Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the F.Y.B.Sc.

Program: B.Sc. Biotechnology

Program Code: RJSUBT

(CBCS 2019-2020)

THE PREAMBLE

Why Biotechnology?

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 encompases 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, personalised 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. Individualised 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 organises talks by eminent personalities from industry, research organisations 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 and Post Graduate Diploma in Industrial Hygiene and Safety, that our students can opt for after graduation simultaneously with post graduation or job. 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 hosts its own **Website**, 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.

Our Curriculum, Your Strength

The syllabus for Biotechnology for the total six semesters is meticulously designed so as to make students understand the principles behind the complex biological processes and their applications in the real world. The syllabus evolves from semester I to semester VI with basics and essential biological concepts explained earlier and the advanced and the current techniques towards the last semester. In the undergraduate curriculum there is a full paper on Research methodologies. Also our students are encouraged to carry out a small project of 2-3 months every year so that they get hands-on experience of doing research. We also have the topic of Entrepreneurship as a full paper in the undergraduate curriculum, this helps to enhance the entrepreneurial skills of our students. For hands-on Bioinformatics sessions the department has a computer labs with internet facility where the students can practice and can be assessed using online bioinformatics tools. As an applied component for third year graduate students in the Vth and VI th semester we offer Medical laboratory Technology (MLT). This subject introduces the students to the latest and advanced clinical and molecular diagnostic techniques making our students employable and industry ready immediately after graduation.

In our post graduate syllabii the most advanced and relevant subjects such as nanotechnology, Genomics, IPR, Bioprocess Technology, Bioinformatics, Developmental biology have been incorporated. These will make the students ready for both industry as well as research oriented endeavours. One entire semester of PG practical course work is dedicated to internship in any of the research institutions, academic institutes or industry. This gives our students an exposure to work away from the campus in the industrial set up, research set up, production set up or pharmaceutical or health care organizations and they get acquainted with the real world projects and processes. These projects also help the students to directly get employment in the field of their choice or help them get research experience useful for their future research career. We organise regular interactions of our illustrious alumni with our current UG and PG students, this provides the students guidance in their studies and assistance in internships and placements.

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 nomenclature and classification of inorganic compounds. Nature and factors affecting chemical bonds and water.
PSO2	Understand the principle, working, applications of microscopy and understand the nature and functions of stains and dyes.
PSO3	Gain insight about stereochemistry, titration and buffers. To understand concepts of calibration of glasswares.
PSO4	Understand the concepts of Biodiversity, ultrastructure of Prokaryotic and eukaryotic cells.Understand the history of microbial classification, enumeration methods and sterilization techniques.
PSO5	To understand the concepts of fundamentals of genetics, microbial genetics and population genetics.Also understand the concepts of DNA Replication and mutation.
PSO6	Gain an understanding about communication and soft skills development.
PSO7	Understand the concepts related to carbohydrates, amino acids, proteins, lipids and nucleic acids. Gain insight into physiology of plants and animals
PSO8	Gain an understanding of the basic concepts of principle, working and functions of various analytical techniques. Also understand the concepts of chemical kinetics and redox reactions.
PSO9	Understand the role of different types of environmental pollution and related issues.
PSO10	Understanding of basic immunology and biostatistics. Also understand the concepts of tissue culture and ecology.
PSO11	Gain an understanding of the basic concepts of good laboratory practices and biosafety.

DISTRIBUTION OF TOPICS AND CREDITS
F.Y.B.Sc. BIOTECHNOLOGY SEMESTER I

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT101	Paper - Basic Chemistry and Microscopy			45 hours
	I	Nomenclature and Classification	2	
	II	Chemical bond and water		
	III	Microscopy, stains and dyes		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT102	Paper - Stereochemistry and Analytical chemistry			45 hours
	I	Stereochemistry	2	
	II	Titration and Buffers		
	III	Calibration of glassware		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT103	Paper - Biodiversity			45 hours
	I	Origin of life and Biodiversity	2	
	II	Ultrastructure of Prokaryotes		
	III	Ultrastructure of Eukaryotes		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT104	Paper -Microbiology			45 hours
	I	History of microbial classification	2	
	II	Nutrition, Enumeration and preservation of		

		microorganisms		
	III	Sterilization techniques		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT105	Paper - Genetics			45 hours
	I	Fundamentals of genetics	2	
	II	Microbial genetics		
	III	Population genetics		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT106	Paper - DNA replication and Mutations			45 hours
	I	DNA Replication	2	
	II	Mutation and DNA repair		
	III	Chromosome and gene mutations		

Ability Enhancement Course

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT107	Paper - Communication and Soft Skills Development			45 hours
	I	English language & Communication skills	3	
	II	Communication skills and GD, PD		
	III	Computer basics		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSUBTP101	Practicals of RJSUBT101 & RJSUBTP102	2	30 hours
RJSUBTP102	Practicals of RJSUBT103 & RJSUBTP104	2	30 hours
RJSUBTP103	Practicals of RJSUBT105 & RJSUBTP106	2	30 hours

F.Y.B.Sc. BIOTECHNOLOGY SEMESTER II

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT201	Paper - Biomolecules			45 hours
	I	Carbohydrates	2	
	II	Amino acids and Proteins		
	III	Lipids and nucleic acids		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT202	Paper - Physical chemistry			45 hours
	I	Analytical techniques	2	
	II	Chemical kinetics		
	III	Redox reactions		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT203	Paper - Physiology			45 hours
	I	Enzymology	2	
	II	Plant Physiology		
	III	Animal Physiology		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT204	Paper - Environmental Sciences			45 hours
	I	Renewable sources of energy	2	
	II	Environmental concerns		
	III	Bioremediation		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT205	Paper - Tissue culture and Ecology			45 hours
	I	Animal tissue culture	2	
	II	Plant tissue culture		
	III	Ecology		

Core subject

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT206	Paper - Basic Immunology and Biostatistics			45 hours
	I	Innate Immunity	2	
	II	Acquired Immunity and antigens		
	III	Biostatistics		

