 RJSUBTP502 RJSUACMT501		Analytical skills Interpretation skills Writing skills	

T.Y.B.Sc. BIOTECHNOLOGY SEM VI**Mapping of the course to employability/ Entrepreneurship/skill development**

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/ skill development	Employability/ Entrepreneurship /Skill development	Specific activity
TYBSc Biotech- nology	Biochemistry	RJSUBT601	Carbohydrate metabolism, Lipid Metabolism , Endocrinology, Nutrition	Skill development & Employability in R & D, hospitals and QA/QC	Biosynthetic pathways and regulation of biomolecules.
	Industrial Microbiology	RJSUBT602	Milk and milk products, Fermentation process, Downstream processing, QA-QC	Skill development & entrepreneurship & Employability in fermentation / pharma industry	Downstream process
	Pharmacology and Neurochemistry	RJSUBT603	Principles of Pharmacology, Drug Absorption and Distribution, Toxicology, Neuro-chemistry	Skill development & Employability in pharma industry, QA/QC	Drug delivery and action in body
	Environmental Biotechnology	RJSUBT604	Industrial effluent treatment, Solid waste treatment, Wastewater treatment, Biofertilizers and Biopesticides	Skill development, entrepreneurship & Employability in R&D (environment)	Treatment of industrial effluent
	Techniques and Automation in MLT	RJSUACMT 601	Diagnostic microbiology, Automation and newer approaches in MLT, Clinical Biochemistry, Organ Function Tests	Skill development & Employability in pathology laboratory	Disease diagnosis and methods involved.

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/ skill development	Employability/ Entrepreneurship /Skill development	Specific activity
	Practicals of	RJSUBTP601 RJSUBTP602 RJSUACMT 601		Analytical skills Interpretation skills Writing skills	