Resolution number: AC/II(21-22).2.RUS1

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus For:

Program: Integrated M.Sc. in Bioanalytical Sciences

(Undergraduate Syllabus)

Program Code: RUSBAS

(Credit Based Semester and Grading System for academic year 2021–2022)

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 Bioanalytical Sciences will be able to:
PSO 1	This course will impart high quality science education in a vibrant academic ambience with the faculty of distinguished teachers and scientists.
PSO 2	It will also equip students for the future who will take up the challenge of doing quality research and teaching and also contribute to industrial production and R & D in the fields of Bioanalysis, Bioinformatics and Nutraceutical Sciences.
PSO 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.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
F.Y.B.Sc	I	RUSBAS101	Biological Sciences I	3
		RUSBAS102	Biological Sciences II	3
		RUSBASP101	Biological Sciences Practical	2
		RUSBAS103	Chemical Sciences I	3
		RUSBAS104	Chemical Sciences II	3
		RUSBASP102	Chemical Sciences Practical	2
		RUSBAS105	Computational Sciences I	2
		RUSBAS106	Computational Sciences II	2
		RUSBASP103	Computational Sciences Practical	2
		RUSBAS107	Foundation Course-I	2
F.Y.B.Sc	II	RUSBAS201	Biological Sciences I	3
		RUSBAS202	Biological Sciences II	3
		RUSBASP201	Biological Sciences Practical	2
		RUSBAS203	Chemical Sciences I	3
		RUSBAS204	Chemical Sciences II	3
		RUSBASP202	Chemical Sciences Practical	2
		RUSBAS205	Computational Sciences I	2
		RUSBAS206	Computational Sciences II	2

		RUSBASP203	**Computational Sciences Practical**	**2**
		RUSBAS207	**Foundation Course-II**	**2**
S.Y.B.Sc	**III**	**RUSBAS301**	**Biological Sciences III**	**3**
		RUSBAS302	**Biological Sciences IV**	**3**
		RUSBASP301	**Biological Sciences Practical**	**2**
		RUSBAS303	**Chemical Sciences III**	**3**
		RUSBAS304	**Chemical Sciences IV**	**3**
		RUSBASP302	**Chemical Sciences Practical**	**2**
		RUSBAS305	**Computational Sciences III**	**2**
		RUSBAS306	**Computational Sciences IV**	**2**
		RUSBASP303	**Computational Sciences Practical**	**2**
		RUSBAS307	**Environmental Sciences**	**2**
S.Y.B.Sc	**IV**	**RUSBAS401**	**Biological Sciences III**	**3**
		RUSBAS402	**Biological Sciences IV**	**3**
		RUSBASP401	**Biological Sciences Practical**	**2**
		RUSBAS403	**Chemical Sciences III**	**3**
		RUSBAS404	**Chemical Sciences IV**	**3**
		RUSBASP402	**Chemical Sciences Practical**	**2**
		RUSBAS405	**Computational Sciences III**	**2**

		RUSBAS406	**Computational Sciences IV**	**2**
		RUSBASP403	**Computational Sciences Practical**	**2**
		RUSBAS407	**Technical Communication skills**	**2**
T.Y.B.Sc	**V**	**RUSBAS501**	**Entrepreneurship Skills**	**3**
		RUSBASP501	**Entrepreneurship Skills Project/CaseStudy/Assignment Practical**	**2**
		RUSBAS502	**Biological Sciences V**	**3**
		RUSBASP502	**Biological Sciences Practical**	**2**
		RUSBAS503	**Chemical Sciences V**	**3**
		RUSBAS504	**Chemical Sciences VI**	**3**
		RUSBASP503	**Chemical Sciences Practical**	**2**
		RUSBAS505	**Computational Sciences V**	**2**
		RUSBASP504	**Computational Sciences Practical**	**2**
T.Y.B.Sc	**VI**	**RUSBAS601**	**Entrepreneurship Skills**	**3**
		RUSBASP601	**Entrepreneurship Skills Project/CaseStudy/Assignment Practical**	**2**
		RUSBAS602	**Biological Sciences V**	**3**
		RUSBASP602	**Biological Sciences Practical**	**2**

		RUSBAS603	**Chemical Sciences V**	**3**
		RUSBAS604	**Chemical Sciences VI**	**3**
		RUSBASP603	**Chemical Sciences Practical**	**2**
		RUSBAS605	**Computational Sciences V**	**2**
		RUSBASP604	**Computational Sciences Practical**	**2**

Course Code: RUSBAS101

Course Title: Biological Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should realize the importance of type specimens and in-vivo models in Biological research.
CO 2	Students will understand basic concepts of microbiology. They should be able to successfully understand the significance and perform aseptic transfer techniques.
CO 3	Students should learn the operation of simple light microscope.
CO 4	Student will know the significance of studying plant and animal anatomy and the functions of specialized cells present in them.

Paper Code	Semester I	lectures
RUSBAS101	**Biological Sciences I**	**45**
101.1 Introduction to Plant Anatomy and Physiology		**15**
Plant Anatomy: (8L) Tissue and Tissue systems in Plants, Meristems, Classification of Meristems, Permanent tissues and classification of permanent tissue, Cell differentiation, Specialized cells of plants, Importance of plant anatomy, Significance of Sunflower, Maize &*Arabidopsis thaliana* as type specimens **Plants Physiology** Seed germination, Photosynthesis: Light reactions, Carbon fixation reactions C3, C4 & CAM pathways, Photorespiration, Storage of plants, Oil seeds.		
101.2 Introduction to Animal Anatomy and Physiology		**15**
Animal Anatomy: (7L) Tissue and Tissue systems in Animals, Classification of Animal tissues, Cell differentiation, Specialized cells of Animals, Importance of Animal anatomy, Significance of Mice, Zebra Fish, Guinea Pig, Non-human primates, *Homo sapiens sapiens as type specimen* **Animal systems**: Respiratory System, Digestive System, Excretory System, Nervous System, Reproductive System,		
101.3 Introduction to Microbiology		**15**
Microbes & their Environment, Biodiversity and types of Microorganisms, Significance and Scope of Microbiology, Visualization of Microorganisms: Staining, Simple and Compound Microscopy, Significance of *E. coli*, Yeast & *Neurospora* crassa as type spceimens Introduction to concepts of asepsis, sterilization and disinfection		

Reference Books:

Biological Sciences I	• B. P. Pandey, Plant Anatomy, S Chand • Gerald Karp, Cell Biology • Micheal J. Pelczar, Jr., E. C. S. Chan, Noel R. Krieg – Microbiology • B.R. Vashishta, A K Sinha,Adarsh, Botany for Degree Students Part III:Bryophyta • Gerald Karp, Cell Biology

Course Code: RUSBAS102

Course Title: Biological Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will appreciate versatility and dynamic nature of carbon.
CO 2	Students should be able to draw the correct structures of biomolecules and understand structure-function and correlation.
CO 3	They should be able to schematically represent and explain various physiological processes in plants and animals.

Paper Code	Semester I	lectures
RUSBAS102	**Biological Sciences II**	**45**
102.1 Introduction to Biomolecules and Carbohydrates		**15**
Introduction to Biomolecules Overview of chemical and physical attributes of Biomolecules, Classification of Biomolecules, Significance of Biomolecules in nature and science. **Carbohydrates** Classification of carbohydrates Structure, structure properties, Isomerism, derivatives, functions & reactions of Monosaccharides, Oligosaccharides, Homopolysaccharides (Starch, Inulin, Glycogen, Cellulose), Heteropolysaccharides		
102.2 Proteins & Nucleic Acids		**15**
Amino acids & Proteins Structure, classification, physical and chemical properties, levels of structural organization of Proteins, Introduction to Ramachandran plot. **Nucleic Acids** Chemistry of nucleic acids, nucleosides, nucleotides, Structure and properties of DNA, stability of nucleic acid structures, Chargaff's rules, Watson and Crick model, Confirmations of DNA-A, B, Z forms of DNA, Structure, function and types of RNA		

102.3 Lipids & Vitamins	**15**
Lipids Classification of fatty acids and lipids, Physical and Chemical properties, Functions of fatty acids, glycolipids, phospholipids, Structure and function of Cholesterol, **Vitamins**: Storage and Occurrence, Structure, properties, Recommended dietary allowance, Deficiency and treatment.	

RUSBASP101	**PRACTICALS**

1. Cleaning, Sterilization of glassware
2. Various types of Media preparation for Microbial growth
3. Aseptic Transfer
4. Isolation of bacteria
5. Staining techniques: Monochrome Staining, Gram staining
6. Estimation of oil from oil seeds
7. Qualitative analysis of Biomolecules - Carbohydrates, Proteins, Nucleic Acids, Lipids
8. Fungal Staining

Reference Books:

Biological Sciences II	• David Hopkin Lewis, Storage Carbohydrates in Vascular Plants: Distribution, Physiology, and Metabolism • David Nelson, Michael Cox: Lehninger's Principle of Biochemistry: Springer • Hiram.F.Gilbert : Basic concept in Biochemistry : Mac Grow Hill • J Koolman, K.H. Roehm : Color Atlas of Biochemistry : 2nd edition : Theime Publication U.Satyanarayana,U.Chakrapani-Biochemistry • S. Mukherji and A. K. Ghosh, Plant Physiology, New Central Book Agency (P) Ltd • Russell; Hunter, W.D. and McMillan: Life of Invertebrates • Kotpal, R.L.: Zoology Phylum – Arthropoda, Rastogi Publication

Course Code: RUSBAS103

Course Title: Chemical Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be able to prepare buffers and operate pH meter.
CO 2	Students should accurately name and identify aromatic compounds.
CO 3	Students should understand the concepts of molecular bonding.

