

#### **OBJECTIVES:**

- To impart high quality science education in a vibrant academic ambience with the faculty of distinguished teachers and scientists.
- To 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.
- To 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.

### **PURPOSE:**

There is very a rapid change in science and technology and it is affecting all walks of life across the globe. The application of science to real world problems is becoming more complex and it is no more possible to find a simple solution to real world problems as we need to adopt what is called as a multidisciplinary approach.

In this age of plurality, application of only pure science is sine qua non! A one dimensional approach is redundant and this holds true for myriad areas of scientific endeavour. Many fields of scientific study such as Astronomy, Biotechnology, Bioinformatics, Environmental Sciences, Forensic Sciences, Nanotechnology etc. are rapidly expanding in terms of the knowledge generated and as a result in these areas the one dimensional approach doesn't work. The purpose of introducing five year integrated course is to teach the students the value of multidisciplinary approach right from the undergraduate days.

### **BACKGROUND:**

A post graduate course in Bioanalytical Sciences is already has gained credence and acceptability amongst the student community. The industry has responded positively to this novel course by absorbing the pool of fresh talent generated in to the corporate domain.

### FEEDBACK:

The Pharmaceutical and food industry is experiencing a paradigm shift in terms of type of products and the exhaustive characterization that is needed to assess the quality and safety of their products. The classical approach of applying specialized knowledge in one field has widened the gap between expectation and reality and introduction of these multidisciplinary subjects have been able to somewhat bridge the gap between what industries wants and what is available to them as fresh manpower.

However, it is not easy to bridge this gap further as there is lack of cohesiveness between the UG and PG level study. The need of the hour now is to become familiar with and embrace the multidimensional approach.

#### **SALIENT FEATURES:**

The uniqueness of this course dovetails a modular learning with credit based evaluation. The program is designed by distinguished professionals and experts drawn from varied professional backgrounds. The team that has designed this integrated course consists of experienced people from the world of academia, research and industry. The design of the course affirms the conviction that the students passing this course will help meet the demand for reliable and well informed Bioanalysts in the areas of Analytical Sciences, Biotechnology, Clinical Research, Immunology, Molecular Biology and Pharmaceutical industry.

#### **BACK TO BASICS:**

The program will encompass the basics of Biology, Chemistry and Computational Sciences together in the First Three years of the Five year Program.

#### THE FIRST THREE YEARS:

The BSc in Bioanalytical Sciences will lay down a sound foundation in the subjects of Biology, Chemistry and Computational Biology. It will be backed by the experience in application of basics in the field of Biology as well as Chemistry. The course is actually designed for the aspirants desirous of pursuing PG studies or research. As per the university norm there is a provision for exit after graduation if the student wishes to discontinue the course. Those who get deeply influenced and interested in the subjects will be confident enough to understand the underlying mélange of the three subject areas. It would propel them to choose Bioanalysis, Bioinformatics, or Nutraceutical Sciences as specialization at the PG level.

#### **INTENT:**

The program aims to broaden, heighten and deepen the extent and scope of the subjects for the learner. This course is largely composite and combinative to blend the rigorous study involved in the diverse disciplines of Biology, Chemistry, Physics, Mathematics, Statistics and Computers. The implicit skill sets needed for operations across the disciplines and the industry wide compulsions will thus be imbibed by the student, through the completion of the five year integrated program.

#### **VISION:**

The program envisions the use of modern sophisticated equipment and state of art instruments like HPLC, HPTLC, PCR, DNA Sequencer etc. The practical sessions are designed to utilize the advanced instrumentation and to train students in the realm of Analytical Techniques, Practical Analysis, Bioanalytical Techniques, Biopharmaceuticals, Industrial Processes, of the Food and Pharmaceutical Industries. Furthermore, the allied modules include the Quality Systems- Quality Assurance, Quality Control, Regulatory Affairs, Data Analysis, Entrepreneurship, Intellectual Property. Each student has to undertake a Research Project during the fifth year of the course and it is expected to assist the student in developing essential practical research skills as well as sharpening of the presentation and communication skills acquired in previous years.

