S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: S.Y. B.Sc.

Program: B.Sc.

Course Code: BIOTECHNOLOGY (RUSBTK)

(Choice Based Credit System (CBCS) with effect from academic year 2019-20)

PROGRAM OUTCOMES

PO	PO Description **A student completing Bachelor's Degree in Science program will be able to:**
PO 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
PO 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
PO 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
PO 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
PO 5	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
PO 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
PO 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
PO 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner

PROGRAM SPECIFIC OUTCOMES

PSO	Description A student completing Bachelor's Degree in Science program in the subject of Biotechnology will be able to:
PSO 1	Adept in basic sciences along with a thorough understanding of biotechnology principles and chemical sciences to create a foundation for higher education with the insights into interdisciplinary approach.
PSO 2	Demonstrate the applications of fundamental biological processes from the molecular, cellular, industrial and environmental perspective.
PSO 3	Develop effective communication skills with improved individual and team work abilities in the domain of scientific research writing. Showcase their innovative ideas and research work efficiently.
PSO 4	Reflect, analyse and interpret information or data for investigating the problem in fields of biotechnology. Acquire scientific and entrepreneur skills to furnish sustainable solutions to coeval problems
PSO 5	Illustrate the relevance of ethical implications and standard laboratory practices in tissue culture techniques, forensic biology, developmental biology and other fields of biotechnology.
PSO 6	Apply the conceptual knowledge to develop coherent, efficacious and proficient practical, technical and analytical skills.

S.P Mandali's
Ramnarain Ruia Autonomous College
Department of Biotechnology

Syllabus for S.Y.BSc Biotechnology

Credit based and Grading system
To be implemented from Academic year 2019-20

Course code	Unit	Topic	Credits	Lectures/ week
Paper I: Biophysics RUSBTK301	**Unit I**	**Optics and Electromagnetic Radiations**	**2**	**1**
	Unit II	**Heat, Sound, Magnetism and Fluid Dynamics**		**1**
	Unit III	**Electrophoretic Techniques**		**1**
Paper II : Applied Chemistry- I RUSBTK302	**Unit I**	**Classical methods of analysis**	**2**	**1**
	Unit II	**Environmental chemistry**		**1**
	Unit III	**Green chemistry and nanomaterials**		**1**
Paper III : Immunology RUSBTK303	**Unit I**	**Effectors of Immune Response**	**2**	**1**
	Unit II	**Antigen-Antibody Interactions**		**1**
	Unit III	**Advanced Immuno-Techniques**		**1**
Paper IV : Cell Biology and Cytogenetics RUSBTK304	**Unit I**	**Cytoskeleton**	**2**	**1**
	Unit II	**Cell Membrane**		**1**
	Unit III	**Cytogenetics**		**1**
Paper V : Molecular Biology RUSBTK305	**Unit I**	**Gene Expression Transcription**	**2**	**1**
	Unit II	**Gene Expression- Translation**		**1**

	Unit III	**Regulation of Gene Expression**		**1**
Paper VI: Bioprocess Technology RUSBTK306	**Unit I**	**Microorganisms in Industrial Processes**	**2**	**1**
	Unit II	**Fermentor and Fermentation Process**		**1**
	Unit III	**Industrial Productions**		**1**
Paper VII : Research Methodology RUSBTK307	**Unit I**	**Introduction to Research Methodology and Research Problem**	**2**	**1**
	Unit II	**Research Design and Data Collection**		**1**
	Unit III	**Interpretation and Report writing**		**1**
Practicals	**Practicals based on Paper I and Paper II**	**Practicals based on Paper I and Paper II**	**2**	
Practicals		**Practicals based on Paper III and Paper IV**	**2**	
Practicals		**Practicals based on Paper V and Paper VI**	**2**	
TOTAL CREDITS			**20**	

Course code	Unit	Topic	Credits	Lectures/ week
Paper I: Biochemistry RUSBTK401	**Unit I**	**Carbohydrate Metabolism ETS**	**2**	**1**
	Unit II	**Amino Acid Metabolism**		**1**
	Unit III	**Lipid Metabolism**		**1**
Paper II : Applied Chemistry- II RUSBTK402	**Unit I**	**Physical Chemistry**	**2**	**1**
	Unit II	**Separation techniques in analytical chemistry**		**1**
	Unit III	**UV-Visible absorption spectroscopy**		**1**
Paper III : Medical Microbiology RUSBTK403	**Unit I**	**Infectious Diseases**	**2**	**1**
	Unit II	**Medical Microbiology- Causative Organisms- I**		**1**
	Unit III	**Medical Microbiology - Causative Organisms- II**		**1**
Paper IV : Environmental Biotechnology RUSBTK404	**Unit I**	**Renewable sources of energy**	**2**	**1**
	Unit II	**Xenobiotic compounds and waste water treatment**		**1**