Paper Code	Semester I	lectures
RUSBAS103	**Chemical Sciences I**	**45**
103.1 Ionic Equilibrium, pH and Buffers		**15**
Acid- Base concept, Hard and soft acid and base (*HSAB),* Ostwald's Dilution Law, Activity coefficient, Solubility, Complex formation and organic complexes, Oxidation and reduction equilibria, Hydrolysis of salts and Solubility product Concept of pH, pKa, pKw, Isoelectric pH, Buffer, Buffering Capacity Derivations: Ionic product of water, Hendersen–Hasselbalch equation, Relation between pI, pKa1 and pKa2 for a neutral, acidic and basic amino acid. Titration and Ionization of Glycine, Lysine and Aspartic acid; pKa, pH, and pI values of these amino acids Physiological Buffers: Preparation, properties and uses of Carbonate-Bicarbonate, Phosphate, and Citrate buffers Preparation and Numericals based on pH and Buffer		
103.2 IUPAC Nomenclature and Aromaticity		**15**
IUPAC: Rules of IUPAC nomenclature, IUPAC nomenclature of basic functional groups, aliphatic poly functional compounds, including monocyclic compounds on the basis of IUPAC priority order. (Line formulae expected) IUPAC nomenclature of Spiro, Biphenyls, Bicyclic compounds, SMILES Notation **Aromaticity**: Characteristic properties of aromatic compounds, Huckel's rule, Aromaticity and anti-aromaticity, Resonance energy, Aromatic hydrocarbons: Benzenoid & Nonbenzenoid compounds (benzene, naphthalene, anthracene, phenanthrene, cyclopropenium, cyclopentadienyl, cycloheptatrieniumcation)		

103.3 Introduction to Molecular Bonding	**15**
Concept of atoms and molecules and atomic structure orbitals Concept of electronic configuration-Pauli's exclusion principle, Hund's rule, Aufbau principle Types of bonds and bonding, Chemical bonding theory, Valence-Bond theory and Molecular orbital theory, Concept of hybridization and its types(change) Molecular orbital theory for polyatomic species: I)BeH_2 II) H_2O III) NH_3 IV) CH_4(New) Polar covalent bonds and Electronegativity, Drawing chemical structures (Based on Lewies dot structure), Molecular models	

Reference Books:

Chemical Sciences I	• John McMurry: Organic Chemistry: 5th Edition: Brooks AND Cole Publication • James House: Inorganic Chemistry: Elsevier • Paula Yurkanis Bruice: Organic Chemistry: Pearson • P.S Kalsi: Organic Reactions and Their Mechanisms: Third Edition, New Age • Ira N. Levine: Physical Chemistry: McGraw-Hill • S.C.Pal: Nomenclature of organic chemistry :Alpha publication • Peter Atkins & Julio de Paulo: Physical Chemistry: Oxford University Press

Course Code: RUSBAS104

Course Title: Chemical Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should analyze conductometric, pH metric and acid-base titration curves to predict the chemical nature of titrant and titrate. They should realize the importance of calibration in science.
CO 2	Students should be able to demonstrate mechanisms of organic reactions and identify the similarities between organic and biochemical reactions

Paper Code	Semester I	lectures
RUSBAS104	**Chemical Sciences II**	**45**
104.1 Stoichiometry and Preparation of Standard Solutions, Titrimetric analysis		**15**
Methods of expressing concentration of solutions-molarity, normality, molality, mole fraction, % calculations (w/w, v/v, w/v) dilution of solutions, concept of milliequivalents, millimols, ppm and ppb, ppt interconversion between different concentration units to (% to ppm, % to molar, % to mg/mL, PPM to mg/ mL, etc.) Primary and secondary standards, Preparation of standard solutions, Calculation of concentration of commercial samples of acids and bases, Use of computers in chemical calculations. Requirements for a reaction to be used in titrimetric analysis, classification of titrimetric analysis, Terms: titration, titrand, titrant, titre value, indicator, endpoint, equivalence point, titration error. Principles of acid-base, oxidation–reduction, complexometric titrations, and precipitation titration with suitable examples. Karl-Fischer Titration		

104.2 Basic Laboratory Instruments and Automation	**15**
1.Basic Set up of a biological, chemical and bioanalytical laboratory 2. Basic principle, Instrumentation and applications of: Lab equipments: centrifuge, ultrasonicator (probe and bath), vortex machine rotary shaker (for tubes and flasks),rotary evaporator, hot air oven, autoclave, incubator, cyclomixer, pulverizer Analytical instruments: pH meter, colorimeter, weighing balance 3. Introduction to automation: Need for automation in a laboratory, Advantages of automation, different types/levels of automation involved in various lab equipment/instruments: vortex machine, micropipettes, autopipettes, pH meter, ultrasonicator, rotary shaker	
104.3 Introduction to Good Laboratory Practices and Safety in Laboratory	**15**
1. General Lab safety rules, laboratory hygiene 2. Introduction to Good Lab Practices 3. Importance of calibration of instruments with any two examples 4. Importance of documentation in laboratory	

RUSBASP102 PRACTICALS

1. Stoichiometric calculations and preparation of primary and secondary standard solutions.
2. Study of pH meter (calibration and analysis)
3. Volumetric analysis (Calculation of % error expected)
   a) Acid – Base titration
   b) Estimation of Iron using Internal Indicator
   c) Estimation of Vitamin C from various samples
   d) Estimation of Total Hardness
   e) Estimation of iodine in iodised common salt using iodometry.
4. Preparation of various buffers and measurement of pH using pH meter and pH paper. Calculation of % error expected: Acetic acid—Sodium acetate Buffer

Calibration of glassware: Burette, Pipette, Standard Flask

Reference Books:

Chemical Sciences II	• Morrison AND Boyyd: Organic chemistry :Allyn&Baconp publication • Richard O.C. Norman, James M. Coxon: Principles of Organic Synthesis, 3rd Edition:CRC Press • Peter Sykes: A Guidebook to Mechanism in Organic Chemistry:6 Edition: Pearson • P.S Kalsi :Organic Reactions and Their Mechanisms :Third Edition, New Age • Ira N. Levine: Physical Chemistry : McGraw-Hill

Course Code: RUSBAS105

Course Title: Computational Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should adapt for basic arithmetic calculations.
CO 2	Students should apply the mathematical equations to find solutions to given problems.

Paper Code	Semester I	Lectures
RUSBAS105	**Computational Sciences I**	**30**
	105.1 System of linear equations and Matrices	**10**
	Matrices over R (order 2 & 3): Matrix operations (addition, subtraction, scalar multiplication, matrix multiplication, transpose of a matrix (it's properties), inverse by elementary row transformation, adjoint method, solution of system of equation both homogenous and non-homogenous using matrix (concept of Rank to be introduced) Determinants: Determinant of a matrix of order 2 and 3, elementary properties of determinants, solving a system of linear equations (up to 3 variables) using Crammer's rule and application to medicines, pharmaceuticals, food and vitamins.	
	105.2 Calculus	**10**
	Derivatives and its application (one variable) Definition by first principle method, rules addition, subtraction, multiplication, division (only statements) Application of derivatives: Rate measure (Physics, Chemistry, Industrial aspects), Approximation and errors, Mean value theorems (without proof) Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem Extreme values using first and second derivatives (application type problem)	

	105.3 Ordinary Differential Equation and Applications	**10**
	First order differential equations: Review of separable differential equations, homogenous and non- homogenous differential equation. Linear differential equations and Bernoulli differential equations. Modeling with first order equations: examples from financial mathematics, chemistry, environmental sciences, population growth and decay. Second order linear differential equations: The general second order differential equations, existence and uniqueness, theorem for the solutions of a second order initial value problem (statement only) Emphasis should be on solving problems with different rules	

Reference Books:

Computational Sciences I	• S.LangLinear Algebra • Schaum's outlines on matrices • Simmons, G.F., Differential Equations With Applications and Historical Notes, • Chapter1, Sections 1,2,3 of Elements of Partial Differential, McGraw Hill • Serge Lang, Introduction to Linear Algebra, , Springer Verlag, Balaguruswamy, E., Discrete Mathematics and Its Applications, Numerical Methods, Tata McGraw Hill

Course Code: RUSBAS106

Course Title: Computational Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should appreciate the extensive applications of optics in analytical instrument like colorimeter and spectrophotometer.
CO 2	Students should grasp the fundamental concepts of crystal geometry and X-ray diffraction.

Paper Code	Semester I	Lectures
RUSBAS106	**Computational Sciences II**	**30**
106.1 Alternating current theory & transient response of circuit.		**10**
AC circuit containing pure R, pure L and pure C Representation of sinusoids by complex numbers, Series L-R, C-R and LCR circuits. Resonance in LCR circuit (both series and parallel) Power in ac circuit. Q-factor. Series LR, CR, LCR circuits. Growth and decay of currents/charge.		
106.2 Optics		**10**
Image formation: coaxial system of two thin lenses in contact and separated by a distance, cardinal points and qualitative description of image formation by a thin lens, aberration of optical images (spherical aberration, distortion, chromatic aberration), methods reducing aberrations, Ramsden eyepiece. **Interference by division of amplitude**: interference in thin films (reflected system only) a wedge shaped film in monochromatic light, Newton's rings, determination of wavelength and the refractive index of a liquid using Newton's rings. **Fraunhofer diffraction:** expression for the resultant of N simple harmonic vibrations of equal amplitude, the same period and phases increasing in an arithmetic progression, use of this expression to study a single slit, a double slit, and a plane diffraction grating(transmission type), comparison of prism and grating spectra. **Introduction to polarization**: pictorial representation of polarized light, polarization by scattering and by reflection, Brester's law, Malus's law, double refraction in calcite and quartz, experimental determination of μ0 and μE of a quartz or a calcite prism.		

106.3 Material Science, Crystal Geometry & X-Ray Techniques	**10**
Material science: classification of materials, organic, inorganic and biological materials, semiconductor materials, current trends and advances in materials, materials structure and examination, selection of materials Crystal geometry and structure: crystals, single crystal, whiskers, lattice point and space lattice, unit cell, primitive cell, atomic radius, density of crystal, direction lattice planes, miller indices, interplanar spacing, crystal planes in cubic unit cells, common planes in simple cubic structure, Co-ordination number, crystal growth X-rays: production, continuous and characteristic X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law. Compton Effect and its experimental verification, energy dependence of photoelectric effect and Compton Effect.	