## **PROSPECTS:**

Past placement records of the current MSc courses in the field of Bioanalytical Sciences is privy to the abundant employment opportunity that abounds for the students with the MSc degree in Bioanalytical Sciences. Five years of intensive and all round training will be a definite recipe to find a job fit in Analysis, Quality Assurance and R&D. This would further give impetus in the domain of innovation and product development in the core areas of Biotechnology, Food, Health Care, Nutraceuticals, and Pharmaceutical industry. There is excellent prospect for the biotechnology and pharmaceutical applications globally.

It is hoped that corporate, MNCs' and TNCs' will realize the potential of our well trained and qualified students and offer them exciting and challenging positions ' vis-à-vis the holders of traditional PG qualification.

### **CREDIT DISTRIBUTION**

F.Y.B.Sc.						
				Semester – I		
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical(Hrs.)	Credits
RUSBAS101	Biological Sciences I	45	3		10	
RUSBAS102	Biological Sciences II	45	3	RUSBASP101	60	2
RUSBAS103	Chemical Sciences I	45	3			
RUSBAS104	Chemical Sciences II	45	3	RUSBASP102	60	2
RUSBAS105	Computational Sciences I	30	2		60	2
RUSBAS106	Computational Sciences II	30	2	KUSDASI 105	00	
RUSBAS107	Foundation Course	30	2	-		-
TOTAL		270	18		180	6
TOTAL CRED	ITS			24		
		Semester – II				
4 F	1			Semester – II		
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Semester – II Practical Paper Code	Practical (Hrs)	Credits
Paper Code RUSBAS201	Paper Nomenclature Biological Sciences I	Lectures(Hrs.)	Credits 3	Practical Paper Code	Practical (Hrs)	Credits
Paper Code RUSBAS201 RUSBAS202	Paper Nomenclature Biological Sciences I Biological Sciences II	Lectures(Hrs.) 45 45	Credits 3 3	Practical Paper Code RUSBASP201	Practical (Hrs) 60	Credits 2
Paper Code RUSBAS201 RUSBAS202 RUSBAS203	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I	Lectures(Hrs.) 45 45 45	Credits 3 3 3	Semester – II         Practical Paper         Code         RUSBASP201	Practical (Hrs) 60	Credits 2
Paper Code RUSBAS201 RUSBAS202 RUSBAS203 RUSBAS204	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I Chemical Sciences II	Lectures(Hrs.) 45 45 45 45	Credits 3 3 3 3 3	Semester - IIPractical Paper CodeRUSBASP201RUSBASP202	Practical (Hrs) 60 60	Credits 2 2
Paper Code RUSBAS201 RUSBAS202 RUSBAS203 RUSBAS204 RUSBAS205	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I Chemical Sciences II Computational Sciences I	Lectures(Hrs.) 45 45 45 45 30	Credits 3 3 3 3 2	Semester – II         Practical Paper         Code         RUSBASP201         RUSBASP202	Practical (Hrs) 60 60	Credits 2 2
Paper Code RUSBAS201 RUSBAS202 RUSBAS203 RUSBAS204 RUSBAS205 RUSBAS206	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I Chemical Sciences II Computational Sciences I Computational Sciences II	Lectures(Hrs.) 45 45 45 45 30 30	Credits 3 3 3 3 2 2	Semester - IIPractical Paper CodeRUSBASP201RUSBASP202RUSBASP203	Practical (Hrs) 60 60 60	Credits 2 2 2 2
Paper Code RUSBAS201 RUSBAS202 RUSBAS203 RUSBAS204 RUSBAS205 RUSBAS206 RUSBAS207	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I Chemical Sciences II Computational Sciences I Computational Sciences II Foundation Course	Lectures(Hrs.) 45 45 45 45 30 30 30	Credits 3 3 3 3 2 2 2 2	Practical Paper Code RUSBASP201 RUSBASP202 RUSBASP203	Practical (Hrs) 60 60 60 -	Credits 2 2 2 2 -
Paper Code RUSBAS201 RUSBAS202 RUSBAS203 RUSBAS204 RUSBAS205 RUSBAS206 RUSBAS207 TOTAL	Paper Nomenclature Biological Sciences I Biological Sciences II Chemical Sciences I Chemical Sciences II Computational Sciences I Computational Sciences II Foundation Course	Lectures(Hrs.) 45 45 45 45 30 30 30 270	Credits 3 3 3 3 2 2 2 18	Practical Paper Code RUSBASP201 RUSBASP202 RUSBASP203 - -	Practical (Hrs) 60 60 60 - <b>180</b>	Credits 2 2 2 - 6