	Unit III	**Bioremediation**		**1**
Paper V : Biostatistics and Bioinformatics RUSBTK405	**Unit I**	**Introduction to Computers and Biological Databases**	**2**	**1**
	Unit II	**BLAST & Structural Bioinformatics**		**1**
	Unit III	**Biostatistics**		**1**
Paper VI: Molecular Diagnostics RUSBTK406	**Unit I**	**Basics of Molecular Diagnostics**	**2**	**1**
	Unit II	**Nucleic Acid Amplification and hybridisation Methods**		**1**
	Unit III	**Molecular Biology based Diagnostics**		**1**
Paper VII : Entrepreneurship Development RUSBTK407	**Unit I**	**Entrepreneurship Development**	**2**	**1**
	Unit II	**Setting-up of an Business enterprise & management aspect**		**1**
	Unit III	**Innovation and Entrepreneurship development**		**1**
Practicals	**Practicals based on Paper I and Paper II**		**2**	
Practicals	**Practicals based on Paper III and Paper IV**		**2**	
Practicals	**Practicals based on Paper V and Paper VI**		**2**	

TOTAL CREDITS		**20**	

S.Y.BSc BIOTECHNOLOGY (2019-2020)
SEMESTER III
Paper I-Biophysics

Course objectives: -

The objective of this course is to have a firm foundation of the fundamentals and applications of current biophysical theories.

Learning outcomes: - By the end of the course the student will:

- Develop an understanding of the different aspects of classical Physics.
- Be able to relate principles of Physics to applications and techniques in the field of Biology such as Microscopy, Spectroscopy and Electrophoresis

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK301	**UNIT I** **Optics and Electromagnetic Radiations**	**Introduction to Optics and Lasers:** ***Optics* :** Properties of Light - Reflection, Refraction, Dispersion, Interference. ***Lasers* :** Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. **Electromagnetic Radiations:** Introduction to Electromagnetic Radiation. **Spectroscopy :** Types and Properties of Spectra; Basic Laws of Light Absorption. Spectrophotometer:-Principle, Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. **Microscopy:** Types of Microscopy; Electron Optics; Electron Microscopy-	**2**	**15**

		Preparation of Specimen, SEM, TEM and Immuno-Electron Microscopy. Fluorescence Microscopy.		
	UNIT II **Heat, Sound, Magnetism and Fluid Dynamics**	**Heat:** Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** Types of Sound Waves Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves. **Magnetism:** Magnetic Field; Magnetism of Earth; Para-magnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism. **Fluid Dynamics :** ***Viscosity*:** Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald'sViscometer. ***Surface Tension*:** Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology. Electricity- AC & DC		**15**
	Electrophoresis	**Electrophoresis:** Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and nonreducing, continuous and discontinuous); IEF and 2D PAGE,		**15**

		Pulse field and Capillary electrophoresis. Staining and Detection Methods; Gel – Documentation, Applications in Biology		

Paper II – Applied chemistry

Course objectives: -

The objective of this course is to have a firm foundation of the fundamentals and applications of Gravimetric analysis and Green Chemistry.

Learning outcomes: - By the end of the course the student will be able to:

- Scope and importance of analytical chemistry.
- Concept of accuracy and precision.
- Chemistry of water and various aspects of assessment of quality of water.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK302	**UNIT I** **Classical methods of analysis**	**Gravimetric analysis:** Introduction to gravimetric analysis, types of gravimetric analysis, conditions for a reaction to be used in gravimetric analysis, solubility and solubility product, factors affecting solubility: temperature, common and diverse ion effect, pH, nature of the solvent, complexation. Unit operations in gravimetric analysis, precipitation, homogenous and heterogeneous precipitation, relative super saturation, nucleation and crystal growth, their effect on particle size, Ostwald's ripening, impurities associated with precipitate formation, filtration, washing of the precipitate, drying and incineration, use of thermal methods. **Titrimetric analysis** Introduction to titrimetric analysis, conditions for a reaction to be used in titrimetric analysis, terms involved: titrant, titrand, indicator, equivalence point, endpoint, titration error, types of titrations.	**2**	**15**

		Acid –base titrations Acid base indicators, theory of acid base indicators, conditions for choosing an indicator. Types of acid base titrations, titration curves. Construction of the titration curves and the choosing of the indicator for A) strong acid –strong base B) strong acid –weak base C) weak acid – strong base D) weak acid –weak base Titration of dibasic acid with a strong base, condition for obtaining two separate equivalence points, qualitative description of the titration curve, determination of the dissociation constant Titration of phosphoric acid with a strong base		
	UNIT II **Environmental Chemistry**	Chemistry of water Water as a natural resource: Physical and Chemical properties of water, significance of water as a universal solvent and its properties viz. pH, Dielectric constant, boiling point. Anomalous behaviour of water. Hydrological cycle. Chemical composition of ground water. Factors affecting solubility of gases in water. Solubility of CO_2 and O_2 in water Water quality : Parameters for determining water quality i) Physical parameters: - pH, pE, conductivity, TS , TSS, TDS ii) Chemical Parameters- acidity, alkalinity, hardness, salinity , chlorine demand , DO, COD, iii) Biological parameter – BOD, MPN Standards for Potable and industrial water.		**15**
	UNIT III **Green Chemistry & Nanomaterials**	**Green Chemistry and Synthesis:** Introduction to Green Chemistry; Need and Relevance of Green Chemistry; Principles of Green Chemistry. Green Synthesis in Industry: Green		**15**

