

Resolution Number: AC/II(22-23).3.RUS1

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)



Syllabus for:

Program: Integrated M.Sc. in Bioanalytical Sciences

(S.Y. B.Sc. Semester III Syllabus)

Program Code: RUSBAS

(Credit Based Semester and Grading System
for
the academic year 2023-24)

GRADUATE ATTRIBUTES

GA	GA Description A student completing Bachelor's Degree in Science program will be able to:
GA 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.
GA 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
GA 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.
GA 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
GA 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.
GA 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
GA 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.
GA 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 OUTCOMES

PO	Description
PO 1	A student completing Bachelor's Degree in Science program in the subject of Bioanalytical Sciences will be able to: This course will impart high quality science education in a vibrant academic ambience with the faculty of distinguished teachers and scientists.
PO 2	It will also equip students for the future who will take up the challenge of doing quality research & teaching and also contribute to industrial production and R & D in the fields of Bioanalysis, Bioinformatics and Nutraceutical Sciences.
PO 3	It will amalgamate classical analytical chemical techniques with modern genomic and proteomic technologies of manufacturing and analysis to better characterize the products useful as medicines as well as nutraceuticals.

Core Course I: RUSBAS301
Course Title: Biological Sciences III
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Comprehend central dogma of molecular biology as a prerequisite to study techniques like cloning, PCR, RFLP, etc.
CO 2	Understand the significance and applications of developmental biology in the modern world.
CO 3	Understand the applications of ethnobotany and pharmacognosy in drug development

Paper Code	Semester III	Lectures
RUSBAS301	Biological Sciences III	45
301.1: Central Dogma of Molecular Biology		15
Concept of Central dogma of molecular biology, Genetic code Replication in prokaryotes, Transcription & Translation in prokaryotes Post translational modification, Regulation of gene expression in prokaryotes, (lac operon and trp operon)		
301.2: Developmental Biology		15
Development of organ system, Developmental signals – polarity, differentiation, apoptosis, Ageing, regeneration (Example of Limb Bud Development) Process of Fertilization in humans, <i>in vitro</i> Fertilization- Gamete Collection and Storage techniques, Introduction to Stem Cell therapy and its applications		
301.3: Pharmacognosy & Ethnobotany		15

<p>Pharmacognosy: (12) The scope & practice of Pharmacognosy, sources of crude drugs, Collection, Processing and evaluation of crude drugs Deterioration and adulteration of Crude drugs, Current Trends in Pharmacognosy, Good Cultivation & harvesting practices(introduction)</p> <p>Ethnobotany: (3) Principles & Importance of Ethnobotany</p>	
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Reference Books:

<p>Biological Sciences III</p>	<ul style="list-style-type: none"> • Buns, G. W.: Science of Genetics - An introduction to heredity, Macmillan, New York. Fairbanks, Daniel J. and Anderson, W. R.: Genetics, Wadsworth Publication. • William S. Kluge and Cummings, M.R.: Concepts of Genetics, Pearson Edu. • Kalthoff, Klaus: Analysis of Biological Development, The University of Texas at Austin. Mc GRAW-HILL, INC. • Peter Russell - Genetics • Buns, G. W.: Science of Genetics - An introduction to heredity, Macmillan, New York • Berril, N. J., Mc. Graw Hill: Developmental Biology, New York. • Brookbank, J.W. and Harpar: Developmental Biology, Raw Publishers, New York. • Subramoniam: Molecular Developmental Biology, Narosa Publishing House, New Delhi, 2008
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Core Course II: RUSBAS302
Course Title: Biological Sciences IV
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Study various sources of plants and animals used as antimicrobial agents. They should understand the significance of drug discovery, also the industrial significance of microorganisms.
CO 2	Classify viruses with respect to their properties and nature also to study their associations with humans.
CO 3	Study the basics of immunology. Describe autoimmune disorders. They should be able to correctly interpret the results of diagnostic tests like VIDAL, VDRL and ELISA.

Paper Code	Semester III	Lectures
RUSBAS302	Biological Sciences IV	45
302.1 Industrial Microbiology		15
Sources of antimicrobial agents: plants and microorganisms, Antimicrobial Agents Used <i>In vivo</i> and their commercial production. Antimicrobial Drug Resistance and Drug Discovery Important microbes in Food & Drug industry, Pathogenic Organisms in Food & Pharma Industry Commercial significance of Microbes: Biopolymers, Biosurfactants.		
302.2 Virology & Interaction of microbes with humans		15
Virology: Introduction, Scope and Current trends in virology Structures and life cycles of bacteriophages, plant and animal viruses Interactions of microbes with Humans – <i>Influenza, Staphylococcus, Plasmodium, Candida, SARS-CoV-2</i> Control of Viruses and Eukaryotic Pathogens.		