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		Semester – III				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS301	Biological Sciences III	45	3		(0)	
RUSBAS302	Biological Sciences IV	45	3	KUSBASP301	60	4
RUSBAS303	Chemical Sciences III	45	3		60	2
RUSBAS304	Chemical Sciences IV	45	3	KU3DA3P302	00	2
RUSBAS305	Computational Sciences III	30	2		(0)	2
RUSBAS306	Computational Sciences IV	30	2	RUSBASP303	60	<i>L</i>
RUSBAS307	Environmental Sciences	30	2		-	-
TOTAL		270	18	-	180	6
TOTAL CRED	ITS	24				
		Semester – IV				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS401	Biological Sciences III	45	3		60	2
RUSBAS402	Biological Sciences IV	45	3	KUSDASP401	80	2
RUSBAS403	Chemical Sciences III	45	3		60	2
RUSBAS404	Chemical Sciences IV	45	3	KU3DA3P402	80	Ζ
RUSBAS405	Computational Sciences III	30	2		(0)	2
RUSBAS406	Computational Sciences IV	30	2	RUSBASP403	60	2
RUSBAS407	Technical Communication skills	30	2	-	-	-
TOTAL		270	18	-	180	6
TOTAL CREDITS		24				

T.Y.B.Sc.										
		Semester – V								
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	redits Practica Paper C		de	Practical (Hrs.)	Credits		
RUSBAS501	Entrepreneurship Skills Project/Case/Study /Assignment	60	3		RUSBASP501		RUSBASP501		60	20
RUSBAS502	Biological Sciences V	45	3		RUSBASE	P502	60	2		
RUSBAS503	Chemical Sciences V	45	3			0502	60	2		
RUSBAS504	Chemical Sciences VI	45	3		RUSDASE	203	00	Z		
RUSBAS505	Computational Sciences V	30	2		RUSBASE	2504	60	2		
TOTAL		270	18			180		6		
TOTAL CREDITS					24					
		Semester – VI								
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Prac Pape	Practical Paper Code		ical (Hrs.)	Credits		
RUSBAS601	Entrepreneurship Skills Project/Case/Study/ Assignment	60	$\hat{\mathbf{O}}$	RUSBASP601		. 60		2		
RUSBAS602	Biological Sciences V	45	3	RUS	BASP602	2 60		2		
RUSBAS603	Chemical Sciences V	45	3	RUS	BASP603	60		2		
RUSBAS604	Chemical Sciences VI	45	3							
RUSBAS605	Computational Sciences V	30	2	RUSBASP604		SP604 60		2		
TOTAL	270	18	-	180		6				
TOTAL CREI	DITS			-	24					
Rau	Inal									