		Materials, Green Reagents, Green Solvents and Green Catalysts. **Nanomaterials:** Introduction to Nanomaterials. Forms of Nanomaterials: Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials.		

Paper III- Immunology

Course objectives: -

The objective of this course is to familiarize students with the Immune Effector Mechanisms and various Immunotechniques.

Learning outcomes: - By the end of the course the student will be able to:

- Understand the role of different types of Cells, Effector Molecules and Effector Mechanisms in Immunology.
- Understand the principles underlying various Immuno-techniques.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK303	**UNIT I Effectors of Immune Response**	Haematopoiesis; Complement System- Classical, Alternate and Lectin; Regulation and Biological Effects of Complement System; Deficiencies of Complement System	**2**	**15**
	UNIT II Antigen antibody interaction	**Antigen antibody interaction techniques- Precipitation Reactions:** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis **Agglutination Reactions:** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests. Synthesis of Monoclonal antibodies & Applications.		**15**
	Unit III Advanced Immuno-Techniques	RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluroscence, Flow Cytometry. **Alternatives to Antigen- Antibody Reactions**		**15**

SEMESTER III

Paper IV - CELL BIOLOGY AND CYTOGENETICS

Course objectives: -

The objective of this course is to have a firm foundation in the fundamentals of Cell Biology and Cytogenetics.

Learning outcomes: -By the end of the course the student will be able to:

- Develop an understanding of the Cytoskeleton and Cell Membrane.
- Discuss the structure of Chromosomes and types of Chromosomal Aberrations.
- Discuss the principles underlying Sex Determination, Linkage and Mapping.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK304	**UNIT I Cytoskeleton**	**Cytoskeleton:** Overview of the Major Functions of Cytoskeleton. Microtubules: Structure and Composition. MAPs: Functions- Role of Mitosis, Structural Support and Cytoskeleton Intracellular Mobility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella. Microfilaments: Structure, Composition, Assembly and Disassembly. Motor Protein: Myosin. Muscle Contractility: Sliding Filament Model. Actin Binding Proteins; Examples of Non Muscle Motility. Intermediate Filaments: Structure and Composition; Assembly and Disassembly; Types and Functions	**2**	**15**
	UNIT II Cell Membrane	**Cell Membrane:** Uptake of Nutrients by Prokaryotic Cells; Overview of membrane functions, History on Plasma membrane structure, Chemical composition of membranes-Membrane carbohydrates & Membrane lipids. Integral, Peripheral & Lipid anchored membrane proteins, Importance & maintenance of Membrane fluidity,		**15**

		Asymmetry of membrane lipids, Lipid rafts, Diffusion of Membrane proteins after cell fusion, Restrictions on Protein and Lipid mobility, Red Blood cell – An example of Plasma membrane structure.		
	UNIT III Cytogenetics	**Cytogenetics:** Structure of Chromosome- Heterochromatin, Euchromatin, Polytene Chromosomes. Variation in Chromosomal Structure and Number: Deletion, Duplication, Inversion, Translocation, Anueploidy, Euploidy and Polyploidy and Syndromes- Klienfelter, Turner, Cri-du-chat, Trisomy -21, Trisomy 18 and Trisomy 13. **Sex Determination and Sex Linkage:** Mechanism of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body. **Genetic Linkage, Crossing Over and Chromosomal Mapping:** Tetrad Analysis, Two-point Cross, Three Point Cross, Pedigree Analysis		**15**

SEMESTER III
Paper V – Molecular Biology

Course objectives: -

The objective of this course is to have an insight into mechanism of Gene Expression and Regulation.