302.3 Introduction to Immunology	15
<p>Concept of antigen, antibody, Types of immunity, Antigen-Antibody Reactions (MHC, APC introduction), Hypersensitivity and its types, Mechanism of wound healing Autoimmune disorders (<i>minimum two</i>) and their management</p>	

RUSBASP301 PRACTICALS
<p>a) Blood grouping b) Isoagglutinin titer- Widal, VDRL tests, Use of diagnostic tests- ELISA demonstration c) Handling of Micropipettes d) Working in Laminar air flow e) Total viable count of the provided sample. f) Direct microscopic counts of provided sample using Breeds count method g) Physical and chemical methods of disinfection h) Study of Normal flora of human body, common microbial contaminants in foods: <i>S. aureus</i>, <i>S. typhi</i>, <i>B. subtilis</i> i) Analysis of Crude drugs by Microscopy with an emphasis on identification of adulteration</p>

Reference Books:

<p>Biological Sciences IV</p>	<ul style="list-style-type: none"> ● Flint - Virology ● Kindt, Goldsby, Osborne - Kuby Immunology ● S. Pathak and U. Palan – Immunology and Fundamental ● Michael J. Pelczar, Jr. E.C.S. Chan, Noel R. Krieg –Microbiology ● Lasing. M. Prescott, Harley, Klein, Microbiology
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Core Course III: RUSBAS303
Course Title: Chemical Sciences III
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply theoretical principles of electrochemistry in analysis of solutions using pH meter and Conductometer. Students should be adept in operation of these two instruments.
CO 2	Perform organic synthesis with minimal use of resources and apply greener methods of synthesis.
CO 3	Describe principles and working of analytical instruments including pH meter, conductometer, turbidimeter, nephelometer and colorimeter

Paper Code	Semester III	Lectures
RUSBAS303	Chemical Sciences III	45
303.1 Electrochemistry		15
<p>Nature of electrolytes in solution: Variation of molar conductance with concentration for weak and strong electrolytes (derivation of equation is not expected).</p> <p>Kohlrausch's law and its application to determine Molar conductance at infinite dilution of a weak electrolyte, Dissociation constant of a weak electrolyte, Solubility of sparingly soluble salts, Migration of ions, ionic mobilities. Nernst theory, EMF, cells, activity, ionic strength, Membrane potential applications</p> <p>Conversion of chemical energy to electrical energy. Galvanic cells, reversible and irreversible cells.</p> <p>Types of electrodes: Metal – metal ion electrode, Redox electrodes, Gas electrode, Glass electrode</p> <p>Classification of cells – Chemical and concentration cells, concentration cells with transference, concentration cells without transference, liquid junction potential, use of salt bridge.</p> <p>Applications, strengths and limitations of electrochemical analysis</p>		

303.2	Newer methods of organic synthesis & Name Reactions (Mechanism and Applications)	15
<p>Newer methods of organic synthesis: Introduction to the use of following organic synthesis Ultrasound, Microwaves, Phase Transfer Catalyst Name Reactions (Mechanism and Applications): Baeyer-Villiger Oxidation, Beckmann rearrangement, Corey-Kim Oxidation, Cornforth rearrangement, Robinson Annulation, Houben-Hoesch Reaction, Favorskii rearrangement, Swern Oxidation, Luche Reduction, Dienone-Phenol rearrangement.</p>		
303.3	Instrumental methods of analysis	15
<p>Principle, instrumentation, working and applications of: Conductometry, Potentiometry, pH metry, Turbidometry, Nephelometry, and Colorimetry Sample preparations for above methods, advantages, disadvantages Possible errors and Precautions in each instrumentation technique</p>		

Reference Books:

<p>Chemical Sciences III</p>	<ul style="list-style-type: none"> ● Hobart. H. Williard, Lyne. L. Merrit, John. A. Dean, Frank. A. Settle. Jr.: Instrumental Methods of Analysis: CBS Publisher. ● Douglas. A. Skoog, F. James Holler, Stanley R Crouch: Principles of analytical: 6th edition: Thomson/Brooks/Cole ● David Harvey: Modern Analytical Chemistry: Mc Grow Hill Publishers ● Douglas. A. Skoog, F. James Holler, Stanley R Crouch: Principles of analytical: 6th edition: Thomson/Brooks/Cole ● Somenath Mitra: Sample preparation Technique in Analytical Chemistry: Wiley interscience ● Allen J. bard: Electrochemical Methods ● P.S Kalsi: Organic chemistry and their mechanism: New Age International
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Core Course IV: RUSBAS304
Course Title: Chemical Sciences IV
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Comprehend the fundamentals of spectroscopy and separation methods which will be useful to study advanced instrumentation in these fields.
CO 2	Demonstrate the structures and organic reactions of heterocyclic compounds.
CO 3	Comprehend the principles of separation and should be able to choose correct separation technique and solvent system when presented with practical problem.