		M.SC. I				
				Semester – VII		
Paper Code	Paper Nomenclature	Lectures	Credits	Practical Paper Code	Practical	Credits
RPSBAS701	Pharmaceutical Microbiology & Pharmaceutical Manufacturing	60	4	RPSBASP701	60	2
RPSBAS702	Pharmacology & Toxicology	60	4	RPSBASP702	60	2
RPSBAS703	Sample handling and Isolation of analytes in Bioanalysis	60	4	RPSBASP703	60	2
RPSBAS704	Different systems of Medicine & Regulations	60	4	RPSBASP704	60	2
Total		240	16		240	8
TOTAL CRED	ITS			24		
				Semester – VIII		
Paper Code	Paper Nomenclature	Lectures	Credits	Practical Paper Code	Practical	Credits
RPSBAS801	Molecular Biology & Tissue culture	60	4	RPSBASP801	60	2
RPSBAS802	IPR, Drugs and Cosmetic Act & Regulations	60	4	RPSBASP802	60	2
RPSBAS803	Quality Management in Pharmaceutical Industry	60	4	RPSBASP803	60	2
RPSBAS804	Pharmaceutical Testing & Proteomics	60	4	RPSBASP804	60	2
	Y	240	16	-	240	8
TOTAL CRED	ITS			24		
		M.SC. II				
				Semester – IX		
Paper Code	Paper Nomenclature	Lectures	Credits	Practical Paper Code	Practical	Credits
RPSBAS901	Research Methodology & Statistics	60	4	RPSBASP901	60	2
RPSBAS902	Advances in Bioanalysis I	60	4	RPSBASP902	60	2
RPSBAS903	Automation and Data Management	60	4	RPSBASP903	60	2
	Industrial Training	-	-	RPSBASP904	360	6
Total		240	12	-	540	12
TOTAL CRED	ITS			24		
						7

				Semester – X		
Paper Code	Paper Nomenclature	Lectures	Credits	Practical Paper Code	Practical	Credits
RPSBAS1001	Analytical Techniques and their Validation	60	4	RPSBASP1001	60	2
RPSBAS1002	Advances in Bioanalysis II	60	4	RPSBASP1002	60	2
RPSBAS1003	Clinical Research & Ethics	60	4	RPSBASP1003	60	2
	Research Project	-	-	RPSBASP1004	360	6
		240	12	-	540	12
TOTAL CRED	ITS			24	9	
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# F.Y.B.S.c Syllabus at a Glance

SEMES	SEMESTER I SEMESTER II					
RUSBA	S101: BIOLOGICAL SCIENCES I (4	45L)	RUSBA	S201: BIOLOGICAL SCIENCES I (	(45L)	
101.1	Type Specimens	15 L	201.1	Introduction to Genetics	15L	
101.2	Introduction to Microbiology	15 L	201.2	Enzymology	15L	
101.3	Anatomy of plants and Animals	15L	201.3	Biological Membranes & Transport	15L	
			1			
RUSBA	<u>S102: BIOLOGICAL SCIENCES II (</u>	45L)	RUSBA	S202: BIOLOGICAL SCIENCES II	(45L)	
102.1	Carbohydrates & Nucleic Acids	15L	202.1	Principles of Bioenergetics	15L	
102.2	Proteins, Lipids& Vitamins	15L	202.2	Carbohydrate Metabolism	15L	
102.3	Physiological Processes in Plants & Animals	15L	202.3	Lipid Metabolism Nucleic Acid Metabolism Amino Acid Metabolism	15L	
RUSBA	S103: CHEMICAL SCIENCES I(45)	L)	RUSBA	S203: CHEMICAL SCIENCES I(45	5L)	
103.1	Buffers	15L	203.1	Stereochemistry-I	15L	
103.2	IUPAC Nomenclature& Aromaticity	15L	203.2	Stereochemistry-II	15L	
103.3	Introduction to Molecular Bonding	15L	203.3	Chemical Kinetics and Chemical Thermodynamics	15L	
DUGDA						
RUSBA	S104: CHEMICAL SCIENCES II(45	L)	RUSBA	S204: CHEMICAL SCIENCE II(45	L)	
104.1	Preparation of Standard Solutions, Titrimetric analysis	15L	204.1	Basic Instruments in Bioanalytical Laboratory	15L	
104.2	Fundamentals of Organic Reactions& Mechanisms-I	15L	204.2	Automation in Analysis	15L	
104.3	Fundamentals of Organic Reactions& Mechanisms-II	15L	204.3	Gravimetric Analysis and Treatment of Analytical Data & Sampling	15L	
	$\sim$					
RUSBA (30L)	S105: COMPUTATIONAL SCIENC	ES I	RUSBA (30L)	S205: COMPUTATIONAL SCIEN	CES I	
105.1	System of linear equations and Matrices	10L	205.1	Types of Data and Data Condensation	10L	
105.2	Calculus	10 L	205.2	Measures of central tendency	10L	
105.3	Ordinary Differential Equation and Applications	10 L	205.3	Measures of Dispersion, Skewness & Kurtosis	10L	