Learning outcomes: -By the end of the course the student will be able to:

- Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation.
- Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK305	**UNIT I Gene Expression – Transcription**	**Gene Expression- an Overview. Transcription Process in Prokaryotes :** RNA Synthesis; Promoters and Initiation of Transcription at Elongation and Termination of Chain. **Transcription in Eukaryotes** Transcription of Protein Coding Genes by RNA Polymerase	**2**	**15**

	UNIT II **Gene Expression-Translation**	**Nature of Genetic Code.** **Wobble Hypothesis.** **Translation:** Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination)		**15**
	UNIT III **Regulation of Gene Expression**	**In prokaryotes:** **In Bacteria:** *Lac* operon of *E.coli, trp* Operon of *E.coli.* **In Eukaryotes:** Operons in Eukaryotes; Control of Transcriptional Initiation Jumping genes in maize		**15**

SEMESTER III

Paper VI- Bioprocess technology

Course objectives: -

The objective of this course is to understand the basics skills applied in Fermentation Technology and build a foundation for more advanced studies in Bioprocess Technology. **Learning outcomes: -**By the end of the course the student will be able to:

- Develop an understanding of the various aspects of Bioprocess Technology.
- Develop skills associated with screening of Industrially Important Strains.
- Understand principles underlying design of Fermenter and Fermentation Process.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK306	**UNIT I** **Microorganisms in Industrial Processes**	**Types of Microorganisms used in Industrial Processes :** Bacteria, Fungi **Screening and Maintenance of Strains:** Primary Screening and Secondary Screening; Cultivation; Preservation of Industrially Important Microbial Strains. **Strain improvement, Inoculum development – One example each.**	**2**	**15**
	UNIT II **Fermentor and Fermentation Processes**	**Design of a fermentor:** Stirred Tank Fermentor, Air lift, Pneumatic, Bubble column, Tower fermentor, -Basic Design; Parts of a Typical		**15**

		Industrial Fermentor. **Process Parameters :** *pH*, Temperature, Aeration, Agitation, Foam, Pressure, Inlet and exit gas analysis, Dissolved oxygen. Carbon dioxide electrodes, microbial biomass, Safety valves.		
	UNIT III **Industrial Productions**	**Product Isolation and Purification.** **Study of Representative Fermentation Processes :** Outline of Penicillin, Ethanol, Streptomycin & Vinegar Production by Fermentation along with a *flow-diagram.*		**15**

SEMESTER III
Paper VII – Research Methodology

Course objectives: -
The objective of this course is to develop Research Aptitude, Logical Thinking and Reasoning.

Learning outcomes: -By the end of the course the student will be able to:

- Understand basic principles of Research Methodology and identify a Research Problem.
- Understand a general definition of Research Design.
- Identify the overall Process of Designing a Research Study from its inception to its Report.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK307	**UNIT I** **Introduction to Research Methodology and Research Problem**	Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique	**2**	**15**

		Involved in Defining a Problem		
	UNIT II **Research Design And Data Collection**	Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; Developing a Research Plan- Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires; Collection of Data through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method		**15**
	UNIT III **Interpretation and Report Writing**	Meaning of Interpretation, Why Interpretation?, Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in report writing, Layout of research report, Types of report, Mechanics of writing a research report, Precaution for writing a research report.		**15**

Practical for semester III

Course Code	Title	Credits
Based on Paper 1 and 2 **RUSBTKP301**	• Determination of Purity of Plasmid DNA using UV Spectrophotometry. • Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration - including Sample Preparation and Staining). • Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation). • Electrophoresis of Proteins by PAGE. • Chemical and Biological Synthesis of Silver Nanoparticles and its Characterisation by UV- VIS Spectrophotometer • To study the kinetics of the reaction between $K_2S_2O_8$ and KI for equal concentration. • To determine the amount of strong acid in the given solution by conductometric titration. • To determine the amount of strong acid in the given solution by pH-metric titration. • Organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. Preparation of: a. m-Dinitrobenzene from nitrobenzene b. Phthalic anhydride from phthalic acid by sublimation c. P-bromoacetanilide from acetanilide • Quantitative determination of salts such as copper sulphate pentahydrate, nickel chloride hexahydrate, anhydrous cupric chloride using standard volumetric methods (any 1) • Gravimetric estimation of Nickel (II) as Ni-DMG.	**2**
Course Code	**Title**	**Credits**
Based on Paper 3 and 4 **RUSBTKP303**	• Passive Agglutination- RA Factor Test. • ELISA (Kit based). • Dot ELISA • Single radial immunodiffusion • Ouchterlony double immunodiffusion • Study of Normal and Abnormal Karyotype (Chromosomal Aberration) - Deletion, Duplication, Inversion, Translocation and Syndromes- Trisomy 21, Trisomy 13, Trisomy 18, Klienfelter, Turner and Cri-du-Chat using Software. • Video demonstration of G- banding • Induction of Polyploidy by PDB/ Colchicine/ UV Treatment	**2**

	Using Suitable Plant material • Study of Polytene Chromosomes • Mapping based on Tetrad Analysis and Three Point Cross. • Pedigree Analysis- Autosomal and Sex- Linked.	
Based on Paper 5and 6 **RUSBTKP305**	• Study of E.coli Diauxic Growth Curve- (Lactose and Glucose) • Expression of β- galactosidase and Measurement of Activity. • Screening for an Antibiotic Producing Strain of Microorganism • Screening for an Acid producing strain of microorganism • Screening for an Alcohol Producing Strain of Microorganism • Lab Scale Production of Penicillin (Static and Shaker) • Lab Scale Production of Ethanol • Estimation of *Penicillin* from Recovery Broth by Chemical (Iodometric) Method. • Estimation of *Penicillin* from Recovery Broth by Biological (Bioassay) Method. • Estimation of Vinegar • Estimation of Alcohol from Recovered Broth by Dichromate Method. • Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast.	**2**

SEMESTER IV

Paper I - Biochemistry

Course objectives: -

The objective of this course is to gain an insight into the Metabolic Processes associated with Catabolism of Carbohydrates, Amino Acids, Lipids and Nucleotides.