Ability Enhancement Course

Course Code	Unit	Topic Headings	Credits	Duration
RJSUBT207	Paper - Good laboratory practices and Biosafety			45 hours
	I	Introduction to Safety	3	
	II	Good laboratory Practices & Biosafety guidelines		
	III	Sterile pharmaceutical products, Factory and hospital hygiene		

Core subject practicals

Course Code	Topic Headings	Credits	Duration
RJSUBTP201	Practicals of RJSUBT201 & RJSUBTP202	2	30 hours
RJSUBTP202	Practicals of RJSUBT203 & RJSUBTP204	2	30 hours
RJSUBTP203	Practicals of RJSUBT205 & RJSUBTP206	2	30 hours

SYLLABUS GRID

YEAR	SEMESTER	CORE SUBJECT						APPLIED COMPONENT	ABILITY ENHANCEMENT COURSE	SKILL ENHANCEMENT COURSE (SEC)	DISCIPLINE SPECIFIC ELECTIVE (DSE)	PRACTICALS	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	:	BASIC CHEMISTRY AND MICROSCOPY
COURSE CODE	:	RJSUBT101
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Classify and name inorganic and organic compounds based on IUPAC system
2	Understand various chemical bonds and the role of water in biology.
3	Understand the role of stains and dyes in observing microscopic organisms.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Introduction to nomenclature and classification systems of organic and inorganic compounds. Let them understand and learn Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds, Alkanes, Alkenes, Alkynes, Cyclic hydrocarbons, Aromatic compounds, Alcohols and Ethers, Aldehydes and Ketones, Carboxylic acids and its derivatives, Amines, Amides, Alkyl halides and Heterocyclic compounds.	1	BT level 1 & 2
CO2	Introduction to different types of chemical bonds with respect to their formation, stability and role in biological compounds. and also to inculcate the understanding of properties of water and its role as solvent, electrolyte, reactant and medium for flourishing of life.	1	BT level 1 & 2
CO3	Introduction to principle, parts, and applications of a microscope which	2	BT level 1 & 2

	is one of the most important tools in biotechnology. Also illustrate to students how resolution and contrast can be enhanced by explaining the working of Bright field microscope, Dark field and Phase contrast microscope. Also introduce students to concepts of dye, chromogens, chromophores, fixatives, mordants, different types of staining methods like simple, differential & Acid-fast staining methods.		

Paper Code: RJSUBT101	**Paper-I: Basic Chemistry and microscopy**	**Credits 2**
Unit I	Nomenclature and Classification	15 hrs
	Nomenclature and Classification of Inorganic Compounds: Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds. Nomenclature and Classification of Organic Compounds: Alkanes, Alkenes, Alkynes, Cyclic hydrocarbons, Aromatic compounds, Alcohols & Ethers, Aldehydes & Ketones, Carboxylic acids and its derivatives, Amines, Amides, Alkyl halides and Heterocyclic compounds.	
Unit II	Chemical Bonds and Water	15 hrs
	Nature & factors affecting - Ionic bond, Covalent Bond (structure of methane & water), Non Covalent bonds & hydrophobic interactions. Water: Properties of Water, weak interactions of molecules in water, ionization of water, water as reactant, water as a medium for life.	
Unit III	Microscopy, Stains and Dyes	15 hrs
	Principle, Parts, functions and applications of - Bright field microscope, Dark field and Phase contrast microscope. Stains and staining solutions-Definition of dye and chromogen. Structure of dye and chromophore. Functions of mordant and fixative. Natural and synthetic dyes. Simple staining, Differential staining and Acid fast staining with specific examples.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	STEREOCHEMISTRY AND ANALYTICAL CHEMISTRY
COURSE CODE	:	RJSUBT102
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Understand the concept of structure and conformation of molecules.
2	Describe the use of titrations, pH and buffers.
3	Know the methods for Calibration of lab equipment and preparation of standard solutions

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce the basics of stereochemistry - chirality, asymmetric carbon and types of isomerism, conformation and configuration. Understanding of how various projection formulas represent configuration of compounds and their interconversion.	3	BT level 1 & 2
CO2	To acquaint students with concepts of titrimetric analytical method, buffers and use of Henderson-Hasselbach equation for preparation of solutions of specific pH.	3	BT level 1,2 & 3
CO3	To understand the need and concept of Calibration of glasswares in Biotechnology, use of measurements and chemical calculations to express the concentration of solutions in different units like molarity, normality etc in analytical chemistry.	3	BT level 1 & 2

Paper Code: RJSUBT102	**Paper-II: Stereo and Analytical Chemistry**	**Credits 2**
Unit I	Stereochemistry	15 hrs
	Isomerism – Types of isomerism; Geometric Isomerism and Optical Isomerism, asymmetric carbon atom, stereogenic/ chiral centers, chirality. Conformation and Configuration , Difference between configuration and conformation. Representation of configuration by "flying wedge formula". Projection formulae – Fischer, Newman and Sawhorse. The interconversion of the formulae.	
Unit II	Titration and Buffers	15 hrs
	Titrimetric Analysis: Titration, Titrant, titrand, End point, Equivalence point, Titration Error, Indicator, Primary and Secondary standards characteristics and examples Types of Titration –Acid –Base, Redox, Precipitation, Complexometric titration. Titration curve and end point evaluation. Theory of Acid – Base Indicators, Choice and suitability of Indicators. pH – Henderson-Hasselbach equation, pH meter Buffer solutions – Concept of Buffers, Types of buffers Derivation of Henderson equation for acidic and Basic buffers, Buffer action, Buffer capacity.	
Unit III	Calibration of glasswares	15 hrs
	Calibration of pipette, volumetric flask, burette. Measurements in analytical chemistry - SI units-fundamental units, derived units. Chemical calculations – expressing concentration of solutions – normality, molarity, molality, mole fraction, weight ratio, volume ratio, weight to volume ratio, ppb, ppm, millimoles, milliequivalents.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIODIVERSITY
COURSE CODE	:	RJSUBT103
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	The process of origin of life and diversity in microbiology.
2	The basic structure and functions of prokaryotic cells
3	The ultrastructure and functions of subcellular organelles of eukaryotic cells and cell cycle.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce concept of origin of life, chemical and biological evolution, microbial diversity, properties of viruses	3	BT level 1 & 2
CO2	To acquaint students with ultrastructure of prokaryotic cells.	3	BT level 1,2 & 3
CO3	To understand the ultrastructure of a eukaryotic cell and cell cycle.	3	BT level 1 & 2