Paper Code	Semester III	Lectures
RUSBAS304	Chemical Sciences IV	45
304.1 Basic Spectroscopy		15
<p>Electromagnetic spectrum (EMR), Units of wavelength and frequency and their inter conversions.</p> <p>Interaction of EMR with matter: Nature of radiation, energy of molecules electronic, vibrational and rotational</p> <p>Beer-Lambert's law, Concept of absorbance, transmittance and molar absorptivity, deviation of Beer-Lambert's equation and its limitations,</p> <p>Quantization of energy, Bohr frequency condition</p> <p>Single beam colorimeter – Principle, components and working.</p> <p>Regions of electromagnetic spectrum and process associated with each region.</p> <p>UV- VIS: Basic theory, Solvents, Nature of UV-Visible spectrum, Concept of Chromophore, Auxochrome, Bathochromic Shift, Hyper chromic and Hypochromic effect, Chromophore-Chromophore interactions and Chromophore-Auxochrome interactions. Sample Preparation, Evaluation of errors and applications of Colorimetry and UV Visible spectroscopy</p>		

304.2 Heterocyclic Compounds**15****Introduction:**

Electronic structure and aromaticity of furan, pyrrole, thiophene and pyridine.

Synthesis: Synthesis of furans, pyrroles, and thiophenes by Paal-Knorr synthesis. Pyridines by Hantzsch synthesis and from 1,5-diketones.

Reactivity:

Reactivity towards electrophilic substitution reactions-of furan, pyrrole and thiophene on basis of stability of intermediate; and of pyridine on the basis of electron distribution. Nucleophilic substitution reaction of pyridine on the basis of electron distribution.

Reactions of heterocycles: The following reactions of furan, pyrrole and thiophene: Halogenation, Nitration, Sulphonation, Vilsmeier formylation reaction, Friedel-Crafts reaction.

Furan: Diels-Alder reaction. Ring opening of furan.

Pyrrole: Acidity and basicity of pyrrole -Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine.

Sulphonation of pyridine, with and without catalyst. Reduction, Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction). N methylation of pyridine. Quaternization of piperidine, pyrrolidine and Hofmann elimination of the quaternary salts.

304.3 Methods of Extraction and Purification in analysis**15**

Partition coefficient and distribution ratio, extraction efficiency, separation factor, role of complexing agents in solvent extraction, chelation, ion pair formation, solvation, types of solvent extraction: batch, continuous.

Purification of solid organic compounds, recrystallisation, use of miscible solvents, use of drying agents and their properties, sublimation.

Purification of liquids. Experimental techniques of distillation, fractional distillation, distillation under reduced pressure.

Solvent extraction, use of immiscible solvents

Difference between extraction, separation and their applications.

RUSBASP302 PRACTICALS**Conductometry:**

1. Determination of Cell constant of conductivity cell
2. Verification of Ostwald's dilution law
3. Investigate the titration of mixture of HCl and Oxalic acid by NaOH.
4. Determination of relative strength of Chloro-acetic acid and Acetic acid by Conductivity measurement.

pH-Metry:

5. Identification of an acid by acid-base titration pH-metrically
6. pH titration of sodium carbonate against HCl to demonstrate the selection of indicators for two inflections.

Colorimetry:

7. Verification of Beer-Lambert's law

8. To determine: a) λ_{\max} b) Molar absorptivity constant

Organic Derivative:

9. Acetylation of Salicylic acid

Reference Books:

Chemical Sciences IV	<ul style="list-style-type: none">● Dand Harvey: Modern Analytical Chemistry: Mc Grow Hill Publishers● Hobart. H. Williard, Lyne L. Merrit, John A. Dean, Frank. A. Settle. Jr. : Instrumental Methods of Analysis: CBS Publisher.● David Harvey: Modern Analytical Chemistry: Mc Grow Hill Publishers● Douglas. A. Skoog, F. James Holler, Stanley R Crouch: Principles of analytical: 6th edition: Thomson/Brooks/Cole● Donald Pavia, Gary Lampman, George Kriz, James Vyvyan: Introduction to Spectroscopy: 4th Edition: Brooks/Cole● John Joule and Keith Mills: Heterocyclic Chemistry
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Core Course V: RUSBAS305

Course Title: Statistics I

Academic Year 2023-24

S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Analyze significance and validity of experimental results with statistical tests such as correlation, regression and hypothesis testing. They should comprehend the concepts of probability theory as a prerequisite to study advanced biostatistics.