Learning outcomes: -By the end of the course the student will be able to

- Discuss the Metabolic Pathways of Carbohydrates, Amino Acids, Lipids and Nucleotides.

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Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK401	**UNIT I Carbohydrate Metabolism , ETS**	**Carbohydrate Metabolism:** Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation **Electron Transport System:** Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS	**2**	**15**
	UNIT II Amino Acid Metabolism	**Amino Acid Breakdown:** Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. Amino Acids as Biosynthetic Precursors.		**15**
	Unit III Lipid Metabolism	**Lipid Metabolism:** Mobilization, Transport of Fatty Acids. Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids, Oxidation of Odd Chain Fatty Acids. Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways)		**15**

Paper II – Applied chemistry

Course objectives: -

The objective of this course is to have a firm foundation of the fundamentals and applications of current Physical chemistry.

Learning outcomes: -By the end of the course the student will:

- Types of electrodes and electrochemical cells.
- Nernst equation and its importance.
- Calculation of pH for strong and weak electrolytes.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK402	**Unit I Physical Chemistry**	**Electrochemistry: Electromotive Force of Galvanic Cells** Electrochemical cells, galvanic cells, reversible cells and reversible electrodes, conventions to represent Galvanic cells. Types of electrodes, standard electrode potential, electrochemical series. Cell potential and standard cell potential. Nernst equation and its importance. Calculation of thermodynamic parameters: ΔG, ΔH, ΔS and equilibrium constant from EMF data. Classification of galvanic cells: chemical cells and concentration cells Determination of pH using glass electrode and quinhydrone electrode. **pH and Buffers** pH concept, calculation of pH for strong and weak electrolytes Buffer, Henderson's equation for acidic and basic buffer Buffer Capacity. Numerical Problems based	**2**	**15**
	UNIT II Separation	**Introduction to separation Techniques**		**15**

	techniques in analytical chemistry	Separation and its importance in analytical chemistry, estimation without separation. Classification of separation methods physical and chemical Chemical methods, precipitation, complex formation. Physical methods of separation, precipitation, fractional precipitation, volatilization, distillation, fractional distillation, vacuum distillation. **Solvent extraction** Nernst's distribution law, partition coefficient, distribution ratio, Percentage extraction, extraction efficiency, percentage extraction for single step and multistep process with the same total volume of the extracting solvent Modes of extraction: Chelation, ion-pair formation and solvation. Batch and continuous extraction, Counter current extraction **Chromatography** Introduction, Stationary and mobile phase, common features of all chromatographic techniques, classification of chromatographic methods on the basis of physical state of the two phases. **Paper chromatography** Introduction and basic principles. Stationary phase, transfer of the sample, mobile phase. Methods of developing the chromatogram, methods of detection, physical, chemical and enzymatic. Applications. Comparison of the paper and thin layer techniques. **Thin layer chromatography** Introduction, mechanism of separation, retardation factor, basic principles. Stationary phase, preparation and transfer of the sample, mobile phases and their nature. Methods of development of the chromatogram, detection methods,		

		physical and chemical. Applications, for determination of purity, following the course of a chemical reaction.		
	UNIT III **UV- Visible Absorption spectroscopy:**	**Recapitulation of basic concept of spectroscopy**. Terms involved in absorption spectroscopy, monochromatic and polychromatic radiation, radiant power, absorbance, transmittance, absorptivity, molar extinction coefficient, wavelength of maximum absorption, Statement of Beer's law & Lamberts' law combined mathematical expression for Beer-Lambert's Law, deviations from Beer-Lambert's law, types of deviations. Components of an optical instrument and their functions, photometers and spectrophotometers. Photometers: Sources, monochromators, sample containers and detectors, block diagram for a single and double beam photometer, (Numerical problems expected.) **Photometric titrations** Basic principles, experimental set up and operational procedures, Requirements for a photometric titration, types of photometric titration curves, and determination of equivalence point. Advantages and limitations **Conductometric titrations** Conductometry and conductometric titrations, basic principles, operational procedure, determination of the equivalence point., Conductometric titration curves for the titration of		**15**

		1] Acid –base titrations of all types 2] Mixture of a weak acid and a strong acid vs. strong base and vice versa. 3] Mixture of acid ans salt ag. base 4] Precipitation titrations 5] Complexometric titrations Advantages and limitations.		