RUSBASP103	**PRACTICALS**

1. Focal length of a lens system
2. High pass Filter, Low pass filter
3. Surface Tension
4. Vernier Caliper, Micrometer screw gauge and their use in pharma
5. Study of light Microscope

Case studies on diagnostic tools such as X-Ray, CT scan, MRI scan

Reference Books:

Computational Sciences II	• Verma, H.C., Concepts of Physics, Volume 1, Bharati Bhavan Publishers & Distributors. • Mathur D. S., Elements of Properties of Matter, , S. Chand and Co. Ltd., Reprint 2001. • Mathur B.K. and T.P. Pandya, Principles of Optics, Gopal Printing Press, Kanpur. • Jenkins F.A. , Fundamentals of Optics, Whitte, 4e, 1981, McGraw Hill International. Ghtak, A., Optics, 2nd Ed., TMH,1992

Course Code: RUSBAS107

Course Title: Foundation course I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be aware about their constitutional rights and current socio-political scenario of India.

Paper Code	Semester I	Lectures
RUSBAS107	**Foundation Course-I**	**30**
107.1 The Indian Constitution		**10**
1. Methods of expressing concentration of solutions-Philosophy of the Constitution as set out in the Preamble 2. The structure of the Constitution-The Preamble, Main Body and Schedules 3. Fundamental duties of the Indian Citizen, tolerance, peace, and communal harmony as crucial values in strengthening the social fabric of the Indian society 4. Basic features of the Constitution		
107.2 Growing Social Problems in India		**10**
1. Substance Abuse-Impact on Youth and Challenges for the future 2. HIV/AIDS- Awareness, prevention, treatment and services 3. Problems of the Elderly-Causes, implications and response 4. Issue of Child Labour-Magnitude, causes, effects and response 5. Child Abuse-Effects and ways to prevent 6. Trafficking of Women- Causes, effects and response		
107.3 Significant aspects of political processes		**10**
1. The party system in Indian Politics 2. Local self-government in urban and rural areas; the 73rd and 74th Amendments and their implications for inclusive politics 3. Role and significance of women in politics		

Reference Books:

Foundation course	• K. T. Basantani; Social Awareness - Foundation Course, Semester - I; Sheth Publisher Pvt. Ltd.

Modality of Assessment for: F.Y.B.Sc. Semester I

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:

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

Paper Pattern for Biological, Chemical, Computational Sciences:

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**	

Paper Pattern for Foundation Course:

Question	Options	Marks	Questions Based on
Q.1. Short answer question	1 out of 2	8	Unit I
	Compulsory	7	
Q.2. Short Answer questions	1 out of 2	8	Unit II
	Compulsory	7	
Q.3. Short Answer questions	1 out of 2	7	Unit III
	Compulsory	8	
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 I

Course	101			102			103			104		
	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	105			106			107			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

Course Code: RUSBAS201
Course Title: Biological Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should comprehend fundamental concepts of genetics.
CO 2	Students should realize the significance of enzymes with respect to drug design.
CO 3	Students should learn the properties and dynamics of plasma membrane as a prerequisite to study transport of drug molecules.

Paper Code	Semester II	Lectures
RUSBAS201	**Biological Sciences I**	**45**
201.1 Introduction to Genetics		**15**
1. Cell cycle- G and S Phases, Control of cell cycle 2. Concept of genes, chromosomes, Mitosis and Meiosis, Apoptosis 3. Non-Mendelian inheritance, Linkage and crossing over, Gene expression 4. Sex determination in animals, sex linked, sex limited and sex influenced genes 5. Variations in chromosome number and structure (e.g., Rice, and Drosophila)		
201.2 Enzymology		**15**
1. Enzymes: Chemical nature, properties, nomenclature, classification, units of enzyme activity: katal specific activity. 2. Mechanism of enzyme action: concept of active site, activation energy, binding energy, energy diagram for enzyme catalysed reactions, lock & key Vs induced fit mechanism 3. Enzyme kinetics: Michaelis-Menton equation, Lineweaver-Burk plot 4. Enzyme inhibitors: Equations & Graphs 5. Allosteric enzymes 6. Types of catalysis: Acid base, covalent, metal ion 7. Isoenzymes, abzymes, synzymes, ribozymes, 8. Applications of enzymes, immobilized enzymes		
201.3 Coenzymes and Biological Membranes & Transport		**15**
201.3.1 Coenzymes: Coenzymes: Coenzymes in hydrogen transfer reactions- nicotinamide nucleotide, flavin nucleotide, lipoic acid. Co enzymes involved in group transfer-biotin,		

pyridoxal phosphate, thiamine pyrophosphate, coenzyme A, cobalamine, tetrahydrofolic acid **(7L)** **201.3.2 Membranes & Transport** Composition of biological Membranes, Different models of Biological Membranes, Membrane dynamics, Solute transport across Biological Membrane (Types & specific examples) **(8L)**	

Reference Books:

Biological Sciences I	• Robert Copeland : Enzyme: 2nd edition: Wiley publication • William .P. Jencks: Catalysis in Chemistry and Enzymology : Courier Dover Publications • Tim Bugg: Introduction to Enzyme and Coenzyme Chemistry : 2nd Edition :Blackwill publication • David Nelson, Michael Cox :Lehninger's Principle of Biochemistry : Springer • Buns, G. W.: Science of Genetics - An introduction to heredity, Macmillan, New York. • William S. Kluge and Cummings, M.R.:Concepts of Genetics, Pearson Edu. • Alberts, Bruce: Essentials of Cell Biology: 5th edition.

Course Code: RUSBAS202

Course Title: Biological Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should appreciate the efficient manner in which cells perform their biological functions while strictly obeying the laws of thermodynamics. They should be able to calculate entropy, enthalpy and free energy change for biochemical reactions.
CO 2	Students should accurately demonstrate metabolic pathways in a sequential manner. They should study metabolic pathways with the perspective of their applications in drug design.

Paper Code	Semester II	Lectures
RUSBAS202	**Biological Sciences II**	**45**
202.1 Principles of Bioenergetics		**15**
Concept of catabolism, anabolism & metabolism. Types of Metabolic pathways converging (catabolism), diverging (anabolism) and cyclic. Types of biochemical reactions- a) Oxidation- reduction. b) Carbon-carbon bond formation or breakdown. c) Internal rearrangement, isomerisation and elimination. d) Group transfer reaction. e)Free radical reaction Concept of Gibbs free energy, enthalpy, entropy, free energy change (ΔG) and standard free energy change ($\Delta G'^0$) with suitable examples. Laws of thermodynamics with suitable examples.		
202.2 Carbohydrate Metabolism		**15**
Introduction to Metabolism, Glycolysis, Krebs Cycle, Pentose Phosphate Pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Metabolic disorders		

202.3 Lipid Metabolism, Nucleic Acid Metabolism & Amino Acid Metabolism	**15**
Lipid Metabolism & Metabolic Disorders **Nucleic Acid metabolism:** Synthesis of Purines & Pyrimidines (*De novo & Salvage pathway*), Catabolism of Purines & Pyrimidines **Amino Acid**: Synthesis of Amino acids, Urea Cycle	

RUSBASP201	**PRACTICALS**

1. Estimation of reducing sugars by DNSA method
2. Enzymology:
   a) Extraction of amylase from starch using buffers.
   b) Determination of optimum pH, temperature
   c) Optimization of substrate and enzyme concentration
   d) Determination of Km value
   e) Effect of inhibitor(s)
3. Extraction and immobilization of Invertase from yeast.
4. Application of enzyme in diagnostics (Example of glucose oxidase kit, Glucometer demonstration)
5. Microscopic visualization of Storage carbohydrates from plant sample
6. Study of Seed germination and effect of various factors on seed germination
7. Study of Karyotype(s)

Reference Books:

Biological Sciences II	• David Hopkin Lewis, Storage Carbohydrates in Vascular Plants: Distribution, Physiology, and Metabolism • U. Satyanarayana, U. Chakrapani – Biochemistry • Micheal M. Cox and David L. Nelson, Lehninger Principles of Biochemistry

Course Code: RUSBAS203

Course Title: Chemical Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should precisely draw and identify stereoisomers. They should realize the applications of stereochemistry for assessment of safety and potency of pharmaceuticals.
CO 2	They should be able to solve problems based on chemical kinetics and thermodynamics

Paper Code	Semester II	Lectures
RUSBAS203	**Chemical Sciences I**	**45**
203.1 Stereochemistry-I		**15**
Optical and Geometrical isomers: Study of enantiomers, diastereoisomers, Geometrical isomerism due to restricted rotation around C-C double bond and Substituted cycloalkanes Idea of configuration. Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms: enantiomers, diastereomers, and racemic mixtures and their properties, threo, erythro and mesoisomers. Representation of configuration by 'flying wedge formula' and projection formulate- Fischer, Newman and Sawhorse. The interconversion of formula Conformational analysis of ethane, propane, 2-methylpropane, 2,2-dimethulpropane, n-butane. Molecular chirality and element of symmetry: Plane of Symmetry, Centre of Symmetry, Alternating axis of symmetry. Chirality without asymmetric carbon Stability of cycloalkanes: Strains in cycloalkanes-angle, eclipising, transannular (3 to 6 membered). Conformations of cyclohexane, mono and di- alkylcyclohexanes and their relative stabilities.		