Paper Code	Semester III	Lectures
RUSBAS305	Statistics I	30
305.1 Types of Data and Data Condensation		10
Concept of Population and Sample. Finite, Infinite Population, Notion of SRS, SRSWOR and SRSWR Different types of scales: Nominal, Ordinal, Interval and Ratio. Methods of Data Collection: i) Primary data: concept of a Questionnaire and Schedule, ii) Secondary Data Types of data: Qualitative and Quantitative Data; Time Series Data and Cross Section Data, Discrete and Continuous Data Tabulation Dichotomous classification - for two and three attributes, Verification for consistency Association of attributes: Yule's coefficient of association Q. Yule's coefficient of Colligation Y, Relation between Q and Y (with proof). Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution Data Visualization: Graphs and Diagrams, Histogram, Polygon/curve, Ogives. Bivariate Frequency Distribution of discrete and continuous variables		
305.2 Measures of central tendency		10

<p>Concept of central tendency of data, Requirements of good measures of central tendency. Location parameters: Median, Quartiles, Deciles, and Percentiles Mathematical averages Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, Mode, Trimmed mean. Empirical relation between mean, median and mode: Merits and demerits of using different measures & their applicability.</p>	
<p>305.3 Measures of Dispersion, Skewness & Kurtosis</p>	<p>10</p>
<p>Concept of dispersion, Requirements of good measure. Absolute and Relative measures of dispersion: Range, Quartile Deviation, Inter Quartile Range, Mean absolute deviation, Standard deviation. Variance and Combined variance, raw moments and central moments and relations between them, their properties. Concept of Skewness and Kurtosis: Measures of Skewness: Karl Pearson's, Bowley's and Coefficient of skewness based on moments. Measure of Kurtosis. Absolute and relative measures of skewness. Box Plot: Outliers.</p>	

Reference Books:

<p>Computational Sciences III</p>	<ul style="list-style-type: none"> ● Probability and measurement by P. Billingsley ● Introduction to probability theory by Das ● Testing Statistical Hypotheses: Lehmann, Erich L., Romano, Joseph P. ● Introduction to Linear Regression Analysis (Wiley Series): Douglas C. Montgomery , Elizabeth A. Peck , G. Geoffrey Vining
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Skill Enhancement Course: RUSBAS306

Course Title: Computational Sciences I

Academic Year 2023-24

S. Y. B. Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply bioinformatics databases and tools to study DNA and protein sequences, protein structure and metabolic pathways

Paper Code	Semester III	Lectures
RUSBAS306	Computational Sciences I	30
306.1 Introduction to Bioinformatics		10
Introduction to Bioinformatics & Databases Application of Bioinformatics INSDC Major Bioinformatics resources: NCBI, EBI, ExPASy Nucleic acid: GENBANK, EMBL, DDBJ Protein structure: domains, motifs (Pfam/Prosite) Protein sequence databases: Uniports, PIR, SWISSPROT, TrEMBL Literature database: PUBMED Genome database: GSS, Genome Specialized database: OMIM Protein structure databases: PDB Metabolic Pathway database: KEGG		
306.2 Basics to Sequencing		10
Molecular biology basics Genomics Proteomics DNA sequencing technology: Whole-genome shotgun sequencing strategies Protein sequencing methods Sequence File formats		

306.3 Pairwise Sequence Alignment	
<p>Basic Concepts of sequences similarity, Identity and homology Definition of homologs, orthologs, paralogs Concepts of sequence alignments Pairwise sequence alignment methods DOT Matrix analysis Scoring matrices: Basic concepts of scoring matrix, PAM and BLOSUM series and principles based on which these matrices are derived</p>	
RUSBASP303	PRACTICALS
<ol style="list-style-type: none"> 1. INSDC- NCBI, EMBL, DDBJ 2. Sequence databases- EMBL-EBI, GenBank, UniProt 3. Structure databases- PDB 4. Domain database: Prosite, PRINT, Pfam. 5. Specialized database: KEGG, PUBMED, OMIM, Use of Rasmol 	

Reference Books:

<p>Computational Sciences I</p>	<ul style="list-style-type: none"> ● Computational Biology and Bioinformatics :Ka-Chun Wong ● Chapter 1, Advanced Data Mining Technologies in Bioinformatics ● W3 Schools: HTML and XML <p>Complete Reference to HTML and XML</p>
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Ability Enhancement Course: RUSBAS307

Course Title: Ethics in Science

Academic Year 2023-24

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Appreciate ethical considerations in science.

Paper Code	Semester III	Lectures
RUSBAS307	Ethics in Science	30
307.1 The role of ethics in science		
Concept of ethics, values and morals Importance of Ethics in science Ethical Principles: Honesty, objectivity, integrity, carefulness, openness, Transparency, Accountability, Intellectual property, Confidentiality, Responsible Publication, respect for colleagues, Social responsibility		
307.2 Practicing Ethics in Science & Technology		
Ethics of methods and process Ethics of topics and findings Mistakes versus misconduct Everyday ethical decisions Enforcing ethical standards		
307.3 Ethical consideration in Scientific Research		
Promoting Ethical Conduct in Science Ethical Rules in Science, Breach of ethics in Science		

Reference Books:

Ethics in Science	The ethics of science: An introduction by David B. Resnic
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Modality of Assessment for: S. Y. B.Sc. Semester III

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1.	Internal Examination	20
2.	Assignment/Group Discussion/Presentation/Class Activity	20
	TOTAL	40

B) External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality) Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions / circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Duration – These examinations shall be of **2.0 Hours** duration.
Theory question paper pattern:

Paper Pattern for Core Subjects

Question	Options	Marks	Questions Based on
Q.1. Short answer question (5 Marks each)	3 out of 4	15	Unit I
Q.2. Short Answer questions (5 Marks each)	3 out of 4	15	Unit II
Q.3. Short Answer questions (5 Marks each)	3 out of 4	15	Unit III
Q.4. Objective/short answer question (5 Marks each)	3 out of 4	15	Combination of all units
	TOTAL	60	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	
Journal	10
Experimental tasks/Attendance	10
Small project/Class assignment/Presentation/Activity /Viva	20
Total	40

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Paper
Required Experiments Performed with appropriate principle, approach, Observations, Result, Demonstration of skills, Conclusion and Viva.	60
Total	60

Overall Examination & Marks Distribution Pattern

Semester III

Course	301			302			303			304		
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practicals	—	—	—	40	60	100	—	—	—	40	60	100

Course	305			306			307			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	700
Practicals	–	–	–	40	60	100	–	–	–	300

Ramnarain Ruia Autonomous College

Resolution Number: AC/II(22-23).3.RUS1

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)



Syllabus for:

**Program: Integrated M.Sc. in Bioanalytical
Sciences**

(S.Y. B.Sc. Semester IV Syllabus)

Program Code: RUSBAS

**(Credit Based Semester and Grading System
for
the academic year 2023-24)**

GRADUATE ATTRIBUTES

GA	GA Description A student completing Bachelor's Degree in Science program will be able to:
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GA 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.
GA 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
GA 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.
GA 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
GA 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.

GA 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.
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PROGRAM OUTCOMES

PO	Description
	A student completing Bachelor's Degree in Science program in the subject of Bioanalytical Sciences will be able to:
PO 1	This course will impart high quality science education in a vibrant academic ambience with the faculty of distinguished teachers and scientists.
PO 2	It will also equip students for the future who will take up the challenge of doing quality research & teaching and also contribute to industrial production and R & D in the fields of Bioanalysis, Bioinformatics and Nutraceutical Sciences.
PO 3	It will amalgamate classical analytical chemical techniques with modern genomic and proteomic technologies of manufacturing and analysis to better characterize the products useful as medicines as well as nutraceuticals.

Core Course I: RUSBAS401
Course Title: Biological Sciences III
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Describe the functioning of nerve and muscles and understand the importance of neurotransmitters as potential target for drugs.
CO 2	Understand genetics and describe inborn errors of metabolism and genetic disorders with respect to mutation, physiology, symptoms, diagnosis and cure. They should be aware of gene therapy as an emerging field to treat these disorders.

Paper Code	Semester IV	Lectures
RUSBAS401	Biological Sciences III	45
401.1 Biology of Muscles and Nerve Conduction		15
Muscle structure, Physiological and biochemical basis of muscle contraction Gibbs-Donnan Membrane Equilibrium and Physiology of nerve conduction Synapse & Synaptic conduction, Neurotransmitters. Drug addiction, Neuropathies		
401.2 Genetic Mutation and repair and genetic engineering		15
Types of mutation – Point and gross, Spontaneous and Induced, Types of Mutagens and effects, Cell survival strategies: repair mechanisms, Concept of transposons, types of transposons, role of transposons in genetic disorders with suitable examples Introduction to genetic engineering – Basics of cloning, Transgenic bacteria and their commercial applications		
401.3 Genetic Disorders		15
Inborn errors of metabolism, Phenylketonuria, Albinism, Lesch-Nyhan Syndrome, Tay-Sachs Disease, Sickle-Cell Anemia, Cystic Fibrosis, Huntington's Disease Duchenne muscular Disorder, Hemophilia, Thalassemia, Down's Syndrome, Spinal Muscular Atrophy (SMA), Diagnosis of genetic disorders,		

Reference Books:

Biological Sciences III	<ul style="list-style-type: none">● Fundamentals of Cytogenetics and Genetics: Mahabal Ram● Human Cytogenetics: Constitutional Analysis: Denis Rooney● Mutation Kindle Edition: Robin Cook● The Concise Book of Muscles, Second Edition: Chris Jarmey● Nerve and Muscle (Studies in Biology) 3rd Edition: R. D. Keynes (Author), D. J. Aidley (Author)
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Ramnarain Ruia Autonomous College

Core Course II: RUSBAS402
Course Title: Biological Sciences IV
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the theory, advantages and disadvantages of RIA, ELISA and Immunohistochemistry. They should be able to choose the most suitable technique as per the nature of sample and objective of analysis. They should understand wide range of the applications of these techniques in research and diagnostics.
CO 2	Describe hormones and grasp the complex nature, co-ordination and integration of biochemical pathways.
CO 3	Describe tissue culturing techniques and be able to design animal and plant tissue culture laboratories.