Alternating current theory & transient response of circuit. Optics Material Science, Crystal Geometry & X-Ray Techniques 107: FOUNDATION COURSE I (3 The Indian Constitution Growing Social Problems in India Significant aspects of political processes	10L 10L 10L 0L) 10L 10L 10L	206.1 206.2 206.3 RUSBA 207.1 207.2 207.3	Introduction to Computers Data Model & languages HTML & XML S207: FOUNDATION COURSE II Globalization and Indian Society Understanding Stress and Conflict Human Rights	10L 10L 10L (30L) 10L 10L
Optics Material Science, Crystal Geometry & X-Ray Techniques 107: FOUNDATION COURSE I (3 The Indian Constitution Growing Social Problems in India Significant aspects of political processes	10L         10L         0L)         10L         10L         10L         10L	206.2 206.3 RUSBA 207.1 207.2 207.3	Data Model & languages HTML & XML S207: FOUNDATION COURSE IN Globalization and Indian Society Understanding Stress and Conflict Human Rights	10L         10L         (30L)         10L         10L         10L
Material Science, Crystal Geometry & X-Ray Techniques 107: FOUNDATION COURSE I (3 The Indian Constitution Growing Social Problems in India Significant aspects of political processes	10L 0L) 10L 10L 10L	206.3 RUSBA 207.1 207.2 207.3	HTML & XML S207: FOUNDATION COURSE II Globalization and Indian Society Understanding Stress and Conflict Human Rights	10L (30L) 10L 10L
107: FOUNDATION COURSE I (3 The Indian Constitution Growing Social Problems in India Significant aspects of political processes	0L) 10L 10L 10L	RUSBA         207.1         207.2         207.3	S207: FOUNDATION COURSE II Globalization and Indian Society Understanding Stress and Conflict Human Rights	(30L) 10L 10L 10L
The Indian Constitution Growing Social Problems in India Significant aspects of political processes	10L 10L 10L	207.1 207.2 207.3	Globalization and Indian Society Understanding Stress and Conflict Human Rights	10L 10L 10L
Growing Social Problems in India Significant aspects of political processes	10L 10L	207.2 207.3	Understanding Stress and Conflict Human Rights	10L 10L
Significant aspects of political processes	10L	207.3	Human Rights	10L
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# Learning Objectives for First Year Semester I:

## **RUSBAS101: BIOLOGICAL SCIENCES I**

- To study microbial, plant and human as type specimens and their applications in research.
- To revise the concepts of plant and animal anatomy.
- To introduce microbiology with respect to Sample handling, and its microscopic evaluation.
- To introduce different animal systems as in-vivo study models for bioanalysis.

## **RUSBAS102: BIOLOGICAL SCIENCES II**

- To revise concepts of organic functional groups.
- To emphasize the importance of water as an essential biomolecule.
- The underline the properties of carbon which make it the most abundantly found element in living systems.
- To understand structure and functions of carbohydrates, proteins, fats, nucleic acids and vitamin. and demonstrate structure-function co-relation.
- To study physiological processes in Plants and animal systems as a crucial knowledge for further research in agriculture and tissue systems.

## **RUSBAS103: CHEMICAL SCIENCES I**

- To revise the concepts of ionic equilibria, pH and introduce the buffer systems.
- To train students to prepare buffers and test their pH using pH meter.
- To demonstrate various types of molecular bonding with the help of ball and stick model.
- To facilitate identify and name complex structures of commercially important phytoconstituents.

## RUSBAS104: CHEMICAL SCIENCES II

- To grasp the concepts of molarity, ppm, dilutions and apply these concepts for preparation of standard solutions.
- To interpret different types of titration curves.
- To equip students with basic laboratory skills like calibration of glasswares & titrations.
- To build up the concepts of reaction mechanisms in organic chemistry and correlate these concepts with biochemistry.

## **RUSBAS105: COMPUTATIONAL SCIENCES I**

- To study basic arithmetic required in day to day calculations.
- To develop mathematical and problem-solving skills.