203.2 Stereochemistry-II	**15**
Assigning stereo descriptors to chiral centres:Cahn-Ingold-Prelog(CIP),Rules for assigning absolute configuration(R&S) to a stereogenic center. Assigning absolute configuration to molecules having maximum two chiral carbon atom E & Z stereodescriptors to geometrical isomers. Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity(de). Topicity-enantiotopic and diastereotopic atoms, groups and faces. Stereochemistry of – Substitution reactions- SN1, SN2, SNi (reaction of alcohol with thionyl chloride). E2-anti-elimination-Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane. Addition reactions to olefins-i)Catalytic hydrogenation ii)Bromination (electrophilic anti addition) iii)Synhydroxylation (molecular addition) with OsO4 and KMnO4.	
203.3 Chemical Kinetics and Chemical Thermodynamics	**15**
Chemical Kinetics: Rate of reaction, definition of rate constant, measurement of reaction rates, order and molecularity, integrated rate equations for zero, first and second order reactions (for second order reactions only a=b to be considered), kinetic characteristics of first and second order reactions, pseudo first order reactions **Chemical Thermodynamics** Transition state theory, Transition State-Activation energy, Measurement of Activation energy, Reaction profile diagram, the rate determining Step, Hammond's postulate, Principle of microscopic reversibility, Kinetics Vs. thermodynamic control. Product analysis, Kinetic studies, Stereochemical outcome, Detection and trapping of intermediates, Crossover experiments, Kinetic isotope effect –primary kinetic & secondary kinetic isotope effect.	

Reference Books:

Chemical Sciences I	• P. S. Kalsi: Stereochemistry:New Age International Ltd • Peter Atkins & Julio de Paulo: Physical Chemistry : Oxford University Press • Ira N. Levine: Physical Chemistry : McGraw-Hill • Peter Vollhardt& Neil Schore: Organic Chemistry structure and Function:5th Edition:W. H. Freeman • Richard O.C. Norman, James M. Coxon: Principles of Organic Synthesis, 3rd Edition: CRC Press

Course Code: RUSBAS204

Course Title: Chemical Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should grasp the functioning and handling of basic instruments in bioanalytical laboratory. They should realize the need and importance of automation in bioanalysis.
CO 2	Students should realize that correct choice of sampling and minimization of error is essential for the success of scientific experiments.

Paper Code	Semester II	Lectures
RUSBAS204	**Chemical Sciences II**	**45**
204.1 Fundamentals of Organic Reactions & Mechanism I		**15**
Electronic effects in organic molecules: Polarization or Inductive effect Nature and polarity of a covalent bond, dipole moment and its effect on properties of molecules such as melting point/boiling point, solubility; Polarizability effect, Hyperconjugation and Tautomerism, Bonds weaker than a covalent bond: Hydrogen bond – nature, effect on melting point/boiling point, solubility in water; Van der waals forces. General Idea of types of reaction: Introduction and few examples of following types of reaction expected: Addition, Elimination, Substitution, Condensation, Rearrangement, Three kinds of Pericyclic reactions: Molecular orbital, Orbital symmetry, Electrocyclic reactions (FMO-Approach) Concept of Electrophilicity, Nucleophilicity, acidity and basicity of organic molecules		
204.2 Fundamentals of Organic Reactions & Mechanism II		**15**
Homolysis & Heterolysis, Concepts of intermediate, carbocation, carbanion and free radicals: Geometry, stability and reactivity. Mechanism and applications of Pinacol-Pinacolone rearrangement, Schmidt reaction, Benzilic acid rearrangement.		

Lossen rearrangement, Knoevenagel condensation, Reimer-Teimann reaction, Hunsdiecker reaction, Sand-Meyer reaction Pericyclic Reaction: 1,3-Dipolar cycloadditions, Cheletropic Reactions, Cycloaddition reactions, Sigmatropic rearrangements, The ENE reaction . (New)	
204.3 Gravimetric Analysis and Treatment of Analytical Data & Sampling	**15**
A) Gravimetric analysis: Conditions of precipitation, Nucleation, Particle size, Crystal growth, Co-precipitation, Precipitation from homogeneous solutions, Drying and ignition of precipitate B) **Treatment of Analytical Data & Sampling** Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation.[Numerical problems expected] Sensitivity, limit of Detection, Detection Power Different types of analysis : (Introduction only) Elemental and elementary analysis, Microanalysis, Stereochemical and topochemical analysis, Trace analysis, surface analysis, Radioanalytical methods and activation analysis, Species analysis (Speciation), DNA analysis Terms involved, importance of sampling, sampling techniques, sampling of gases, ambient and stack sampling, equipment used, sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids, methods and equipments used, sampling of solids, importance of particle size and sample size, samples used, need for the reduction in the sample size, methods of reduction in sample size, collection, preservation and dissolution of the sample Summary of experimental methods currently available for analysis : History and development	

RUSBASP202	**PRACTICALS**

1. Chemical Kinetics & Chemical Thermodynamics:
   A. To determine the rate of acid hydrolysis of methyl acetate and determination of order by graphical method.
   B. To determine the order of the acid hydrolysis of methyl acetate by the method of equi fractional time. Second order reaction between-a)$K_2S_2O_8$ and KI (With equi-molar concentrations)
2. b $K_2S_2O_8$and KI (With unequal concentrations
3. Complete identification of an organic compound: Identification by micro-scale techniques following – Preliminary tests, Solubility, Type, Elemental detection, Group tests, Physical Constant determination (Minimum 08 compounds to be given for the identification)
4. Synthesis of Fluorescein, a classic fluorescein dye
5. Gravimetric Analysis:
   A. Estimation of mixture of $BaSO_4$ and NH_4Cl

   Estimation of mixture of Na_2CO_3 and $NaHCO_3$

Reference Books:

Chemical Sciences II	• 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 • Peter Atkins & Julio de Paulo: Physical Chemistry: Oxford University Press • Ira N. Levine: Physical Chemistry: McGraw-Hill

Course Code: RUSBAS205

Course Title: Computational Sciences I

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be able to choose the correct statistical test to analyze biological data.

Paper Code	Semester II	Lectures
RUSBAS205	**Computational Sciences I**	**30**
205.1 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 a 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		
205.2 Measures of central tendency		**10**
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.		

205.3 Measures of Dispersion, Skewness & Kurtosis	**10**
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	

Reference Books:

Computational Sciences I	• B.K.Mahajan: Methods in Biostatistics • David Asquith: Statistics- from Concept to Practice. • Arora & Malhan: Biostatistics- Himalayan Publishing House.

Course Code: RUSBAS206

Course Title: Computational Sciences II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be able to use basic functions of Microsoft office. They should effectively use web browsers and search engines. They should be able to design a webpage.
CO 2	Students should effectively use web browsers and search engines. They should be able to design a webpage.

Paper Code	Semester II	Lectures
RUSBAS206	**Computational Sciences II**	**30**
206.1 Introduction To Computers		**10**
History of computers and their generations Basic Organization of Computers: Introduction to Computer, Block diagram of a Computer, parts of Computer & functional Units, their integration and function, Input-output devices Computer architecture & functionalities Computer memory & memory unit Operating System & Interface: OS, tasks performed by OS , DOS, Windows and Linux/UNIX		
206.2 Data models & languages		**10**
DBMS: Data models Basics Basics of relational model (overview, entity relation model, Entity and entity sets, Relations and relationship sets, E – R Diagram, Reducing E- R diagram to tables, schema refinement and normal forms) Query languages (relational algebra, creating and altering tables, handling data using SQL etc)		

206.3 HTML & XML	**10**
Introduction to HTML and XML, basic HTML tags Tables , hyperlinks, Image Insertion, marquee image mapping, Frame set HTML forms, Get and Post methods Basics of XML XML syntax and semantics	

RUSBASP203	**PRACTICALS**

1. Introduction of MS-Office:
    a. Different elements of word processing (MS-WORD),
    b. Spreadsheets (MS EXCEL) and
    c. PowerPoint presentation (MS POWERPOINT)
2. Browsers, various search engines and metadata, E-Mail/Web mail etc.
3. Introduction to HTML
4. HTML Tags, HTML Tables
5. HTML Forms, HTML Framesets

Webpage designing.

Reference Books:

Computational Sciences II	• Andrew Leach: Chemoinformatics

Course Code: RUSBAS207

Course Title: Foundation course II

F.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be aware of the current trends in globalization.
CO 2	Students should realize the importance of stress management to live a healthy life.
CO 3	Students should be aware about basic human rights.

Paper Code	Semester II	Lectures
RUSBAS207	**Foundation Course-II**	**30**
207.1 Globalization and Indian Society		**10**
Understanding the concepts of liberalization, privatization and globalization Growth of Information Technology and Communication and its impact manifested in everyday life Impact of globalization on Industry: Changes in employment and increasing migration Changes in agrarian sector due to globalization, rise in corporate farming and increase in farmer's suicide. Debate regarding Genetically Modified Crops. Increasing Urbanization, problems of housing, health and sanitation Changing lifestyles and impact on culture in a globalized world		
207.2 Understanding Stress and Conflict		**10**
Causes of stress and conflict in individuals and society Agents of socialization and the role played by them in developing the individual Significance of values, ethics and prejudices in developing the individual Stereotyping and prejudice as significant factors in causing conflicts in society Aggression and violence as the public expression of conflict Types of conflicts and use of coping mechanisms for managing individual stress Maslow's theory of self-actualization Different methods of responding to conflicts in society Conflict-resolution and efforts towards building peace and harmony in society		
207.3 Human Rights		**10**
Concept of human rights: Origin and evolution of the concept The Universal Declaration of Human Rights Human rights constituents with special reference to Fundamental Rights stated in the constitution Development projects and Human Rights Violations LGBTQ - Concept, Evolution, Debates in India		

Reference Books:

Foundation course	• Micheal Vaz, Madhu Nair, Meeta Seta; Foundation Course, Semester - II; Manan Prakashan • K.T. Basanti:Social Problems (foundation Course),Seth Publication

Modality of Assessment for: F.Y.B.Sc. Semester II

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:

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

Paper Pattern for Biological, Chemical, Computational Sciences:

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**	

Paper Pattern for Foundation Course:

Question	Options	Marks	Questions Based on
Q.1. Short answer question	1 out of 2	8	Unit I
	Compulsory	7	
Q.2. Short Answer questions	1 out of 2	8	Unit II
	Compulsory	7	
Q.3. Short Answer questions	1 out of 2	7	Unit III
	Compulsory	8	

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 II

Course	**201**			**202**			**203**			**204**		
	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	**205**			**206**			**207**			**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**