Paper III – Medical Microbiology

Course objectives: -

The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms.

Learning outcomes: -By the end of the course the student will be able to:

- List the factors playing a role in causing a disease.
- Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis.
- Gain the technical capability of handling, isolating and identifying various Bacteria.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK403	**UNIT I** **Infectious Diseases**	**Host Parasite Relationship:** Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.	**2**	**15**
	UNIT II **Medical Microbiology Causative Organisms- I**	**Skin :** *S. aureus, S. pyogenes.* **Respiratory Tract Infections :** *M. tuberculosis, S. pneumonia* (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR **Urinary tract infections***:* *E.coli* : Characteristics, Virulence, Clinical disease, and *E.coli* Infections.		**15**

	UNIT III Medical Microbiology - Causative Organisms- II	**GI Tract Infections :** *Salmonella and Shigella spps.* (Characteristics, Virulence-Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment). **Sexually Transmitted Diseases :** Syphilis and Gonorrhoea. **Nosocomial Infections :** *Ps. Aeruginosa*		**15**

Paper IV – Environmental Science

Course objectives: -

The objective of this course is to gain awareness about different Types of renewable sources of energy, Xenobiotic compounds and its treatment by bioremediation mechanisms.

Learning outcomes: -By the end of the course the student will be able to:

- Gain an understanding of the types of renewable sources of energy and its production.
- Study the different xenobiotic compounds and its degradation
- Discuss the various bioremediation strategies.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK404	**UNIT I** **Renewable sources of energy / Waste resources**	**Sources of available biomass, energy scanarios,** Biogas technology- Biogas plant & types, Biodigester. Biogas composition, production and factors affecting production, uses. Biofuels – ethanol production. Microbial hydrogen production, Biodiesel, Petrocrops. Case studies on biogas and biofuel, Advanced biofuels.	**2**	15
	UNIT II **Xenobiotics & waste water treatment**	Definition and types of recalcitrant xenobiotic compounds, Hazards from xenobiotics,Biodegradation of xenobiotics, Aerobic waste water treatment Measurement of level of pollution, Process – Preliminary, primary, secondary, tertiary & sludge treatment. Anaerobic treatment of waste		15

		water – Microorganisms in sludge treatment.		
	UNIT III Bioremediation	Concept of Bioremediation. Microorganisms in Bioremediation, Myco remediation and Phytoremediation. Bioremediation Technologies. Measuring Bioremediation in the Field. Bioaugmentation and Biostimulation. Monitoring the Efficacy of Bioremediation.		15

Paper V – Bioinformatics and Biostatistics

Course objectives: - The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.

Learning outcomes: -By the end of the course the student will be able to:

Gain an understanding of the basic concepts of Bioinformatics and Biostatistics

- Understand the tools used in Bioinformatics.
- Apply the various Statistical tools for Analysis of Biological Data

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK405	**UNIT I Introduction to Computers and Biological Databases**	MS Word, PowerPoint, Excel, Coral Draw **Biological Databases :** Classification of Databases based on Resource, Type Of Molecule, Basis Of Information - Raw and Processed Databases; Primary (NCBI, PIR), Secondary (PRINTS, OWLS) and Tertiary or Composite (REACTOME, Introduction to KEGG) Databases; Structure and Sequence Databases. Specialized Databases, Protein databank Protein Pattern Databases; Protein Structure and domain classification (CATH/SCOP). **Genome Information Resources:** DNA Sequence Databases Specialized Genomic Resources.	**2**	**15**

	UNIT II **BLAST & Structural bioinformatics**	**BLAST:** BLAST and its Types; Retrieving Sequence using BLAST, BLAST based searching, FASTA & Dot Plot Method, Introduction to molecular representations on computers, Visualization of biomolecular structures (Protein, DNA, RNA, drugs), Analysis of biological structures. Introduction to Algorithms		**15**
	UNIT III **Biostatistics**	Theory and Problems based on – Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests:- Z Test – Single Mean and Two Means, t- Test – Single Mean, Paired and Unpaired; Chi- Square Test.		**15**

Paper VI- Molecular Diagnostics

Course objectives: -

The objective of this course is learning and understanding Molecular Techniques and utilizing these techniques in Diagnosis.