## **RUSBAS106: COMPUTATIONAL SCIENCES II**

- To study the basic theory of optics that is applied in different analytical instruments and is required for better understanding of the instrument function.
- To introduce material science and give awareness about crystal geometry for different chemical substances used in day to day analysis.

## **RUSBAS107: FOUNDATION COURSE I**

• To create awareness about the constitution of India & fundamental duties of Indian citizens

Paper Code	Semester I	lectures
RUSBAS101	Biological Sciences I	45
	<b>101.1:</b> Type Specimens	15
	Significance of Studying type specimen, <i>E. coli</i> , Yeast & <i>Neurospora crassa</i> ,	
	Sunflower, Maize & Arabidopsis thaliana, Mice, Zebra Fish, Guinea Pig, Non-	
	human primates, <i>Homo sapiens sapiens</i>	
	<b>101.2:</b> Introduction to Microbiology	15
	Microbes & their Environment, Biodiversity and types of Microorganisms,	. ()
	Significance and Scope of Microbiology, Visualization of Microorganisms:	0
	Staining, Simple and Compound Microscopy,	7.9
	Introduction to concepts of asepsis, sterilization and disinfection	15
	101.3: Anatomy of plants and Animals	15
	Plant Anatomy: (8L)	
	Issue and Issue systems in Plants, Meristems, Classification of Meristems,	
	differentiation Specialized cells of plants Importance of plant contents	
	Animal Anatomy: (71)	
	Tissue and Tissue systems in Animals Classification of Animal tissues Cell	
	differentiation Specialized cells of Animals, Importance of Animal anatomy	
• To anal	vze the emerging social problems in India also to study varied aspects of politic	l ral
- To unu	yze the emerging social problems in maid, also to study varied aspects of points	cui
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Paper Code	Semester I	lectures
RUSBAS102	Biological Sciences II	45
	<b>102.1:</b> Introduction to Biomolecules, Carbohydrates & Nucleic Acids	15
	Introduction to Biomolecules (3L)	
	Overview of chemical and physical attributes of Biomolecules, Classification	
	of Biomolecules, Significance of Biomolecules in nature and science.	0.
	Carbohydrates (8L)	
	Classification of carbohydrates	3
	Structure, structure properties, Isomerism, derivatives, functions &	0-
	reactions of Monosaccharides, Oligosaccharides, Homopolysaccharides	Þ
	(Starch, Inulin, Glycogen, Cellulose), Heteropolysaccharides	
	Nucleic Acids (4L)	
	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	
	<b>102.2:</b> Proteins, Lipids & Vitamins	15
	Amino acids & Proteins	
	Structure, classification, physical and chemical properties, levels of	
	structural organization of Proteins, Introduction to Ramachandran plot.	
	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.	
	<b>102.3:</b> Physiological Processes in Plants & Animals	
	Plants:	
	Seed germination, Photosynthesis: Light reactions, Carbon fixation reactions	15
	C3, C4 & CAM pathways, Photorespiration, Storage of plants, Oil seeds.	
	Animai systems: Deminatore Directive Eventere Content Neurope Deminatories	
	DDACTICATS	
NUSDASP101	1 Cleaning Starilization of glassware	
	1. Utaling, Stermization of glassware	
	2. Agentic Transfor	
	A Isolation of bactoria	
	7. Isolation of Datterna 5. Staining techniques: Gram staining Endosnore staining Motachromatic	
	staining teeningues. Grain staining, Encospore staining, Metachi Olilatie	
	6 Estimation of oil from oil seeds	
	7 Qualitative analysis of Riomolecules- Carbobydrates, Protoine, Nucleic	
	Acide Linide	
	8 Photosynthesis	