Course Code: RUSBAS301

Course Title: Biological Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should comprehend central dogma of molecular biology as a prerequisite to study techniques like cloning, PCR, RFLP, etc.
CO 2	Students should understand the significance and applications of developmental biology in the modern world.
CO 3	Students should understand the applications of ethanobotany 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, *in vitro* Fertilization- Gamete Collection and Storage, Technique, Introduction to Stem Cell therapy and its applications		
301.3: Pharmacognosy & Ethnobotany		**15**
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) **Ethnobotany: (3)** Principles & Importance of Ethnobotany		

Reference Books:

Biological Sciences III	• 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

Course Code: RUSBAS302

Course Title: Biological Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should 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	Students should be able to classify viruses with respect to their properties and nature also to study their associations with humans.
CO 3	Students should study the basics of immunology. They should be able to 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 *In vivo* 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** – *Influenza*, *Staphylococcus, Plasmodium*, *Candida, SARS-CoV-2* Control of Viruses and Eukaryotic Pathogens.		
302.3 Introduction to Immunology		**15**
Concept of antigen, antibody, Types of immunity, Antigen-Antibody Reactions (MHC, APC introduction), Hypersensitivity and its types, Mechanism of wound healing Autoimmune disorders (*minimum two*) and their management		

RUSBASP301	**PRACTICALS**

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: *S. aureus, S. typhi, B. subtilis*
i) Analysis of Crude drugs by Microscopy with an emphasis on identification of adulteration
j) Preparation of antigen and vaccines

Reference Books:

Biological Sciences IV	• Flint - Virology • Kindt, Goldsby, Osborne - Kuby Immunology • S. Pathak and U. Palan – Immunology and Fundamental • Micheal J. Pelczar,Jr.,E.C.S. Chan,Noel R. Krieg –Microbiology • Lasing.M.Prescott, Harley,Klein ,Microbiology

Course Code: RUSBAS303

Course Title: Chemical Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should apply theoretical principles of electrochemistry in analysis of solutions using pH meter and Conductometer.
CO 2	Students should be adept in operation of these two instruments. They should perform organic synthesis with minimal use of resources and apply greener methods of synthesis.

Paper Code	Semester III	Lectures
RUSBAS303	**Chemical Sciences III**	**45**
303.1 Electrochemistry		**15**
Nature of electrolytes in solution: Variation of molar conductance with concentration for weak and strong electrolytes (derivation of equation is not expected). 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 Conversion of chemical energy to electrical energy. Galvanic cells, reversible and irreversible cells. Types of electrodes:Metal – metal ion electrode, Redox electrodes, Gas electrode**,** Glass electrode Classification of cells – Chemical and concentration cells, concentration cells with transference, concentration cells without transference, liquid junction potential, use of salt bridge. Applications, strengths and limitations of electrochemical analysis		

303.2 Newer methods of organic synthesis & Name Reactions (Mechanism and Applications)	**15**
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.	
303.3 Instrumental methods of analysis	**15**
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	

Reference Books:

Chemical Sciences III	• 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 editionn : 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 editionn : Thomson/Brooks/Cole • SomenathMitra : Sample preparation Technique in Analytical Chemistry : Wiley interscience • Allen J. bard:Electrochemical Methods • P.S Kalsi: Organic chemistry and their mechanism : New Age International

Course Code: RUSBAS304

Course Title: Chemical Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should comprehend the fundamentals of spectroscopy and separation methods which will be useful to study advanced instrumentation in these fields.
CO 2	Students should correctly demonstrate the structures and organic reactions of heterocyclic compounds.

Paper Code	Semester III	Lectures
RUSBAS304	**Chemical Sciences IV**	**45**
304.1 Basic Spectroscopy		**15**
Electromagnetic spectrum (EMR), Units of wavelength and frequency and their inter conversions. Interaction of EMR with matter: Nature of radiation, energy of molecules- electronic, vibrational and rotational Beer-Lambert's law, Concept of absorbance, transmittance and molar absorptivity, deviation of Beer-Lambert's equation and its limitations, Quantization of energy, Bohr frequency condition Single beam colorimeter – Principle, components and working. Regions of electromagnetic spectrum and process associated with each region. **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		

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-Knor 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, Vilsmeir 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 piperdine, 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) λmax b) Molar absorptivity constant

Organic Derivative:

9. Acetylation of Salicylic acid

Reference Books:

Chemical Sciences IV	• 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

Course Code: RUSBAS305

Course Title: Computational Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should effectively use algorithms and graphs for analysis and representation of biological data. They should be able to solve problems based on numerical methods.

Paper Code	Semester III	Lectures
RUSBAS305	**Computational Sciences III**	**30**
305.1 Algorithms		**10**
1. Definition and characteristics of an algorithm, selection and interactive constructs in pseudocode. Data structures like array. 2. Sorting, insertion sort, bubble sort 3. Searching algorithms, linear search and binary search 4. Algorithms on integers, algorithm on matrices.		
305.2 Graphs		**10**
1. Introduction to graphs: types of graph (simple graph, multigraph, pseudograph, directed graph, with an example of each), some special simple graphs (complete graph, cycle, wheel in graph, loop, bipartite graph, regular graph) 2. Representing graphs and graph isomorphism, their application 3. Elementary combinatories: Sets; functions; relations (equivalence relations) 4. Permutations and combinations with respect to applications.		
305.3 Numerical Methods		**10**
1. Finding roots of equations- a. Bisection method b. Iteration method c. Newton Raphson method d. Secant method 2. Finding solutions of system of linear equations and numerical approximations- a. LU decomposition (Doolittle's method, Crout's method) 3. Inverse of matrix by Cholesky method		

Reference Books:

Computational Sciences III	• Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. ... • "Algorithms Unlocked" by Thomas H. Cormen. ... • "The Algorithm Design Manual" by Steven S. Skiena. • A Textbook of Graph Theory 2nd Edition, Kindle Edition by R. Balakrishnan (Author), K. Ranganathan (Author, Contributor)

Course Code: RUSBAS306

Course Title: Computational Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should 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
RUSBAS306	**Computational Sciences IV**	**30**
306.1 Correlation, Simple linear Regression Analysis		**10**
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		
306.2 Probability Theory		**10**
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)		

306.3 Basics of Theory of Estimation and Testing of hypothesis	**10**
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, Power 3. Small sample tests-Independent sample t-test, paired t-test. Concept of p-value. (Use of Excel and SPSS)	

RUSBASP303	**PRACTICALS**
1. Introduction of MS-Office: Different elements of word processing (MS-WORD), Spreadsheets (MS EXCEL) and PowerPoint presentation (MS POWERPOINT) 2. Working with various forms of graphs 3. Google docs: Word, Sheets, Slides and Forms 4. Google Jam board, Concept Board and Mind Map	

Reference Books:

Computational Sciences IV	• 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

Course Code: RUSBAS307

Course Title: Environmental Sciences

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should inculcate greener approach in their daily life. They should prepare themselves for prompt and efficient management of disasters.

Paper Code	Semester III	Lectures
RUSBAS307	Environmental Sciences	30
307.1 Environment: An overview and Natural Resources		10
1. Environment – Structure and components – Topology – Natural and Human. 2. Ecosystem as part of Environment – Functioning and levels of organization – Linkage with society and economy. 3. Emerging issues of development – Environment as a source and depository of resources, products and waste. 4. Sustainable use of resources – a multidisciplinary approach – importance of Environmental Studies. 5. Definition, importance and classification of natural resources. 6. Resource rich and resource poor regions – emerging gaps 7. Distribution patterns, utilization and conservation of water, forest and energy resources		
307.2 Disaster – Natural and Man-made & Environmental issues and Movements		10
1. Concept of disaster – Natural and man-made 2. Natural hazard/Disasters: Causes and Consequences – Earthquake and Tsunami, Cyclone, Flood and Drought (a case study) 3. Man-made disasters – Causes and Consequences – nuclear accident, oil spill and leakage, industrial accident 4. Disaster Management cycle – Pre-disaster, disaster occurrence and post-disaster- Role of technology 5. Environmental problems – Causes and Effects 6. Global issues – Global climate changes, Threats to Biodiversity, tremendous pollution, population and ozone depletion (a case study) 7. Regional issues – Acid rain, Desertification (a case study) 8. Major environmental movements in India		
307.3 Environmental Management		10
1. Environmental management – concept and need – relevance of Environmental education		

2. Constitutional and legal provisions in India – International efforts towards environmental protection – role of WTO 3. Environmental Statement, ISO 14000, ISO 16000, Environmental Impact Assessment 4. Role of technology in environmental management (GIS, GPS, Remote sensing as tools) 5. Carbon bank and Carbon credit	

Reference Books:

Environment Studies	• Dr. Y. K. Singh: Environmental Science • Abhijit Mitra, Tanmay Ray Chaudhari: Basics of Environmental Science

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:

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

Paper Pattern for Biological, Chemical, Computational Sciences III, Environmental Sciences:

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**	

Paper Pattern for Computational Sciences IV:

Question	Options	Marks	Questions Based on
Q.1. Short answer question	1 out of 2	8	Unit I
	Compulsory	7	
Q.2. Short Answer questions	1 out of 2	8	Unit II
	Compulsory	7	
Q.3. Short Answer questions	1 out of 2	7	Unit III
	Compulsory	8	
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

Course Code: RUSBAS401

Course Title: Biological Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should be able to describe the functioning of nerve and muscles and understand the importance of neurotransmitters as potential target for drugs.
CO 2	Students should be able to 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 & Repair		**15**
Types of mutation – Point and gross, Spontaneous and Induced, Types of Mutagens and effects, Cell survival strategies: repair mechanisms, Inborn errors of metabolism with examples, 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**
Diagnosis of genetic disorders, 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)		

Reference Books:

Biological Sciences III	• Fundamentals of Cytogenetics andGenetics: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)

Course Code: RUSBAS402

Course Title: Biological Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should 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	Students should have a knowledge of hormones and grasp the complex nature, co-ordination and integration of biochemical pathways.
CO 3	Students should have an idea about the 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, 2nd messengers, and bacterial chemotaxis		

402.3 Tissue Culture- Plants & Animals	**15**
Plant Tissue culture: Concept of Plant Tissue Culture, Nutrient Requirement, Callus Induction, Micropropagation, Callus Culture, Suspension Culture, Batch Culture, Application of Plant Tissue Culture **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	

RUSBASP401	**PRACTICALS**

1. Protein estimation by Lowry's Method
2. Total Sugar estimation by Anthrone's method
3. UV survival curve of *E.coli*: photo reactivation and dark repair.
4. Visit to Animal tissue culture & Plant tissue culture laboratory.
5. Radio immunosorbent assay (demo).
6. Immunodiffusion assay
7. Trypsinization of Liver homogenate
8. Study of Glucose uptake by Yeast

Reference Books:

Biological Sciences IV	• 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

Course Code: RUSBAS403

Course Title: Chemical Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should study pharmaceutical chemistry and bio-organic chemistry with the perspective of their applications in Bioanalytical sciences.
CO 2	Students should be aware of the 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**
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). **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.	