Paper Code: RJSUBT103	**Paper-III: Biodiversity**	**Credits 2**
Unit I	Origin of Life & Biodiversity	15 hrs
	Origin of Life, Chemical and Biological Evolution, Origin of Eukaryotic cells. Microbial Diversity - Archaebacteria, Eubacteria, Blue-green Algae, Actinomycetes, Eumycota. Virus properties; General structure of viruses – bacteriophage, plant and animal virus, basic classification.	
Unit II	Ultrastructure of Prokaryotic Cell	15 hrs
	Concept of Cell Shape and Size. Detail structure of Cell Wall (Gram Positive and Negative), Cell Membrane and Genetic Material, Reserve/ Storage Bodies, Ribosomes, Mesosomes and Spores. External Cell Coverings: Cilia, Flagella, Pilli, Capsule.	
Unit III	Ultrastructure of Eukaryotic Cell	15 hrs
	Plasma membrane, Cytoplasmic Matrix, cytoskeleton, Mitochondria and Chloroplasts, Endoplasmic Reticulum, Golgi Apparatus, Lysosome, Proteasome, Nucleus –Nuclear Structure, Nucleolus. Cell cycle and checkpoints	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	MICROBIOLOGY
COURSE CODE	:	RJSUBT104
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Know the principles behind different growth media for growing microorganisms.
2	Use different methods for enumeration of viable and non-viable microorganisms.
3	Understand the significance and methods of sterilization and disinfection.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To acquaint the students with the history of microbiology, spontaneous generation, germ theory, developments in the chemotherapy, microbiology and methods of microbial classification and identification.	4	BT level 1 & 2
CO2	To introduce students to the concept of microbial nutritional requirements and how different types of culture media, isolation techniques to grow pure microbial culture. Also to acquaint students with various microbial enumeration and preservation methods.	4	BT level 1 & 2

CO3	To elaborate the concept of sterilization and disinfection so that students understand pros and cons of various sterilization methods and disinfectants.	4	BT level 1,2 & 3

Paper Code: RJSUBT104	**Paper-IV:Microbiology**	**Credits 2**
Unit I	History of microbial classification	15 hrs
	Brief history of microbiology, spontaneous generation, golden age of microbiology, birth of chemotherapy, developments in microbiology. Taxonomic hierarchy, classification of prokaryotes and eukaryotes; methods of microbial classification and identification.	
Unit II	Nutrition, Enumeration and preservation of microorganisms	15 hrs
	Nutritional Requirements, Classification based on Nutrition. Types of Culture Media, Concept and Methods of Isolation, Pure Culture Techniques. Enumeration of Microorganisms- Direct and Indirect Methods. Preservation of Cultures- Principle, Methods, advantages and limitations.	
Unit III	Sterilization techniques	15 hrs
	Types and Applications of Sterilization -Physical and chemical methods. Ideal Disinfectant - Examples of Disinfectants and evaluation of Disinfectant.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	GENETICS
COURSE CODE	:	RJSUBT105
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Understand fundamentals of Mendelian genetics
2	Understand methods of gene exchange in bacteria.
3	Understand the concepts of Population Genetics and apply it in conservation biology

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To go beyond Mendelian inheritance and understand the concept of genetic interaction, epistatic interactions, multiple alleles and inheritance of blood groups in man. To understand how multiple genes are involved in inheritance of quantitative characters and their cumulative effect on expression of the character.	5	BT level 1,2 & 3
CO2	To acquaint students with the mechanisms of genetic exchange methods in bacteria and their applications.	5	BT level 1,2 & 3
CO3	To introduce students to concepts of genetic structure of populations,	5	BT level 1,2 & 3

	Hardy- Weinberg law & its assumptions and factors used for measuring genetic variation and how population genetics can be used in conservation biology.		

Paper Code: RJSUBT105	**Paper V- Genetics**	**Credits 2**
Unit I	Fundamentals of genetics	15 hrs
	Mendel's Laws of heredity; Monohybrid cross; Dihybrid cross. Incomplete dominance and codominance; Environmental effect on the expression of genes; Gene Interaction; Epistasis.	
Unit II	Microbial genetics	15 hrs
	Mechanism of genetic exchange in Bacteria: Conjugation; Transformation. Transduction; (Generalized transduction, Specialized Transduction); transposable elements.	
Unit III	Population genetics	15 hrs
	Genetic structure of populations – genotypic frequencies and allelic frequencies; Hardy- Weinberg law and its assumptions; Genetic variations in populations - Measuring genetic variation, Natural Selection. Genetic Drift; Speciation. Role of population genetics in Conservation biology.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	DNA REPLICATION AND MUTATIONS
COURSE CODE	:	RJSUBT106
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Learn the molecular details of DNA replication
2	Understand the reasons for DNA mutations and mechanism of DNA repair.
3	Understand chromosomal aberrations and disorders associated with gene mutations

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To understand the process of DNA replication in prokaryotes and eukaryotes with respect to semiconservative replication, proteins and enzymes involved in replication.	5	BT level 1 & 2
CO2	To acquaint students with definitions and types of mutations, mutagens and repairing mechanisms.	5	BT level 1,2 & 3
CO3	To introduce students to concepts of chromosomal mutations with respect to number and structure and how it can be used in diagnosis of chromosomal disorders.	5	BT level 1,2 & 3