Paper Code	Semester I	lectures
RUSBAS103	Chemical Sciences I	45
	<ul> <li>103.1: Ionic Equilibrium, pH and Buffers</li> <li>Acid- Base concept, Hard and soft acid and base (<i>HSAB</i>), Ostwald's Dilution Law, Activity coefficient, Solubility, Complex formation and organic complexes, Oxidation and reduction equilibria, Hydrolysis of salts and Solubility product</li> <li>Concept of pH, pKa, pKw, Isoelectric pH, Buffer, Buffering Capacity</li> <li>Derivations: Ionic product of water, Hendersen-Hasselbalch equation, Relation between pI, pKa1 and pKa2 for a neutral, acidic and basic amino acid.</li> <li>Titration and Ionization of Glycine, Lysine and Aspartic acid; pKa , pH, and pI values of these amino acids</li> <li>Physiological Buffers : Preparation, properties and uses of Carbonate-Bicarbonate, Phosphate, and Citrate buffers</li> <li>Preparation and Numericals based on pH and Buffer</li> </ul>	15
	<ul> <li>103.2: IUPAC Nomenclature and Aromaticity</li> <li>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</li> <li>Aromaticity: Characteristic properties of aromatic compounds, Huckel's rule, Aromaticity and anti-aromaticity, Resonance energy, Aromatic hydrocarbons: Benzenoid &amp; Nonbenzenoid compounds (benzene, naphthalene, anthracene, phenanthrene, cyclopropenium, cyclopentadienyl cyclobentatrieniumcation)</li> </ul>	15
	<ul> <li>103.3: Introduction to Molecular Bonding</li> <li>Concept of atoms and molecules and atomic structure orbitals</li> <li>Concept of electronic configuration-Pauli's exclusion principle, Hund's rule, Aufbau principle</li> <li>Types of bonds and bonding, Chemical bonding theory, Valence-Bond theory and Molecular orbital theory, Concept of hybridization and its types</li> <li>Polar covalent bonds and Electronegativity, Drawing chemical structures, Molecular models</li> </ul>	15

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Paper Code	Semester I	lectures
RUSBAS104	Chemical Sciences II	45
	104.1 <b>Stoichiometry and Preparation of Standard Solutions</b> , Titrimetric analysis	15
	Methods of expressing concentration of solutions-molarity, normality,	
	molality, mole fraction, dilution of solutions, interconversion between	0
	different concentration units, concept of milliequivalents, millimols, ppm	
	and ppb	9
	Primary and secondary standards, Preparation of standard solutions,	
	Calculation of concentration of commercial samples of acids and bases, Use	
	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, and complexometric titrations	
	Theory of acid base indicators, choice of an indicator for the titration.	
	dependence on the pH at the equivalence point. Acid-base, redox and	
	metal-ion indicators	
	Acid-base Titrations: Construction of titration curves and choice of	
	indicators in the titration of Strong acid and strong base, Strong acid and	
	Weak base, weak acid and strong base, weak acid and weak base	
	titration curve. Volhard's method. Mohr's method	
	104.2 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	
	General Idea of types of reaction: Introduction and few examples of	
	following types of reaction expected: Addition Elimination Substitution	
	Condensation, Rearrangement, Pericyclic reactions, Oxidation-reduction	
	Concept of Electrophilicity, Nucleophilicity, acidity and basicity of organic	
	molecules	
	104.3: Fundamentals of Organic Reactions & Mechanism II	
	Homolysis & Heterolysis, Concepts of intermediate, carbocation, carbanion	
	and free radicals: Geometry, stability and reactivity.	
$\sim$	reaction Benzilic acid rearrangement	
	Lossen rearrangement. Knoevenagel condensation. Reimer-Teimann	
	reaction, Hunsdiecker reaction, Sand-Meyer reaction	
	Aldol condensation, Diels Alder reaction, Birch reduction	