Reference Books:

Chemical Sciences III	• 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, HelmaWennemers: Highlights in Bioorganic Chemistry: • Wiley-VCHBy 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)

Course Code: RUSBAS404

Course Title: Chemical Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should grasp the concept of radioactivity and understand its applications in diagnostics and therapeutics.
CO 2	Students should understand importance of inorganic metals in maintenance of health.
CO 3	Students should 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 Sulpher proteins in Electron Transport Chain, Role of metal ions (Mg2+, Cu2+ 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	• 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, ChristophHoeschen : Radiation Physics for Nuclear Medicine: Springer • Douglas.A.Skoog, F.James Holler, Stanley R Crouch : Principles of analytical : 6th edition : Thomson/Brooks/Cole

Course Code: RUSBAS405

Course Title: Computational Sciences III

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should apply statistical tests like ANOVA to analyze biological data. They should understand the basic concepts of experimental design with relevant examples in Bioanalytical sciences

Paper Code	Semester IV	Lectures
RUSBAS405	**Computational Sciences III**	**30**
405.1 Analysis of Variance		**10**
1. Introduction, One way classification with equal & unequal observations per class 2. Two way classification with one observation per cell. 3. Three way classification		
405.2 Design Of Experiments		**10**
1. Concepts of Experiments, Experimental unit, Treatment, Yield, Block, 2. Replicate, Experimental Error, Precision. **Completely Randomized Design (CRD) & Randomized Block Design (RBD):** 3. Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. (Concept only-No derivations) 4. Estimation of linear contrasts, Standard Error and Confidence limits Testing for significance of elementary linear contrasts. Efficiency of RBD relative to CRD. 5. Missing plot technique for one missing observation in case of CRD, RBD.		
405.3 Latin Square Design (LSD)		**10**
1. Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. 2. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. 3. Efficiency of the design relative to RBD, CRD. 4. Missing plot technique for one missing observation in case of LSD.		

Reference Books:

Computational Sciences III	• Designing experiments and analyzing data: Maxwell & Delaney • Statistical principle in experiment design: Winer and Kirk • Latin Square Design: David J. SavilleGraham R. Wood • Fundamentals of Applied Statistics: S.C. Gupta & V.K. Kapoor

Course Code: RUSBAS406

Course Title: Computational Sciences IV

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should effectively use bioinformatics databases and tools to study DNA and protein sequences, protein structure and metabolic pathways

Paper Code	Semester IV	Lectures
RUSBAS406	**Computational Sciences IV**	**30**
406.1 Introduction to Bioinformatics		**10**
1. Introduction to Bioinformatics & Databases 2. Application of Bioinformatics 3. INSDC 4. Major Bioinformatics resources: NCBI, EBI, ExPASy 5. Nucleic acid: GENBANK, EMBL, DDBJ 6. Protein structure: domains, motifs (Pfam/Prosite) 7. Protein sequence databases: Uniports, PIR, SWISSPROT, TrEMBL 8. Literature database: PUBMED 9. Genome database: GSS, Genome 10. Specialized database: OMIM 11. Protein structure databases: PDB 12. Metabolic Pathway database: KEGG		
406.2 Basics to Sequencing		**10**
1. Molecular biology basics 2. Genomics 3. Proteomics 4. DNA sequencing technology: Whole-genome shotgun sequencing strategies 5. Protein sequencing methods 6. Sequence File formats		
406.3 Pairwise Sequence Alignment		**10**
1. Basic Concepts of sequences similarity, Identity and homology 2. Definition of homologs, orthologs, paralogs 3. Concepts of sequence alignments 4. Pairwise sequence alignment methods 5. DOT Matrix analysis 6. Scoring matrices: Basic concepts of scoring matrix, PAM and BLOSUM series and principles based on which these matrices are derived		

RUSBASP403	**PRACTICALS**

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:

Computational Sciences IV	• Computational Biology and Bioinformatics :Ka-Chun Wong • Chapter 1, Advanced Data Mining Technologies in Bioinformatics • W3 Schools: HTML and XML • Complete Reference to HTML and XML

Course Code: RUSBAS407

Course Title: Technical Communication Skills

S.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students should know the expected format and standards of professional writing.
CO 2	Students should be adept and confident in writing skills like letters, resume, abstract, book review etc.

Paper Code	Semester IV	Lectures
RUSBAS407	**Technical Communication Skills**	**30**
407.1 Basics of effective communication		**10**
1. **Basics of effective communication** **a)** Concepts **b)** Process **c)** Myths about communication **2. Communication : It's interpretation** **a)** Verbal Communication **b)** Non-verbal Communication **c)** Barriers to Communication **3. Case study** 4. **Listening skills**		
407.2 Mechanics of writing		**10**
1. Writing basics a) Spelling rules b) Punctuation c) Abbreviations d) Proof Reading **2. Letters** a) Application Letter b) Bank Letters c) Business Letters d) Letters to the Editor e) E-Communication **3. Resume writing** **4. Interview skills** **5. Reports** a) Experimental Report		

b) Field Work Report c) Industrial Visit Report **6. Group discussion**	
407.3 Technical writing	**10**
1. Assignment Writing 2. Written Scientific Communication 3. Book review 4. Minutes of the meeting **5.** PowerPoint presentation skills	

Reference books:

Technical Communication Skills	• The Essentials of Technical Communication : Elizabeth Tebeaux , Sam Dragga • A Field Guide for Science Writers: Deborah Blum

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:

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

Paper Pattern for Biological, Chemical, Computational Sciences IV:

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**	

Paper Pattern for Computational Sciences III, Technical Communication Skills:

Question	Options	Marks	Questions Based on
Q.1. Short answer question	1 out of 2	8	Unit I
	Compulsory	7	
Q.2. Short Answer questions	1 out of 2	8	Unit II
	Compulsory	7	
Q.3. Short Answer questions	1 out of 2	7	Unit III
	Compulsory	8	
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

Course Code: RUSBAS501

Course Title: Entrepreneurship Skills

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be motivated to start their own enterprise.
CO 2	Students should be aware of the required skill set for an entrepreneur and also realize the challenges in this area.

Paper Code	Semester V	Lectures
RUSBAS501	**ENTREPRENEURSHIP SKILLS**	**40**
501.1 The Entrepreneur		**10**
1. Entrepreneurial motivation – dynamics of motivation. 2. Entrepreneurial competency – Concepts. 3. Developing Entrepreneurial competencies - requirements and understanding the process of entrepreneurship development, self awareness, interpersonal skills, creativity, assertiveness, achievement, factors affecting entrepreneur's role.		
501.2 Conceptual Frame Work		**10**
1. Concept, need and process in entrepreneurship development. 2. Role of enterprise in national and global economy 3. Types of enterprise – Merits and Demerits 4. Government policies and schemes for enterprise development 5. Institutional support in enterprise development and management		
501.3 Business Economics		**10**
1. Demand analysis, concept & types of demand ,law of demand 2. Utility analysis, concept & types of utility ,law of utility 3. Introduction to Cost & Revenue , its types 4. STP (segmentation / targeting / positioning) 5. Sources of Growth–Concept and Importance of Knowledge Economy 6. WTO: Functions and Agreements with Reference to TRIPS,TRIMS and GATS.		
501.4 Knowledge Management		**10**
1. Introduction 2. History and Evolution 3. Pillars of Knowledge Management 4. Scope & Significance Technology & Knowledge Management. 5. Critical Success Factors of KM 6. Case Studies 7. P's of Marketing		

RUSBASP501	**PRACTICALS**
Case Study/Assignment/Project Report/Industrial Visit	

Reference Books:

Entrepreneurship Skills	• Eric Ries: The Lean Startup • Kimiz Dalkir: Knowledge Management in theory and Practice • Jugaad Innovation: Radjou,Prabhu,Ahuja

Course Code: RUSBAS502

Course Title: Biological Sciences V

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be able to design basic cloning experiments to obtain genetically modified organisms. They should be sensitized regarding ethical guidelines of cloning.
CO 2	Students should realize the importance of phytochemicals as possible drug candidates and learn the techniques to extract phytochemicals from plants.