Paper Code: RJSUBT106	**Paper-VI: DNA Replication and mutations**	**Credits 2**
Unit I	DNA Replication	15 hrs
	DNA replication in prokaryotes - Semi-conservative DNA replication, DNA polymerases and its role, Bidirectional Replication of circular DNA molecules, Rolling circle replication. DNA replication in Eukaryotes, DNA recombination–Holliday model for Recombination.	
Unit II	Mutation and DNA repair	15 hrs
	Definition and Types of Mutations. Physical, Chemical and Biological Mutagens – examples and mode of action. DNA repair: Photoreversal, Base Excision, Nucleotide Excision, Mismatch, SOS and Recombination Repair.	
Unit III	Chromosome and gene mutations	15 hrs
	Variation in Chromosomal Structure : Deletion, Duplication, Inversion, Translocation. Variation in Chromosome Number: Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	COMMUNICATION AND SOFT SKILLS DEVELOPMENT
COURSE CODE	:	RJSUBT107
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Demonstrate corporate etiquettes and build professional competencies
2	Use computers, create documents effectively.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To acquaint the students to Computer basics and Web page designing.	6	BT level 1,2 & 3
CO2	To introduce students to fundamentals, working and applications of Word, Spreadsheets and Presentations softwares.	6	BT level 1,2 & 3

Paper Code: RJSUBT107	**Paper VII- Communication and Soft Skills Development**	**Credits 3**
Unit I	English language Skills	15 hrs
	Grammar, pronunciation, improving writing skills – letter writing, SOP writing. Listening skills.	
Unit II	Communication skills and GD, PD	15 hrs
	Recitation of short stories, interview skills, group discussion, social conversation skills, presentation skills and grooming for corporate.	
Unit III	Computer basics	15 hrs
	Word Processing - Basic Operations, Creating and Editing documents, Formatting documents. Spreadsheet - Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions. Presentation Graphics - Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics. Personal Information Manager - Setting up a new email account in - Microsoft Outlook Sending, receiving, replying, forwarding, mail messages Including a signature in outgoing messages. Creating a web page	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BIOMOLECULES
COURSE CODE	:	RJSUBT201
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Describe the structure and functions of various carbohydrates.
2	Understand protein structure and conformations.
3	Understand the classification, structure and role of lipids and nucleic acids.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce students to properties, classifications, functions and detection methods of carbohydrates.	7	BT level 1 & 2
CO2	To introduce students to properties, various conformations, functions and analytical methods of proteins.	7	BT level 1 & 2
CO3	To acquaint students with structure, functions and types of lipids and nucleic acids.	7	BT level 1,2 & 3

Paper Code: RJSUBT201	**Paper-I: Biomolecules**	**Credits 2**
Unit I	Carbohydrates	15 hrs
	Structure, isomers, properties of carbohydrates. Physical and chemical reactions for detection of monosaccharide, disaccharides, and polysaccharides.	
Unit II	Amino acids and Proteins	15 hrs
	Classification and properties of amino acids, zwitterion, isoelectric point, Titration curve of amino acids, Reactions of amino acids, Structure of peptides.Proteins: Classification based on structure and functions, N-terminal and C-terminal analysis, Denaturation of protein, Glycoproteins.	
Unit III	Lipids and Nucleic acids	15 hrs
	Lipids: Classification of Lipids, structure and properties of saturated, unsaturated fatty acids, rancidity, and hydrogenation of oils; Structure and function of Phospholipids, Action of phospholipases; Triacylglycerol; Sterols; Lipoproteins. Nucleic Acids: Structure of Purine and Pyrimidine bases, nucleosides nucleotides and polynucleotides.Properties and types of DNA, RNA	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PHYSICAL CHEMISTRY
COURSE CODE	:	RJSUBT202
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Describe the methods of separation of molecules from a mixture
2	Understand the kinetics of chemical reactions
3	Understand the mechanism of redox reactions

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce students to the principle and application of various bioanalytical techniques Precipitation, Filtration, Distillation and Solvent Extraction, Chromatography, Colorimetry, Centrifugation.	8	BT level 1 & 2
CO2	To introduce students to concepts of chemical kinetics and its applications.	8	BT level 1 & 2
CO3	To acquaint students with Principles of Oxidation & Reduction Reactions, oxidation number and methods of balancing the redox reactions.	8	BT level 1,2 & 3

Paper Code: RJSUBT202	**Paper-II: Physical chemistry**	**Credits 2**
Unit I	Analytical techniques	15 hrs
	Methods of Separation - Precipitation, Filtration, Distillation and Solvent Extraction. Chromatography: Principles, Types; Paper Chromatography; Thin Layer Chromatography and its Applications. Colorimetry: Beer-Lambert's law and its limitations, working, applications of Colorimeter.Centrifugation - Basic Principles of sedimentation, Preparative- Differential and density gradient	
Unit II	Chemical Kinetics	15 hrs
	Reaction kinetics: Rate of Reaction, rate constant, Measurement of Reaction Rates Order & Molecularity of reaction, Integrated rate equation of first and second order reactions.Determination of order of reaction by Integration method, Graphical Method, Ostwald's Isolation Method and Half Time method.	
Unit III	Redox reactions	15 hrs
	Principles of Oxidation & Reduction Reactions - Oxidizing and Reducing agents. Oxidation number, Rules to assign Oxidation numbers with examples. Balancing redox reactions by ion electron method.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PHYSIOLOGY
COURSE CODE	:	RJSUBT203
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Classify enzymes and understand the kinetics of enzyme catalyzed reactions.
2	Understand the chemical basis of photosynthesis and functions of plant growth regulators
3	Understand the physiology of various systems in animals

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce students to concepts of need of catalyst, properties, classification system, working mechanism and application of enzymes	7	BT level 1 & 2
CO2	To describe in detail the process of photosynthesis, photorespiration. Also to give an account of properties and role of phytohormones.	7	BT level 1 & 2
CO3	To acquaint students with the mechanism of respiration, circulation, excretion and digestion.	7	BT level 1 & 2