Paper Code	Semester IV	Lectures
RUSBAS402	Biological Sciences IV	45
402.1	Biochemical methods for Diagnostics	15
Purification & Analysis of Biomolecules, Principle and diagnostics applications of: Immunohistochemistry, ELISA and RIA, IRMA, Flow Cytometry and its applications in cancer diagnostics		
402.2	Cell communication and Cell signalling	15
Hormones and classification of hormones, Hormone secreting glands, organization of endocrine system, Physiological role of – pancreatic hormones-(insulin, glucagon), thyroxine, glucocorticoids, epinephrine Signal transduction pathways, 2 nd messengers, and bacterial chemotaxis		

402.3	Tissue Culture- Plants & Animals	15
<p>Plant Tissue culture: Concept of Plant Tissue Culture, Nutrient Requirement, Callus Induction, Micropropagation, Callus Culture, Suspension Culture, Batch Culture, Application of Plant Tissue Culture</p> <p>Animal Tissue culture: Concept of Animal Tissue culture Nutritional requirements of animal tissues (including significance of serum in media), Role of media components in production of tissue culture products, Concept of cell line & its classification with specific examples, Application of Animal Tissue Culture</p>		
RUSBASP401	PRACTICALS	
<ol style="list-style-type: none"> 1. Extraction of proteins from suitable biological sample and its estimation by Lowry's Method 2. Total Sugar estimation by Anthrone's method 3. Extraction of carbohydrates from suitable biological sample and their analysis by TLC 4. UV survival curve of <i>E.coli</i>: photo reactivation and dark repair. 5. Visit to Animal tissue culture & Plant tissue culture laboratory. 6. Radio immunosorbent assay (demo). 7. Immunodiffusion assay 		

Reference Books:

Biological Sciences IV	<ul style="list-style-type: none"> ● Plant Tissue Culture: Basic and Applied: Timir Baran Jha / Biswajit Ghosh ● Advances in Plant Tissue Culture: Kirti K. Prasad ● Animal Cell Culture: Essential Methods: John M. Davis ● Molecular Cell Biology: Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger ● Biochemical Methods of Analysis: Saroj Dua ● Ian Freshney: Animal Tissue culture
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Core Course III: RUSBAS403
Course Title: Chemical Sciences III
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Study pharmaceutical chemistry and bio-organic chemistry with the perspective of their applications in Bioanalytical sciences.
CO 2	Explain advances in biopolymers biomaterials and their applications.

Paper Code	Semester IV	Lectures
RUSBAS403	Chemical Sciences III	45
403.1 Introduction to Pharmaceutical Chemistry and Pharmacology		15
Scope of pharmacology, Source, Nature and Nomenclature of Drugs, Factors influencing Dosage and Drug Action, Introduction to drug action: Absorption, Distribution, Metabolism, Excretion of Drug (Drug Disposition and Pharmacokinetics)		
403.2 Introduction to Bio-Organic Chemistry		15
Overview of α -Amino acids: Structure, configuration, Essential amino acids and their abbreviations, classification, Properties: pH dependency of ionic structure and isoelectric point, Methods of preparations of α -Amino acids: Strecker synthesis, amidomalonate synthesis, Erlenmeyer azalactone synthesis. Polypeptides and Proteins: Polypeptides: Peptide bond. Nomenclature and representation of polypeptides. Merrifields solid phase peptide synthesis (example of di- and tri- peptides for nomenclature and synthesis). Structures and properties of crown ethers, cryptands, cyclophanes, calixarenes, rotaxanes and cyclodextrins. Synthesis of crown ethers, cryptands and calixarenes. Molecular recognition and catalysis, molecular self-assembly.		

403.3 Material Chemistry: Polymers And Biomaterials	15
<p>Polymers: Introduction: General idea of structure. Namings, types of polymers, tacticity, polymerization processes with examples, radical and ionic mechanisms of polymerizations. Characteristic properties of polymers. General ideas of resins, plastics, rubber, idea of plasticizers, stabilizers, stabilizers, fillers. Structure, preparation and applications of PE (types and Ziegler – Natta process), PP, Teflon, PVC, polyacrylates, PAN, Neoprene, Terylene, Nylons, Phenol/Melamine/Urea-formaldehyde Resins, polyurethane, polycarbonate, epoxy resins (structures of the monomers and those of the polymers are expected).</p> <p>Biomaterial: Introduction: Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties. Metallic implant materials – Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with biometal, corrosion behaviour and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.</p>	

Reference Books:

Chemical Sciences III	<ul style="list-style-type: none"> ● F. A. Carey: R.J Sunderberg: Advanced organic chemistry: Plenum ● J. W. Steed, J. L. Atwood Supramolecular Chemistry: 2nd edition: John Wiley & Sons 2009 ● Carsten Schmuck, Helma Wennemers: Highlights in Bioorganic Chemistry: ● Wiley-VCH By Buddy D. Ratner, et. al. Biomaterials Science: An Introduction to Materials in Medicine, Academic Press ● Sujata V. Bhat: Biomaterials: Narosa Publishing House, 2002. ● J B Park: Biomaterials – Science and Engineering: Plenum Press, 1984 ● Pharmaceutical Chemistry: Watson (Author)
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Core Course IV: RUSBAS404
Course Title: Chemical Sciences IV
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Grasp the concept of radioactivity and understand its applications in diagnostics and therapeutics.
CO 2	Understand importance of inorganic metals in maintenance of health.
CO 3	Comprehend basics of separation techniques as a prerequisite to study advanced and hyphenated separation techniques.