Paper Code	Semester V	Lectures
RUSBAS502	**Biological Sciences V**	**45**
502.1: Recombinant DNA Technology		**15**
Cloning and expression vectors (Plasmids, Phages, Cosmids, YACs, BACs, etc.), Restriction Enzymes, process of generating recombinant DNA, Transgenic Bacteria, Plants and Animals: Commercial applications with suitable examples (Any Two), Application of Transposons as genetic tools, Cloning- current Status, Regulations, Ethics etc.		
502.2: Phytochemistry		**15**
Primary and secondary metabolites from plants, Classification of Plant Secondary metabolites, Functions of Plant Secondary Metabolites, Chemistry of Phenolics, Terpenoids, Alkaloids, Phytochemicals as Drugs, Key factors affecting synthesis of secondary metabolites, Commercial applications		
502.3: Extraction Technologies for Phytochemicals		**15**
Extraction of phytoconstituents, Choice of solvent for extraction, classical and modern methods of extraction, Percolation & Maceration, Soxhlet extraction, Steam Distillation & Rotary vacuum evaporator, Liquid- Liquid & Solid Phase Extraction, Ultrasonication, Microwave Assisted Extraction, Supercritical Fluid extraction		

RUSBASP502	**PRACTICALS**

1. Extraction of phytoconstituents by maceration, percolation, steam distillation and using soxhlet extractor
2. Qualitative tests for Phytoconstituents
3. Standardization of a solvent for extraction of phytoconstituents
4. Estimation of alkaloids by gravimetry
5. Quantitation of tannins by colorimetry
6. Study of antimicrobial activity of phytoconstituents
7. Extraction of Genomic DNA from suitable plant or microbial material
8. Microscopic evaluation of plants
9. Replica plate technique
10. Problems on Restriction enzyme digestion

Reference Books:

Biological Sciences V	• Molecular Biotechnology:Glick • Biotechnology and Genetic Engineering:Kathy Wilson • Gene Cloning :T.A.Brown • Text book of Pharmacognosy:G.E. Trease,W.C. Evans • Herbal Drug Technology:Agrawal,Paridhavi

Course Code: RUSBAS503

Course Title: Chemical Sciences V

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will get familiar with the basic concepts of atomic and molecular spectroscopy and their applications in bioanalysis. They should be able to choose the correct method for analysis based on chemical property of analyte and objective of analysis.
CO 2	Students will also be introduced to concepts of Raman Spectroscopy and applications of the same.

Paper Code	Semester V	Lectures
RUSBAS503	**Chemical Sciences V**	**45**
503.1 Atomic Spectroscopy		**15**
1. Atomic Absorption Spectroscopy a. Principles & Instrumentation b. Applications 2. Atomic Emission Spectroscopy a. Principles & Instrumentation (Atomic Emission Spectrophotometer, Flame Photometer & Inductively Coupled Plasma- Atomic Emission Spectroscopy, Optical Emission Spectroscopy), Applications 3. Quantitative applications of atomic absorption and flame photometry, calibration curve method, standard addition and internal standard method.		
503.2 Molecular Spectroscopy		**15**
Molecular Fluorescence and Phosphorescence Spectroscopy: Theory, instrumentation and applications, Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure. Rotational Spectrum: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift. **Vibrational spectrum: (IR):** Vibrational motion, degrees of freedom, modes of vibration, Vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels,		

zero point energy, conditions for obtaining Vibrational spectrum, selection rule, nature of spectrum. **Vibrational-Rotational spectrum of diatomic molecule** Vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, harmonic oscillator: energy levels, selection rule, fundamental band, overtones. Application of vibration rotation spectrum in determining Force constant. Introduction to infrared spectra of simple molecules like H_2O and CO_2	
503.3 Raman Spectroscopy	**15**
Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, Anti- Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion. (Example of CO_2 molecule)	

Reference Books:

Chemical Sciences V	• Principles of instrumental analysis:Douglas a. Skoog • Introduction to Spectroscopy:Donald L. Pavia • Organic Spectrocsopy:William Kemp • Introduction to Molecular Spectroscopy:Gordon M. Barrow • Molecular Luminescence Spectroscopy Methods and Applications John Wiley and sons • Concept Instrumentation and techniques in Atomic Absorption Spectroscopy: Perkin Elmer • Principles of instrumental analysis:Douglas a. Skoog

Course Code: RUSBAS504

Course Title: Chemical Sciences VI

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be able to interpret simple IR and NMR spectra. They should be introduced to basic concepts of hyphenated techniques which will be useful in studying advanced instrumentation.
CO 2	Students should realize the importance of safe handling of biomatrices. They should be familiar with routine diagnostic tests and advanced instrumentation in pathological testing.

Paper Code	Semester V	Lectures
RUSBAS504	**Chemical Sciences VI**	**45**
504.1 Infrared Spectroscopy		**15**
Diatomic Molecules, Polyatomic Molecules, Characteristic Vibration Frequencies, Factors Affecting Group Frequencies. Qualitative Analysis –Identification of Structural Features, Quantitative Analysis, Sampling Procedures, Near Infrared Spectrometry, Applications of Infrared Spectrometry.		
504.2 Nuclear Magnetic Spectroscopy		**15**
Chemical shift, Shielding and deshielding of protons, low resolution N.M.R. spectrum of methanol and ethanol. PMR Spectroscopy: Basic theory of NMR, Nature of PMR spectrum, Chemical shift (∂ unit), Standard for PMR, Solvents used, Factors affecting Chemical Shift: Inductive effect, Anisotropic effect (with reference to C=C, $C \equiv C$, C=O and benzene ring), Spin-spin coupling and coupling constant. Proton exchange application of deuterium exchange, Application of PMR in structure determination.		
504.3 Bioanalysis		**15**
Introduction to Bioanalysis, Different sample matrices and special precautions to be taken while handling clinical samples Biochemical analysis of clinical samples: Glucose, calcium, kidney test, liver test, electrolytes, proteins, complete blood count. Advanced instrumentation in Bioanalysis: Flowcytometer, blood gas analyzer, automatic haematology analyzer, blood glucose analyzer, alcohol breath analyzer		

RUSBASP503	**PRACTICALS**

1. Gravimetric Analysis of Estimation of Nickel as Ni-DMG
2. Antioxidant activity of any one sample
3. **Flame photometric determination**

Flame photometric determination of Li/Na/K by Calibration Curve and Standard addition methods

4. Spectroscopic Techniques: -

1. Atomic absorption spectroscopy (AAS)- Sample preparation only
2. Infrared (IR) analysis (Glucose and Glycine)
3. Nuclear Magnetic Resonance (Demo)

5. Handling of plasma (Ask SP)

Reference Books:

Chemical Sciences V	• Principles of instrumental analysis:Douglas a. Skoog • Introduction to Spectroscopy:Donald L. Pavia • Organic Spectrocsopy:William Kemp • Introduction to hyphenated techniques and applications in pharmacy:Patel • Principle and practice of Bioanalysis: Richard F. Venn

Course Code: RUSBAS505

Course Title: Computational Sciences V

Academic year 2020-21

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will comprehend the logic behind dynamic programming algorithms.
CO 2	Students should effectively use bioinformatics algorithms like BLAST and FASTA for sequence alignment and phylogenetic studies.

Paper Code	Semester V	Lectures
RUSBAS505	**COMPUTATIONALSCIENCES V**	**30**
505.1 Dynamic Programming Algorithm		**10**
1. Global and local alignment 2. Needleman & Wunch, Smith & Waterman algorithms for Pairwise alignment 3. Use of pairwise alignments for analysis of Nucleic acid and Protein Sequences and interpretation of results. 4. Overview of BLAST, its variants & working, BLAST algorithm 5. PSI BLAST and PHI BLAST: Working and interpretation of result		
505.2 Multiple sequence alignment		**10**
1. Concept of multiple sequence alignment (MSA) 2. Algorithm in MSA and its application 3. Multiple sequence alignment methods 4. PSSM 5. MSA Tool: Clustal Omega- Working		
505.3 Molecular Phylogenetics		**10**
1. Phylogenetic analysis 2. Basic concepts in taxonomy and phylogeny. 3. Definition and description of Phylogenetic trees and various methods 4. Clustering method –UPGMA & NJ 5. Cladistic method – Maximum Parsimony 6. Phylogenetic Analysis software Phylip/PAUP		

RUSBASP504	**PRACTICALS**

1. Working with BLAST
2. Basic BLAST
    a. Proteins
    b. Nucleotides
3. Advanced BLAST
    a. PHI BLAST
    b. PSI BLAST
4. Working with FASTA
    a. Proteins
    b. Nucleotides
5. Working of Clustal Omega
6. Phylogenetic Tree construction & Visualization
7. Basics of PHYLIP
8. PAUP

Reference Books:

Computational Sciences V	• Algorithms and Data structure:Niklaus Wirth • The Art of Computer Programming:Donald E.Knuth • Multiple Squence Aligment Methods:Russelland Springer • Molecular Evolution and Phylogenetics:MasatoshiNeiand Sudhir Kumar

Modality of Assessment for: T.Y.B.Sc. Semester V

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:

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

Paper Pattern for Biological, Chemical and Computational Sciences:

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**	

Paper Pattern for Entrepreneurship skills:

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. Short Answer questions (5 Marks each)	3 out of 4	15	Unit IV
	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 V

Course	501			502			503			504		
	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	–	–	–	40	60	100

Course	505			Grand Total
	Internal	External	Total	
Theory	40	60	100	500
Practicals	40	60	100	400

Course Code: RUSBAS601

Course Title: Entrepreneurship Skills

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be keenly interested in developing innovative ideas which may be commercially viable.
CO 2	Students should start building knowledgebase and skill set which will be useful to start a new enterprise in future.

Paper Code	Semester VI	Lectures
RUSBAS601	**ENTREPRENEURSHIP SKILLS**	**40**
601.1 Launching and Organizing An Enterprise		**10**
1. Environment scanning – Information, sources, schemes of assistance, problems. 2. Enterprise selection, market assessment, enterprise feasibility study, SWOT Analysis. 3. Resource mobilisation - finance, technology, raw material, site and manpower. 4. Costing and marketing management and quality control. 5. Feedback, monitoring and evaluation.		
601.2 Growth Strategies, Networking & Innovation		**10**
1. Performance appraisal and assessment 2. Profitability and control measures, demands and challenges 3. Need for diversification 4. Future Growth – Techniques of expansion and diversification, vision strategies 5. Concept and dynamics 6. Methods, Joint venture, co-ordination and feasibility study		
601.3 Principles of Corporate Management		**10**
1. Principles 2. Functions of management 3. Quality Circles 4. MBO 5. Management by Wandering		
601.4 Innovation		**10**
1. Introduction 2. Principle 1 Seek Opportunity in adversity		

3. Principle 2 Do more with less 4. Principle 3 Think & act flexibly 5. Principle 4 Keep it simple 6. Principle 5 Include the margin 7. Principle 6 Follow your Heart	
RUSBASP601 **PRACTICALS**	
Case Study/Assignment/Project Report/Industrial Visit	

Reference Books:

Entrepreneurship Skills	• Jugaad Innovation: Radjou,Prabhu,Ahuja

Course Code: RUSBAS602

Course Title: Biological Sciences V

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will learn Phytochemistry with an emphasis on its applications in pharmaceuticals and bioanalysis. They should be able to perform and interpret qualitative tests for phytochemicals.
CO 2	Students should be able to interpret results of molecular biology experiments like PCR and RFLP.
CO 3	Students should appreciate and study biopharmaceuticals as an upcoming branch in pharmaceuticals.