Paper Code: RJSUBT203	**Paper-III: Physiology**	**Credits 2**
Unit I	Enzymology	15 hrs
	Enzyme Classification, Nomenclature, Properties of Enzymes, Mechanism of Enzyme action, Active sites, Enzyme specificity, Effect of pH, Temperature, substrate concentration on enzyme activity, enzyme kinetics, types of enzyme inhibitions.Zymogens, isoenzymes, Immobilized Enzymes, Application of enzymes.	
Unit II	Plant Physiology	15 hrs
	Fundamental reactions of photosynthesis, photosynthetic pigments, Hill reaction and its significance, light reactions, cyclic and non-cyclic photoinduced electron flow. Photorespiration, Functions of Plant hormones - Auxin, Cytokinins, Gibberellin, Ethylene and Abscissic acid.	
Unit III	Animal Physiology	15 hrs
	Respiration – Mechanism, Physical principles of gaseous exchange. Mechanism and working of heart. Digestion and absorption. Animals Excretion and Osmoregulation	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	ENVIRONMENTAL SCIENCES
COURSE CODE	:	RJSUBT204
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Gain an understanding of the causes, types and control methods for Environmental Pollution.
2	Understand global environmental concerns and find solutions for the same.
3	Use microorganisms and plants for environmental remediation.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To give a detailed account of various renewable sources of energy that can be used as an alternative to non renewable sources of energy.	9	BT level 1 & 2
CO2	To explain reasons and effects of environmental concerns like greenhouse effect, global warming, ozone depletion, acid rain and also the preventive measures to reduce the damage to earth.	9	BT level 1, 2 & 3
CO3	To acquaint students with principles,applications and pros & cons of various bioremediation methods	9	BT level 1, 2 & 3

Paper Code: RJSUBT204	**Paper-IV: Environmental Sciences**	**Credits 2**
Unit I	Renewable sources of energy	15 hrs
	Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy. Biogas technology- biogas plant & types, biodigester. Biogas composition, production and factors affecting production, uses; Biofuels – ethanol production. Microbial hydrogen production.	
Unit II	Environmental concerns	15 hrs
	GreenHouse Effect: Factors Responsible for GreenHouse Effect; GreenHouse Gases. Global Warming. Ozone Depletion; Kyoto Protocol; UV Radiation; Acid Rain.	
Unit III	Bioremediation	15 hrs
	Concept of Bioremediation. Microorganisms in Bioremediation, Mycoremediation and Phytoremediation.Bioremediation Technologies. Measuring Bioremediation in the Field. Bioaugmentation and Biostimulation. Monitoring the Efficacy of Bioremediation.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	TISSUE CULTURE AND ECOLOGY
COURSE CODE	:	RJSUBT205
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Understand the basic culturing techniques of animal cell culture.
2	Understand aseptic techniques involved in plant tissue culturing and perform culturing under sterile conditions.
3	Understand functioning of ecosystem and biogeochemical cycles.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To give a detailed account of fundamentals of animal tissue culture, lab requirements, applications and future prospects	10	BT level 1, 2 & 3
CO2	To understand the difference between conventional plant breeding and plant tissue culturing in the lab with respect to media, laboratory, applications and pros & cons.	10	BT level 1, 2 & 3
CO3	To introduce students to concepts of components of ecosystem, food chain, ecological interactions and biogeochemical cycles to understand the working of ecosystems.	10	BT level 1, 2 & 3

Paper Code: RJSUBT205	**Paper-V: Tissue culture and ecology**	**Credits 2**
Unit I	Animal Tissue Culture	15 hrs
	Organization of animal cell culture laboratory, equipment and glassware, tissue culture media. Establishment and maintenance of primary cell cultures of adherent and non-adherent cell lines with examples. Applications of ATC.	
Unit II	Plant Tissue Culture	15 hrs
	Basic structure and growth of plant, conventional plant breeding, history, types of culture, tissue culture media, media preparation. Basic technique in PTC, micropropagation, callus culture, cell culture, virus free plants. applications of PTC	
Unit III	Ecology	15 hrs
	Ecology and Biogeography. Structure and Function of Ecosystems. Aquatic and terrestrial ecosystems, Biotic and Abiotic factors, Trophic levels, Food chain and Food web, Ecological Pyramids, Ecological Interactions. Biogeochemical cycles: water, Carbon, Oxygen, Nitrogen and Sulphur.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	BASIC IMMUNOLOGY AND BIOSTATISTICS
COURSE CODE	:	RJSUBT206
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Differentiate between innate and acquired immunity
2	Understand the different functional units of immune system in the body
3	Apply statistical tools in data analysis.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To acquaint students with the properties and role of various line of defense and its associated cells & organs in innate immunity	10	BT level 1, 2 & 3
CO2	To introduce students to the concepts of immunogen and antigen and also to explain the types of acquired immunity and its comparison with innate immunity.	10	BT level 1, 2 & 3
CO3	To understand the concepts of various statistical analytical tools and its applications in biotechnology.	10	BT level 1, 2 & 3

Paper Code: RJSUBT206	**Paper-VI: Basic Immunology and Biostatistics**	**Credits 2**
Unit I	Innate Immunity	15 hrs
	Innate immunity - types, first line of defense, second line of defense, phagocytosis and inflammation. Cells of the immune system - Hematopoiesis, structure and function. Organs of immune system - Primary and Secondary lymphoid organs: structure and function	
Unit II	Acquired Immunity and antigens	15 hrs
	Acquired immunity, Humoral and Cell mediated immunity, Local and Herd Immunity. Antigens – Types, General properties of antigens, Haptens and Superantigens.	
Unit III	Biostatistics	15 hrs
	Types of Data, Normal and Frequency Distribution, Representation of Data and Graphs, Types of population sampling Measures of Central tendency for Raw, Ungroup & group Data. Central tendencies, Measures of Dispersion Range, Variance, Coefficient of Variance. Standard Derivation. Standard Error.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	GOOD LABORATORY PRACTICES AND BIOSAFETY
COURSE CODE	:	RJSUBT207
CREDITS	:	02
DURATION	:	45 HOURS

LEARNING OBJECTIVES	
1	Understand the importance of biosafety at different levels
2	Learn and implement the biosafety guidelines in India.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	To introduce students to laboratory safety measures in academia and industry with respect to potential biohazards posed by the microbes, GMOs.	11	BT level 1, 2 & 3
CO2	To understand the requirements and applications of sterile products and Environmental cleanliness & hygiene.	11	BT level 1, 2 & 3