Learning outcomes: -By the end of the course the student will be able to:

- Gain an understanding of the basic Principles used in Molecular Diagnosis.
- Gain critical thinking and analytical skills to understand new Diagnostic Methods.
- Apply the knowledge and skills gained in the course should be useful in developing new Diagnostic Kits

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK406	**UNIT I** **Basics of Molecular Diagnostics**	**Introduction to Molecular Diagnostics :** Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in Post Genomic Era; Areas used in Molecular Diagnostics; Future Prospects - Commercializing Molecular Diagnostics, Personalized Medicine, Theranostics.	2	**15**

		Characterization and analysis of Nucleic – Acids and Proteins : Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping.		
	UNIT II Nucleic Acid Amplification and hybridization Methods	**Target amplification :** PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. Types of PCR Reverse Transcriptase, Real time, Multiplex & Nested PCR. **Hybridization Techniques :** Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.		15
	UNIT III Molecular Biology based Diagnostics	**DNA Polymorphism and Identification:** RFLP and Parentage Testing; RFLP and Sickle-Cell Anaemia. **Molecular Diagnostics for Infectious Diseases** Molecular Testing for *Neisseria*, Molecular Diagnosis for HIV-1; **Genetic Counselling and Molecular Diagnosis** Genetic Testing-Need and Uses; genetic Counselling. Case Studies-Diagnostic Testing for Cystic Fibrosis; Fragile X Diagnostic and Carrier Testing. **Ethical, Social and Legal Issues to Molecular - Genetic Testing**		15

Paper VII- ENTERPRENEURSHIP DEVELOPMENT

Objective:

To develop and systematically apply an Entrepreneurial way of thinking that will allow identification and creation of Business Opportunities.

Learning Outcome: By the end of the course the student will be able to:

- Develop an understanding of the systematic process and to select and screen a Business Idea.
- Design strategies for setting up successful business ideas.
- Creation of unique ideas for business development.

Course Code	UNIT	TOPICS	Credits	Lectures
RUSBTK407	**UNIT I Entrepreneurship Development**	Concept of Entrepreneur; Entrepreneurship; Need and Importance Factors responsible for shaping an entrepreneur. Entrepreneurship development process Difference between entrepreneur and manager.	2	**15**
	UNIT II Setting up the Business and Management Aspect	Launching of an enterprise. Enterprise selection, analysis of suitable market, feasibility study, SWOT analysis of business Resource mobilization - financial, technological, raw material. Evaluation of project designing business plan. Principles of management, quality circles, MBO, MBW, TQM		**15**
	UNIT III Innovation and entrepreneurship development	Innovation and Marketing Management Marketing management and business development Marketing plan, sales promotion, market segmentation - STP analysis Principles of innovation, business diversification Strategies and		**15**

		innovative ideas		

PRACTICALS for SEMESTER IV

Course Code	Title	Credits
Practicals based on paper 1 and 2 **RUSBTKP401**	• Determination of blood glucose levels for detection of Diabetes mellitus. • Organ Function Tests: Liver (SGPT, SGOT) • Kidney function tests (Urea from Serum). • Qualitative Detection of Ketone Body in Urine. • Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme. • Determination of acid number and iodine number of oil/ fats. • To determine dissociation constant of weak acid by incomplete titration method using pH meter. • Qualitative Analysis of bi-functional organic compounds (minimum four) on the basis of a. Preliminary examination b. Solubility profile c. Detection of elements C, H, (O), N, S and X. d. Detection of functional groups e. Determination of physical constants (M.P/B.P) f. Confirmatory tests to be performed. Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, and alkyl and aryl halides. • Chromatography: a) Separation of cations: Fe(III), Ni(II) and Cu(II) in a sample by paper chromatography b) Separation of a mixture of o-and p-nitrophenols by thin layer chromatography (TLC). • To determine partition coefficient of iodine between water and CCl_4 • To verify Beer Lamberts law. • Determination of amount of Fe (III) in the given solution by photometric titration using salicylic acid. • Determination of amount of Fe (II) present in the given solution titrimetrically using diphenylamine indicator.	**2**

Course code	Title	Credits
Practicals based on Paper 3and 4 **RUSBTKP403**	• Identification of *S.aureus*-Isolation, Catalase, Coagulase Test. • Identification of *E.coli*-Isolation, Sugar Fermentations, IMViC. • Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant. • RPR Test (Kit Based). • Permanent Slide- *Mycobacterium*. • Determination of total solids from an effluent sample. • Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample. • Most Probable Number (MPN) – Presumptive, Confirmed and Completed Tests. • Bioremediation of Metal. • Mass and energy calculation for biogas and biofuels • Visit to STP / CETP	**2**
Course code	**Title**	**Credits**
Practicals based on Paper 5 and 6 **RUSBTKP405**	• Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases. • Use of NCBI BLAST Tool. • Classification of Proteins using CATH/SCOP. • Visualization of proteins using Rasmol. • Visualization of biomolecular structures – PyMOL, Chimera. • Analysis of three dimensional structures – Similarity, interactions. • Handling and Calibration of Micropipette. • Isolation and Detection of RNA from Bacteria and Yeast. • RFLP- Kit Based. • Primer Designing through Open Online Source NCBI-BLAST. • DNA Amplification – PCR. • Excel based Biostatistics Practicals. • Poster of any recently published paper.	**2**

REFERENCES:-

1. Biotechnology: Environmental Processes- Rehm and Reed- Wiley

2. Molecular Biotechnology- Glick and Pasterman ASM Press

3. Food Microbiology- Frazier

4. Industrial Microbiology- A. H. Patel

5. Industrial Microbiology- L. E. Casida- John Wiley & Sons

6. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA

7. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers

8. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA

9. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA

10. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.

11. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet, John Wiley and Sons, I. USA

12. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and Company, NY

13. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India

14. Biochemical Methods.1st, (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India

15. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,

16. Proteins: biotechnology and biochemistry, 1stedition (2001), Gary Walsch, Wiley, USA

17. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.

18. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

19. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The

McGraw Hill Companies Inc. NY

20. Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA

21. Text book of Medical Microbiology, Anantnarayan

22. Microbiology- Frobisher

23. General Principles of Microbiology- Stanier

24. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill

25. Genetics, (2006) Strickberger MW - (Prentice Hall, India)

26. Human Genetics- A. M. Winchester – MacMillan Press

27. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition (2012), Freeman and Co., NY

28. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India

29. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA. 21

30. Introduction to Immunology- C V Rao- Narosa Publishing House

31. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins

32. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International

33. iGenetics- Peter Russell -Pearson Education

34. Microbial Genetics- Freifelder –Narosa Publishing House

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

36. Bioinformatics- methods and S.C.Rastogi, N. Mendiratta, PHL learning Pvt. Ltd. applications Genomics, Proteomics P.Rastogi 3rd edition and Drug discovery,

37. Molecular diagnostics- Fundamentals, methods and clinical applications – Buckingham and Flaws F.A. Davis Company Philadelphia.

38. Molecular diagnostics for the clinical laboratorian by Coleman and Tsongalis,

Humana press

39. Environmental Biotechnology Allan Scragg Oxford University press

40. Environmental Biotechnology Indu shekhar Thakur IK International (Basic concepts and applications)

41. Research methodology- C.R. Kothari

42. Entrepreneurship – Kurup

43. Handbook of Entrepreneurship development- Basotia and Sharma

44. Phytochemical methods- J.C. Harbone

45. Plant drug analysis- Wagner and Blandt

46. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhatacharjee, 7th Edition, Pearson Education (2011).

47. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)

48. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education

49. Fundamentals of Organic Chemistry, G. Marc Loudon, 4th Edition Oxford

50. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition, 2008 7. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008

51. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill

52. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd

53. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge

54. Advanced Methods in Protein Microsequencing, Witmann

55. Essential Biophysics, Narayanan, New Age Publ

56. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley

57. Principles & techniques of Biochemistry & Molecular Biology, Wilson & Walker

58. Principles of fermentation technology – Stanbury & Whittaker

59. Cell & Molecular Biology Concepts & Experiments – Gerald Karp.

60. Biotechnology: Expanding Horizons – B.D.Singh

MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40% :40 marks.

Sr No	Evaluation type	Marks
1	One Assignment (Animations/Presentations/Posters/ Video Making/ Skits/ Written assignments)	20
2	One class Test (multiple choice questions or objective)	20
	Total Marks	40

B) External examination - 60 %: 60 marks

Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of **02 hours** duration.

ii. Paper Pattern:

1. There shall be **03** questions each of **20** marks. On each unit there will be one question. All questions shall be compulsory with internal choice within the questions.

2. 60% options will be provided.

Questions	Options	Marks	Questions on

Q.1)A)	*Any 5 out of 8*	*05*	*Unit I*
Q.1)B)	*Any 3 out of 5*	*15*	
Q.2)A)	*Any 5 out of 8*	*05*	*Unit II*
Q.2)B)	*Any 3 out of 5*	*15*	
Q.3)A)	*Any 5 out of 8*	*05*	*Unit III*
Q.3)B)	*Any 3 out of 5*	*15*	

Practical Examination Pattern:

(A)Internal Examination:

Heading	**Practical I**
Test (2 performing practicals) ***RUSBTKP301/401*** ***RUSBTKP303/403*** ***RUSBTKP305/405***	*30*
Journal	*10*
Total	40

Note- Similar pattern for internal practical will be followed for all three Practical papers.

(B) External (Semester end practical examination):

Particulars	**Practical 1**
Laboratory work	*60*
2 major practicals	*20/25*
1 minor practicals	*10*
Viva	*10/5*
Total	**60**

Note – Similar pattern for external Practical will be followed for all three practical papers

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Semester: III/ IV

Course	***RUSBTKP301/401***			***RUSBTKP302/402***			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**

Course	***RUSBTKP303/403***			***RUSBTKP304/404***			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**

Course	***RUSBTKP305/405***			***RUSBTKP306/406***			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	

Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**