Paper Code	Semester IV	Lectures
RUSBAS404	Chemical Sciences IV	45
404.1	Nuclear chemistry	15
Basic nuclear chemistry: Overview, Definitions/Terms involved. Use of radioisotopes as tracers in: Chemical investigations- reaction mechanism, Age determination- dating by Carbon-14 Activation analysis- basic principles, fast neutron activation analysis, radio-chemical method in activation analysis Isotopic dilution method- principle and applications, Auto, x-ray and gamma radiography. Applications of radio-analytical techniques. Introduction to Nuclear medicine: Therapeutic Radioisotopes, Radiopharmaceuticals for therapy, Tissue targeting, Radiopharmaceutical quality control Beta particles: Copper Radioisotopes, Dysprosium-165, Erbium-169, Iodine-131, Iodine-125, Lutitium-177, Phosphorous-32, Radioisotopes of Rhenium, Samarium-153, Strontium-89, Yttrium-90, Indium-111, Tin-Sn-117 Alpha particle emitters: Actinium, Bismuth, and Other Alpha Emitters. Cancer Radio Therapy, Applications of Nuclear chemistry in genetics		
404.2	Aspects of Bio-Inorganic Chemistry	15
Overview of Metals in biological systems, Significance of metals in various physiological processes: Cytochrome and Iron Sulphur proteins in Electron Transport Chain, Role of metal ions (Mg^{2+} , Cu^{2+} , Zn^{2+} , Mn^{2+} , etc) as co-factors of Metalloenzyme or Metal dependent enzymes, Role of calcium in biology, Metals in medicine with an emphasis of platinum-based DNA binding drugs.		
404.3	Introduction to Planar Chromatography	15
Principles of Planar Chromatography Basics of Chromatography: Stationary Phase, Mobile Phase, Rf Value, Chromatogram, Chromatograph, Solvent front, etc. Sample preparation for paper chromatography and thin layer chromatography (TLC) Paper chromatography and its applications TLC and its applications Introduction to High Performance Thin Layer Chromatography (HPTLC) Advances of HPTLC over TLC		
RUSBASP402	PRACTICALS	
Separation of Organic mixtures: 1. Water soluble + Water insoluble (Solid + Solid) 2. Water insoluble + Water insoluble (Solid + Solid) Solvent Extraction: Determination of Fe and Cu from their mixture Viscosity measurements:		

To determine the molecular weight of polyvinyl alcohol using viscometer.

Colorimetry

To determine indicator constant of a given indicator by Colorimetric measurements

Turbidimetry

Turbidimetric analysis of cough syrup

Reference Books:

Chemical Sciences IV	<ul style="list-style-type: none">● P S Kalsi: Bioorganic, Bioinorganic and Supramolecular Chemistry: New Age International● Peter Atkins & Julio de Paulo: Physical Chemistry: Oxford University Press● Ira N. Levine: Physical Chemistry: McGraw-Hill● Marie Claire Cantone, Christoph Hoeschen: Radiation Physics for Nuclear Medicine: Springer● Douglas. A. Skoog, F. James Holler, Stanley R Crouch: Principles of analytical: 6th edition: Thomson/Brooks/Cole
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Core course V: RUSBAS405

Course Title: Statistics II

Academic Year 2023-24

S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Analyze significance and validity of experimental results with statistical tests such as correlation, regression and hypothesis testing. Comprehend the concepts of probability theory as a prerequisite to study advanced biostatistics.

Paper Code	Semester IV	Lectures
RUSBAS405	Statistics II	30
405.1 Correlation, Simple linear Regression Analysis		10
<ol style="list-style-type: none"> 1. Visualizing relationship using Scatter Diagram, 2. Karl Pearson's Product moment correlation coefficient and its properties. 3. Spearman's Rank correlation. (With and without ties) 4. Concept of Simple linear regression. Principle of least squares. Fitting a straight line by method of least squares (Linear in Parameters) 5. Relationship between regression coefficients and correlation coefficient, cause and effect relationship, Spurious correlation. 6. Concept and use of coefficient of determination (R^2). 7. Measures of association with the help of Tau A, Tau B, Tau C, Gamma and Lambda, Somer's d 		
405.2 Probability Theory		10
<ol style="list-style-type: none"> 1. Trial, random experiment, sample point and sample space. 2. Definition of an event, mutually exclusive and exhaustive events. 3. Classical (Mathematical) and Empirical definitions of Probability - Discrete random variable 4. Random variable- Discrete and Continuous 5. Standard Discrete Probability Distribution Functions Binomial, Poisson (Concept Only) 6. Standard Continuous Probability Distribution Functions: Normal, t, Chi-square and F distribution (Concept only) 		