Paper Code: RJSUBT207	**Paper-VII: Good Laboratory Practices and Biosafety**	**Credits 3**
Unit I	Introduction to Safety	15 hrs
	Introduction to biosafety, biosafety considerations in fermentation biotechnology. Containment: Physical - BLI, II, III, IV and biological – prokaryotes and GMO. Biosafety with respect to recombinant DNA technology. Biosafety guidelines and regulations, Biosafety guidelines in India.	
Unit II	Good laboratory practices & biosafety guidelines	15 hrs
	GLP – Concept, Practice, Guidelines; Documentation of Laboratory work; Preparation of Standard Operating Procedures; Calibration records; Validation of methods; Documentation of results; Audits & Audit reports. Emergency procedures for microbiological laboratories..	
Unit III	Sterile pharmaceutical products factory and hospital hygiene	15 hrs
	Types of sterile product, sterilization consideration, Quality control and quality assurance of sterile products. Definition, control of microbial contamination during manufacture, manufacture of sterile products, guide to good pharmaceutical manufacturing practice. Environmental cleanliness and hygiene, clean and aseptic areas.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT101 & RJSUBT102
COURSE CODE	:	RJSUBTP101
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Preparation of solutions of specific strength and standardization
2	Preparation of buffers and validation of pH
3	Calibration and validation of glasswares for validation of the results
4	Understanding of working of microscopes
5	Preparation of smear and staining for examination

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Preparation of 0.1 N sodium thiosulphate standard solution and would learn the concept of normality and dilutions.	1	BT levels 2,3 & 4
CO2	Concept of molarity and methods of standardization of standard solutions.	1,3	BT levels 2,3 & 4
CO3	Preparation of phosphate buffer, pH 7.4 and it would help students to learn how to prepare a buffer of a specific strength and pH , how to use Henderson equation for the calculation and validate the pH	1	BT levels 2,3 & 4

	using pH meter.		
CO4	Determination of strength of HCl in commercial samples and it would allow students to learn about methods that can be used for determination of acidity of any sample and validate the claim.	1	BT levels 2,3 & 4
CO5	Calibration and validation of glass pipette and burette which would allow better understanding of analytical approaches and to how to increase the accuracy and precision in results.	3	BT levels 2,3 & 4
CO6	Calibration and validation of volumetric flask and would help students to prepare the standard solutions with minimum error in concentrations.	3	BT levels 2,3 & 4
CO7	Handling of the microscope Preparation of the smear, monochrome staining and morphological observation.	2	BT levels 2,3 & 4

Paper Code: RJSUBTP101	**Practical-I: Practicals based on RJSUBT101 and RJSUBT102**	**Credits 2**
1	Preparation of 0.1 N sodium thiosulphate standard solution	
2	Preparation of 0.1M NaOH solution and standardization	
3	Preparation of phosphate buffer, pH 7.4	
4	Determination of strength of HCl in commercial sample	
5	Calibration and validation of glass pipette and burette.	
6	Calibration and validation of volumetric flask.	
7	Study of simple and compound microscope	
8	Monochrome staining	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT102 & RJSUBT103
COURSE CODE	:	RJSUBTP102
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Equipments and instruments of a Biotechnology lab
2	Use of Gram staining to differentiate between Gram Positive and Gram Negative organisms
3	Use of staining method to study cell wall
4	Use of staining method for detection of capsule
5	Use of aseptic technique for contamination free results
6	Isolated colonies in microbiological studies
7	Effect of pH and temperature on microbes
8	Pros and cons of various enumeration methods
9	Data presentation with the help of frequency distribution, graphical representation of data- frequency polygon, histogram, pie chart.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Working and applications of instruments - Autoclave, Hot air oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, pH meter and colorimeter in a biotechnology lab	8	BT levels 2,3 & 4
CO2	Use of primary & secondary stains, decolorization of smears and mordants	2	BT levels 2,3 & 4
CO3	Use of set of stains to visualize the cell wall	2	BT levels 2,3 & 4
CO4	Aseptic area, how burners can be used to create the aseptic area and transferring without contamination of the sterile media	8	BT levels 2,3 & 4
CO5	Various isolation techniques like T method, pentagonal method, 4-Quadrant method for obtaining isolated colonies.	8	BT levels 2,3 & 4
CO6	Inoculation in different tubes, incubation at different temperature, observation of the growth and conclusion of optimum conditions for a particular culture	8	BT levels 2,3 & 4
CO7	Various enumeration techniques, ● Making of Breed's count slide, use of reference counting chart and calculation of cell density	8	BT levels 2,3 & 4

	using cells count and area of the field. ● Use of nephelometric tubes for cell density determination ● Serially dilute the stock culture to get countable colonies. ● Pouring plate technique , handling of the media butt. ● Spreading of the culture on the medium with spreader		

Paper Code: RJSUBTP102	**Practical-II: Practicals based on RJSUBT103 and RJSUBT104**	**Credits 2**
1	Study of Laboratory Instruments - Autoclave, Hot air oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, pH meter and colorimeter	
2	Gram staining	
3	Bacterial cell wall staining	
4	Capsule staining	
5	Aseptic transfer technique	
6	Isolation of Organisms	
7	Effect of temperature and pH on growth of bacteria	
8	Enumeration techniques a. Breed's count b. Opacity tube - Nephelometer c. Serial Dilution d. Pour plate e. Spread plate	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT105 & RJSUBT106
COURSE CODE	:	RJSUBTP103
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Effect of UV radiation on organisms
2	Antibiotic resistant organisms and replica plate technique
3	Isolation of antibacterial agents resistant using gradient plate technique
4	ABO & Rh Blood group antigens and agglutination reaction
5	Use of karyotype in cytological study of chromosome
6	Laws of dominance, Law of segregation, Law of independent assortment & test cross, monohybrid, dihybrid
7	Properties of Mobile genetic elements

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Use of UV radiation as mutagen and calculation of % survival rate.	8	BT levels 2,3 & 4
CO2	Use of replica plate technique to differentiate between antibiotic resistant and sensitive organisms	9	BT levels 2,3 & 4
CO3	Preparation of gradient plate with antibacterial agent for obtaining resistant organisms.	9	BT levels 2,3 & 4
CO4	Use of slide agglutination method to determine blood groups	9	BT levels 2,3 & 4
CO5	Organization of karyotype to diagnose chromosomal aberration disorders	5	BT levels 2,3 & 4
CO6	Solving problems based on mendelian genetics	5	BT levels 2,3 & 4
CO7	Use of maize as the model organism to study the effect of transposons	9	BT levels 2,3 & 4