Paper Code	Semester VI	Lectures
RUSBAS602	**Biological Sciences V**	**45**
602.1: Phytochemical Analysis		**15**
Classical methods of analysis (Gravimetric & Titrimetric), Chromatographic & Spectroscopic analysis of phytoconstituents Chromatographic fingerprints, Phytochemical variations in plants Analysis of herbal formulation, Effect of drying on phytoconstituents		
602.2: Techniques in Recombinant DNA Technology		**15**
RFLP, AFLP, PCR, RAPD, Nucleic acid probes, Southern Blotting, Northern Blotting, Edible Vaccines, Biosensors and Biochips		
602.3: Introduction to Biopharmaceuticals &Biosimilars		**15**
Introduction to Biopharmaceuticals, Sources of Biopharmaceuticals (*E. Coli,* Animal cells, Additional systems), Upstream & Downstream processing, Product Analysis, Therapeutic Hormones, Recombinant Blood Products & Therapeutic Enzymes, Production of antibodies, Vaccines & adjuvants		

RUSBASP602	**PRACTICALS**	
	1. Demonstration of SDS-PAGE 2. Demonstration of PCR, RFLP 3. Preparation of antigens for vaccine production (TAB vaccine) 4. Sterility testing of biopharmaceuticals 5. Preservation of microbial cultures 6. Analysis of Biosimilars by Bradford's method & UV-Visible Spectrophotometer. 7. Study of secondary metabolites produced by plants and their qualitative detection 8. Study of Chromatographic fingerprint for raw material by: i) HPLTC ii) HPLC iii) GC	

Reference Books:

Biological Sciences V	• The Medicinal Plant Industry: Wojesekera • Pharmaceutical Chemistry: H.J.Roth,A.Kleemann • Pharmacognosy: Tyler,Brody,Robbers • Molecular Biotechnology: Mukesh Pasupuleti • Biosimilars: Regulatory,Clinical and Biopharmaceutical development:Springer

Course Code: RUSBAS603

Course Title: Chemical Sciences V

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be introduced to theory and instrumentation of HPLC and GC. They should be able to analyze and interpret simple chromatograms. LC-MS and GC-MS as hyphenated techniques will be introduced.
CO 2	Students should understand advantages and limitations of biochemical techniques like SDS-PAGE, native PAGE, 2D-gel electrophoresis etc. and choose suitable technique as per the biochemical properties of analyte and objective of analysis. They should familiarize with the concept of microarrays and biochips as advanced methods of diagnostics.

Paper Code	Semester VI	Lectures
RUSBAS603	**Chemical Sciences V**	**45**
603.1 Biochemical Methods of Analysis		**15**
Electrophoresis: PAGE, SDS-PAGE, Western Blotting, 2D gel electrophoresis, AGE, ELISA, Microarray		
603.2 Introduction to Liquid chromatography		**15**
Liquid Chromatography and its development to HPLC and its applications HPLC Instrumentation, Pumps, solvent delivery system, isocratic and gradient programming modes, Sample introduction system, Columns, Detectors. Reversed phase and normal phase chromatography Introduction to LC-MS and its applications		
603.3 Introduction to Gas chromatography		**15**
Gas Chromatography, Gas Solid and Gas liquid Chromatography and its applications Gas Chromatography Instrumentation, Carrier gas supply, Injectors, Columns, Packed and capillary columns, Column oven and temperature programming, different detectors.		

Introduction to GC-MS and its applications	

Reference Books:

Chemical Sciences V	• Principles and Practice of Chromatography:B.Ravindranath • High performance liquid chromatography in biotechnology;William S. Hancook • Principle and practice of Bioanalysis:Richard F. Venn • Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker • Biochemical methods ;S.Sadasivam,A. Manickam

Course Code: RUSBAS604

Course Title: Chemical Sciences VI

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will be introduced to basic concepts of drug development and action and understand the importance of a bioanalyst in pharmaceutical industry.
CO 2	Students should realize the problems involved in analyzing trace elements and complex matrices and learn to choose the suitable bioanalytical method for their analysis.
CO 3	Students should apply techniques learned in bioanalysis for characterization of nutritional value of a food sample.

Paper Code	Semester VI	Lectures
RUSBAS604	**Chemical Sciences VI**	**45**
604.1 Drug development and Drug Action		**15**
Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD50, ED50, Therapeutic Index. Brief idea of the following terms: Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia. Routes of drug administration with advantages and disadvantages Formulations, Different dosage forms (emphasis on sustained release formulations) Introduction to Drug Discovery, Design and Development, Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation Drug development from Natural Sources: Anti-infective agents, Anti-cancer agents, CNS agents, Development of drug: Pharmacophore identification, modification of structure or functional group. Different types of chemical transformation of drugs with specific examples. Structure and therapeutic use of Diclofenac sodium (DFS), Aceclofenac, Paracetamol, Phenytoin, Aspirin, Atenolol, Laevodopa, Ciprofloxacin, Metronidazole, Dapsone, Ethambutol		

604.2 Micro analysis and Surface analysis	**15**
Microanalysis : Problems associated with trace analysis, Special extraction procedures for separating analyte/s from the complex matrix, Extraction of organic/inorganic analyte from organic/inorganic matrix. Special techniques and care to be taken during micro analysis **Surface analysis:** Surface chemistry, Phenomenon of adsorption, Adsorption isotherms Surface area by BET method, Pore size distribution, Particle size analysis Catalysis, Heterogeneous and homogenous catalysis	
604.3 General Metabolism and Nutrition	**15**
Overview of mineral metabolism and abnormalities of mineral metabolism with respect to calcium, iron, iodine, fluoride, manganese, selenium Energy metabolism and nutrition: Concepts of calorific value, Respiratory quotient, BMR, RDA, Nutritional indices, proximate principles of diet, protein energy malnutrition, obesity, BMI, diseases related to obesity, glycemic index. Free radicals and anti-oxidants: reactive oxygen species- generation and damage, free radical scavenger systems, inflammation, respiratory, skin and age related diseases, atherosclerosis, lipid per oxidation, preventive and chain breaking anti-oxidants	

RUSBASP603	**PRACTICALS**

Separation of Organic mixtures:-

1. Volatile liquid + Non-volatile liquid (Liquid + Liquid) by fractional distillation method
2. Volatile liquid + Water insoluble solid (Liquid + Solid) by distillation method.

Separation Techniques: -

1. Paper chromatography for Separation of Plant Pigments (Spinach)/ Separation of Amino acids
2. Thin Layer Chromatography of Alkaloids
3. Column Chromatography of Separation of mixture of dyes/Separation of Plant Pigments (Spinach)
4. Ion Exchange Chromatography of Estimation of sodium using cation exchanger/Estimation of Mg using anion exchange resin column
5. **High Performance Thin Layer Chromatography –** Menthol and Paracetamol
6. **High Performance Liquid Chromatography –** Separation of modern drug (Diclofenac sodium) from their combination formulation.
7. **Gas Chromatography -** Separation of solvent mixtures (Toluene and n-Hexane)

Reference Books:

Chemical Sciences VI	• Pharmaceutical Analysis: David Lee • Excipients and Delivery Systems of Pharmaceutical formulations: Karsa, Stephenson • Microanalysis of solids: Yacobi, Holt, Kazmerski • Surface Analysis Methods in Material Science: Brett Sexton, R. C. Smart • Introduction to nutrition and Metabolism: David A. Bender

Course Code: RUSBAS605

Course Title: Computational Sciences V

T.Y.B.Sc.

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Students will comprehend the programming logic for protein structure prediction, Cheminformatics and drug design.
CO 2	Students should effectively use bioinformatics tools like Modeller, Marvin Sketch and iGem Dock for basic structural characterization.

Paper Code	Semester VI	Lectures
RUSBAS605	**Computational Sciences V**	**30**
605.1 Protein structure prediction		**10**
1. Protein structure basics 2. Computational prediction methods 3. Homology modeling 4. Protein threading 5. Fold recognition 6. Tools used for prediction		
605.2 Cheminformatics		**10**
1. Cheminformatics Introduction 2. Chemical structure storage formats 3. Cheminformatics tools 4. Applications		
605.3 Computational Drug designing		**10**
1. Introduction to drugs 2. Steps in drug discovery & development 3. Computational Drug designing 4. Structure based drug designing 5. Virtual Screening 6. Novel drug Targets		

RUSBASP604	**PRACTICALS**

1. Homology modelling study using Modeller
   a. Download and Installation
   b. Basic Modelling
   c. Advanced Modelling
2. Automated modelling using Swiss Model
3. Validation of predicted structures
   a. ProSA
   b. Verify 3D
   c. SAVES
4. Chemical structure designing- Marvin Sketch/ Marvin View

5.Virtual Screening- iGemDock

Reference Books:

Computational Sciences V	• Cheminformatics: Johann Gastieger • Bioinformatics and drug Discovery: Richard S. Larson

Modality of Assessment for: T.Y.B.Sc. Semester VI

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:

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

Paper Pattern for Biological, Chemical and Computational Sciences:

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**	

Paper Pattern for Entrepreneurship skills:

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. Short Answer questions (5 Marks each)	3 out of 4	15	Unit IV
	TOTAL	**60**	

Practical Examination Pattern:

C) Internal Examination: 40%- 40 Marks

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

D) 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 VI

Course	601			602			603			604		
	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	–	–	–	40	60	100

Course	605			Grand Total
	Internal	External	Total	
Theory	40	60	100	500
Practicals	40	60	100	400