405.3 Basics of Theory of Estimation and Testing of hypothesis	10
<ol style="list-style-type: none">1. Point and Interval estimate of single mean, single proportion from sample of large size.2. Statistical tests: Concept of hypothesis, Null and Alternative Hypothesis, Types of Errors, Critical region, Level of significance, Power3. Small sample tests-Independent sample t-test, paired t-test. Concept of p-value. (Use of Excel and SPSS)	

Reference Books:

Statistics II	<ul style="list-style-type: none">• Probability and measurement by P. Billingsley• Introduction to probability theory by Das• Testing Statistical Hypotheses: Lehmann, Erich L., Romano, Joseph P.• Introduction to Linear Regression Analysis (Wiley Series): Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining
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Skill Enhancement Course: RUSBAS406
Course Title: Tools and Techniques in Biology
Academic Year 2023-24
S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Describe the types of microscopy.
CO2	Differentiate between different types of electrophoresis.
CO3	Describe biochemical diagnostic tests. They will understand pathological reports.

Paper Code	Semester IV	Lectures
RUSBAS406	Tools and Techniques in Biology	30
406.1 Advances in Microscopy		10
Phase Contrast Microscopy Principle, working, advantages, disadvantages, and applications of Scanning Electron Microscopy, Transmission Electron Microscopy Sample preparation for microscopic studies (Special emphasis on SEM/TEM)		
406.2 Electrophoresis:		10
Basic Principles of Electrophoretic Separation, Support media in electrophoresis Instrumentation and types of Electrophoresis Agarose Gel Electrophoresis Polyacrylamide gel electrophoresis and its types Applications of electrophoresis		
406.3 Principles of clinical biochemistry		10
Basis of analysis of body fluids for diagnostic, prognostic and monitoring purposes Clinical Measurements & Quality Control Examples of biochemical aids to clinical diagnosis		

RUSBASP403	PRACTICALS
<ul style="list-style-type: none"> • Understanding Human pathological reports (CBC, liver profile). • Analysis of Urine • Microscopic examination of blood components • Separation of plasma from blood • Estimation of glucose/proteins, from blood sample. • SDS-PAGE (Demo) • Agarose Gel Electrophoresis • Demonstration of SEM/TEM 	

Reference Books:

Advances in Microscopy	Light and Electron Microscopy by Elizabeth M. Slayter, Henry S. Slayter
Electrophoresis	Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein by Reiner Westermeier
Principles of Clinical Biochemistry	Clinical Biochemistry: Metabolic and Clinical Aspects: With Expert Consult access by William J. Marshall MA PhD MSc MBBS FRCP FRCPATH FRCPedin FRSB FRSC, Márta Lapsley MB BCh BAO MD FRCPATH, Andrew Day MA MSc MBBS FRCPATH, Ruth Ayling PhD FRCP FRCPATH

Ability Enhancement Course: RUSBAS407

Course Title: Research Methodology

Academic Year 2023-24

S. Y. B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply critical thinking for conducting research.

Paper Code	Semester IV	Lectures
RUSBAS407	Research Methodology	30
407.1 Introduction to Research methodology		10
Research: A Way of Thinking Meaning, objective and motivation of Research Types of research		
407.2 The Research Process		10
Planning and conduct of research Formulating a research problem		
407.3 Conceptualising a Research Design		10
Definition of Research Design Features of a good Research Design Need of Research Design Important concepts in Research Design		

Reference Books:

Research Methodology	Research Methodology by C.R. Kothari, New Age International Publications
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Modality of Assessment for: S. Y. B.Sc. Semester IV

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1.	Internal Examination	20
2.	Assignment/Group Discussion/Presentation/Class Activity	20
	TOTAL	40

B) External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions / circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

1. Duration - These examinations shall be of **2.0 Hours** duration.
2. Theory question paper pattern:

Question	Options	Marks	Questions Based on
Q.1. Short answer question (5 Marks each)	3 out of 4	15	Unit I
Q.2. Short Answer questions (5 Marks each)	3 out of 4	15	Unit II
Q.3. Short Answer questions (5 Marks each)	3 out of 4	15	Unit III
Q.4. Objective/short answer question (5 Marks each)	3 out of 4	15	Combination of all units
	TOTAL	60	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	
Journal	10
Experimental tasks/Attendance	10
Small project/Class assignment/Presentation/Activity /Viva	20
Total	40

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Paper
Required Experiments Performed with appropriate principle, approach, Observations, Result, Demonstration of skills, Conclusion and Viva.	60
Total	60

Overall Examination & Marks Distribution Pattern

Semester IV

Course	401			402			403			404		
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practicals	—	—	—	40	60	100	—	—	—	40	60	100

Course	405			406			407			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	700
Practicals	—	—	—	40	60	100	—	—	—	300