Paper Code: RJSUBTP103	**Practical-III: Practicals based on RJSUBT105 and RJSUBT106**	**Credits 2**
1	Study the effect of UV radiation as a mutagenic agent.	
2	Isolation of antibiotic resistant mutants using replica plate technique	
3	Gradient plate technique.	
4	Study of Human Blood Groups	
5	Study of Chromosomal Aberration Syndromes using karyotype for Trisomy 21, Trisomy 13, Trisomy 18, Klinefelter, Turner and Cri-du-Chat.	
6	Problems based on Mendelian genetics	
7	Study of transposable element in maize	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT201 & RJSUBT202
COURSE CODE	:	RJSUBTP201
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Principle, advantages and limitations of qualitative tests that can be used for detection of biological macromolecules
2	Use of absorption maxima and Beer-Lambert's Law in analytical study
3	Use of DNSA method for quantitative study of Carbohydrates
4	Use of Folin Lowry method for quantitative study of proteins
5	Principle of normal phase paper chromatography and use of Rf value.
6	Basics of Chemical kinetics, factors affecting the reaction
7	How to calculate order of reaction and rate constant

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Principle and experimental setup for qualitative study of monomeric and polymeric biological macromolecules	4	BT levels 2,3 & 4
CO2	Use of light absorption property by a molecule for its analytical study with respect to absorption maxima and degree of absorption on the basis of concentration and path length (Beer Lambert's Law)	8	BT levels 2,3 & 4
CO3	Preparation of different concentrations of stock glucose solutions using diluent and its quantitative estimation by DNSA using reducing property of the sugars. Students will also learn to extrapolate the graph for determination of sugar concentration in unknown solutions.	2	BT levels 2,3 & 4
CO4	Use of CuSO4 & reducing property of aromatic amino acid residues for quantitative study of proteins.	2	BT levels 2,3 & 4
CO5	Differential separation of amino	7	BT levels 2,3 & 4

	acids on the basis of the polarities and their interaction with mobile phase and stationary phase. Students would also learn to calculate Rf values and its significance.		
CO6	Rate constant and how it can be calculated graphically using hydrolysis of ester using an example.	2	BT levels 2,3 & 4
CO7	Fundamentals of kinetic reaction using of reaction between thiosulphate ion and HCl as an example.	2	BT levels 2,3 & 4
CO8	Order of reaction and how it can be calculated graphically using potassium persulphate and potassium iodide reaction using an example.	2	BT levels 2,3 & 4

Paper Code: RJSUBTP201	**Practical I: Practicals based on RJSUBT201 and RJSUBT202**	**Credits 2**
1	Qualitative test for biomolecules – carbohydrates, lipids, amino acids, proteins, RNA and DNA	
2	Determination of absorption maxima and verification of Beer Lambert's Law	
3	Estimation of Reducing sugar by DNSA method	
4	Estimation of Protein by Lowry method	
5	Separation of amino acids by paper chromatography	
6	Determine the rate constant for hydrolysis of ester using HCl as a catalyst	
7	Study the kinetics of reaction between thiosulphate ion and HCl	
8	Study reaction between potassium persulphate and potassium iodide kinetically and hence to determine order of reaction	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT203 & RJSUBT204
COURSE CODE	:	RJSUBTP202
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Basics of enzymology and how to setup qualitative tests for enzymes
2	Significance of Optimum pH and Optimum temperature for an enzymatic reaction.
3	Determination of Vmax & Km of an enzymatic reaction
4	Photophosphorylation and its use in validation of Hill's reaction
5	How to determine air quality by comparing solid impaction rate

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Concepts of enzyme, substrate, product and detection of an enzymatic reaction using qualitative enzymatic reactions catalysed by urease, dehydrogenase, catalase and invertase as examples.	3	BT levels 2,3 & 4
CO2	Effect of pH and temperature on enzyme structure and thus on the rate of the reaction.	3	BT levels 2,3 & 4
CO3	Use of different substrate concentrations to determine effect of substrate on enzymatic reaction which would be confirmed by	3	BT levels 2,3 & 4

	plotting Michaelis -Menten & Lineweaver-Burk Graphs and calculating Km and Vmax of the reaction.		
CO4	Extraction of leaf extract and studying reduction of artificial electron acceptor DCPIP to colorimetrically analyse the degree of phosphorylation.	10	BT levels 2,3 & 4
CO5	Exposing different culture media to air and studying the number & types of colonies for determination of sedimentation rate and microbial load in the air.	10	BT levels 2,3 & 4

Paper Code: RJSUBTP202	**Practical I: Practicals based on RJSUBT203 and RJSUBT204**	**Credits 2**
1	Qualitative test for enzymes – Urease, catalase, invertase and dehydrogenase	
2	Enzyme Kinetics : Effect of pH and temperature on enzyme activity	
3	Study of Effect of Substrate Concentration on enzyme activity and determination of Vmax and Km	
4	Study of Hill's reaction	
5	Determination of air quality by Solid impaction method.	

SEMESTER	:	CORE SUBJECT
TITLE OF THE SUBJECT/COURSE	:	PRACTICALS OF RJSUBT205 & RJSUBT206
COURSE CODE	:	RJSUBTP203
CREDITS	:	2
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	Components, preparation and sterilization of a PTC media
2	Use of germinated seeds as explant and aseptic Seed germination technique
3	Use of trypsinization and haemocytometer in animal tissue culture.
4	Data presentation with the help of frequency distribution, graphical representation of data- frequency polygon, histogram, pie chart.
5	To find the central tendency for any given data and calculation of standard deviation.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Preparation of PTC media using macronutrients and micronutrients, use of different sterilization methods depending on the property of the nutrients. How to dilute stock solutions to prepare the working media.	10	BT levels 2,3 & 4
CO2	Steps of seed surface sterilization and how to germinate seeds aseptically which can be later used for PTC experiment as explant.	10	BT levels 2,3 & 4

CO3	Principle of trypsinization and use of haemocytometer to enumerate the viable cells using trypan blue as exclusion dye.	10	BT levels 2,3 & 4
CO4	Types of statistical data and presentation using Polygon, Histogram and Pie Diagram	10	BT levels 2,3 & 4
CO5	Basics of biostatistics, sampling, central tendency calculation of mean, median and mode and calculation of standard deviation.	10	BT levels 2,3 & 4

Paper Code: RJSUBTP201	**Practical I: Practicals based on RJSUBT201 and RJSUBT202**	**Credits 2**
1	Preparation of Stock Solutions and media for plant tissue culture.	
2	Sterilization of seeds and aseptic germination of seeds	
3	Trypsinization of Tissue and Viability Count using hemocytometer	
4	Data representation using frequency Polygon, Histogram and Pie Diagram	
5	Biometric Analysis for Mean, Median, Mode and Standard Deviation	

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50. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Bartlett Inc. USA

51. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

52. Molecular Biology, 5th Edition (2011), Weaver R., McGraw Hill Science. USA

53. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press.

54. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp Jones & Bartlett Learning, USABiotechnology by U.Satyanarayana, Books and Allied (P) Ltd.

55. Introduction to plant tissue culture, 2nd edition, M K Razdan.Oxford and IBH publishing Co. Pvt. Ltd.

56. Plant tissue culture by Kalyan Kumar De., New Central Book Agency (P) LTd.

57. Fermentation technology, Volume 2, 2009, H. A. Modi, Pointer publishers.
58. World Health Organization. Laboratory biosafety manual. – 3rd ed., 2004,
59. A Guide to Biosafety & Biological Safety Cabinets ESCO.

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 F.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 F.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 report -20 marks
- **Semester End Examination – 60 marks**
  - Question paper covering all units

- **Course Semester End Examination in Semester1 -Paper I to VII (RJSUBT101 to RJSUBT107) and Semester II - Paper I to VII (RJSUBT201 to RJSUBT207)**

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
Unit 1	08	03	04	15
Unit 2	08	03	04	15
Unit 3	08	03	04	15
Short notes from topics covering all the units	08	03	04	15
-TOTAL- Per objective	32	12	16	**60**
% WEIGHTAGE	53	20	27	**100%**

- **Evaluation of Practicals 300 marks with individual paper passing.**
- **100 marks for each practical Sem I - RJSUBTP101, RJSUBTP102 & RJSUBTP103; Sem II - RJSUBTP201, RJSUBTP202 & RJSUBTP203**
- 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.

Mapping of the course to employability/ Entrepreneurship/skill development

F.Y.B.Sc. BIOTECHNOLOGY SEM I

Class	**Course Code**	**Course Name**	**Topic focussing on Employability/ Entrepreneurship/skill development**	**Employability/Entrepreneurship/Skill development**	**Specific activity**
FYBSc Biotechnology	Basic Chemistry and Microscopy	RJSUBT101	Nomenclature and classification Chemical bond and water Microscopy, stains and dyes	Skill development in the form of gaining knowledge of basic chemistry principles and application of dyes and stains for staining microorganisms	Staining of Microorganisms
	Stereochemistry and Analytical Chemistry	RJSUBT102	Stereochemistry Titration and Buffers Calibration of glassware	Skill development by gaining understanding of Normality calculations and preparation of buffers	Titration and Calibration of glasswares
	Biodiversity	RJSUBT103	Origin of life and Biodiversity Ultrastructure of Prokaryotic cell & Eukaryotic Cell	Skill development in understanding Ultrastructure of eukaryotic and prokaryotic cells	Biodiversity
	Microbiology	RJSUBT104	History of microbial classification Nutrition, Enumeration and preservation of microorganisms Sterilization techniques	Skill development, Employability Entrepreneurship Useful in industries as well as in research processes	Enumeration and sterilization methods
	Genetics	RJSUBT105	Fundamentals of genetics Microbial genetics Population Genetics	Skill development Understanding the basic concepts	Microbial genetics Population Genetics
	DNA Replication and mutations	RJSUBT106	DNA Replication Mutation and DNA repair Chromosome and gene mutations	Skill development Understand the basic concepts	DNA Replication Mutation and DNA repair Chromosome
	Communication and soft skills development	RJSUBT107	English language skills, Communication	Skill development Employability	English language & Communicati

			skills and GD, PD, Computer basics		on skills, Computer skills
	Practicals of	RJSUBTP101 RJSUBTP102 RJSUBTP103		Analytical skills Interpretation skills Writing skills	Basic microbiology techniques

F.Y.B.Sc. BIOTECHNOLOGY SEM II

Class	Course Code	Course Name	Topic focussing on Employability/ Entrepreneurship/ skill development	Employability/Entrepreneurship/Skill development	Specific activity
FYBSc Biotechnology	Biomolecules	RJSUBT201	Carbohydrates Amino acids and Proteins Lipids and nucleic acids	Skill development	Biomolecular structure and function
	Physical chemistry	RJSUBT202	Analytical techniques Chemical kinetics Redox reactions	Skill development, Employability	Chemical kinetics Redox reactions
	Physiology	RJSUBT203	Enzymology Plant physiology Animal physiology	Skill development	Metabolic pathways
	Environmental sciences	RJSUBT204	Renewable sources of energy Environmental concerns Bioremediation	Skill development, Employability, Entrepreneurship	Renewable sources & Bioremediation
	Tissue culture and ecology	RJSUBT205	Animal tissue Culture Plant Tissue Culture Ecology	Skill development, Employability, Entrepreneurship	Animal tissue Culture Plant Tissue Culture
	Basic Immunology and Biostatistics	RJSUBT206	Innate Immunity Acquired Immunity and antigens Biostatistics	Skill development, Employability	Immune system basics
	Good Laboratory Practices and Biosafety	RJSUBT207	Introduction to Safety Good laboratory practices & Biosafety guidelines, Sterile pharmaceutical products Factory and hospital hygiene	Skill development, Employability	GLP and Biosafety
	Practicals	RJSUBTP201 RJSUBTP202 RJSUBTP203		Analytical skills Interpretation skills Writing skills	Entrepreneurial skills, organizational skills, team work