KUSBASP102	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
	d) Estimation of Calcium (Complexemetric Titration)
	e) Estimation of Total Hardness
	f) Estimation of jodine in jodised common salt using jodometry.
	4. Preparation of various buffers (5-6 buffers at least) and measurement of pH
	using pH meter and pH paper. Calculation of % error expected
	a) Carbonate-Bicarbonate Buffer
	b) Ammonia – Ammonium Chloride Buffer
	c) Acetic acid—Sodium acetate Buffer
	5. Sunstation of glassware. Burette, ripette, standard ridsk
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Paper Code	Semester I	Lectures
RUSBAS105	Computational Sciences I	30
	<b>105.1</b> 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	0
	solution of system of equation both homogenous and non-homogenous	~~
	using matrix (concept of Rank to be introduced)	5
	Determinants: Determinant of a matrix of order 2 and 3. elementary	5
	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	
	nrohlem)	
	105.3 Ordinary Differential Equation and Applications	10
	First order differential equations: Paview of senarable 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	
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Paper Code	Semester I	Lectures
RUSBAS106	Computational Sciences II	30
	<b>106.1</b> 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	0
	circuit. Q-factor. Series LR, CR, LCR circuits. Growth and decay of	
	currents/charge.	5
	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.	
	vibrations of equal amplitude, the same period and phases increasing in ap	
	arithmetic progression use of this expression to study a single slit a double	
	slit and a plane diffraction grating(transmission type) comparison of	
	nrism and grating spectra	
	<b>Introduction to polarization</b> : 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 $\mu 0$	
	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.	
	Lompton Effect and its experimental verification, energy dependence of	
	photoelectric effect and compton Effect	
NUSDASP 103	1 Eacal length of a long system	
•	2 High pass Filter I ow pass filter	
	2. Ingh pass Filter, LOW pass filter	
	4 Vernier Caliner Micrometer screw gauge and their use in nharma	
	5 Study of light Microscope	
	1. Study of light microscope	

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	7.9
	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 73 <sup>rd</sup> and 74 <sup>th</sup>	
	Amendments and their implications for inclusive politics	
	3. Role and significance of women in politics	
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# Learning Outcomes for First Year Semester I:

## **RUSBAS101: BIOLOGICAL SCIENCES I**

Students should realize the importance of type specimens and in-vivo models in the field of bioanalytical sciences. They will understand basic concepts of microbiology. They should be able to successfully perform aseptic transfers. They should learn operation of simple light microscope.

## **RUSBAS102: BIOLOGICAL SCIENCES II**

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

### **RUSBAS103: CHEMICAL SCIENCES I**

Students should be able to prepare buffers and operate pH meter. They should accurately name and identify aromatic compounds. They should understand the concepts of molecular bonding.

## **RUSBAS104: CHEMICAL SCIENCES II**

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. They should be able to demonstrate mechanisms of organic reactions and identify the similarities between organic and biochemical reactions.

## **RUSBAS105: COMPUTATIONAL SCIENCES I**

Students should be adept in basic arithmetic calculations. They should apply the mathematical equations to find solutions to given problems.

# **RUSBAS106: COMPUTATIONAL SCIENCES II**

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

## **RUSBAS107: FOUNDATION COURSE I**

Students should be aware about their constitutional rights and current socio-political scenario of India.



## List of Reference books for F.Y.B.Sc. Semester I:

List of Referen	ce books for F.Y.B.Sc. Semester I:
Paper	Reference books
Foundation course	<ul> <li>K. T. Basantani; Social Awareness - Foundation Course, Semester - I; Sheth Publisher Pvt. Ltd.</li> </ul>
Biological Sciences I	<ul> <li>B. P. Pandey, Plant Anatomy, S Chand</li> <li>Gerald Karp, Cell Biology</li> <li>Micheal J. Pelczar, Jr., E.C.S.Chan, Noel R. Krieg – Microbiology</li> <li>B.R. Vashishta, A K Sinha, Adarsh, Botany for Degree Students Part III:Bryophyta</li> <li>Gerald Karp, Cell Biology</li> </ul>
Biological Sciences II	<ul> <li>David Hopkin Lewis, Storage Carbohydrates in Vascular Plants:Distribution, Physiology, and Metabolism</li> </ul>
	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
	<ul> <li>U.Satyanarayana,U.Chakrapani-Biochemistry</li> <li>S. Mukherji and A. K. Ghosh, Plant Physiology, New Central Book Agency (P) Ltd</li> <li>Russell; Hunter, W.D. and McMillan: Life of Invertebrates</li> </ul>
	Kotpal, R.L.: Zoology Phylum – Arthropoda, Rastogi Publication
Chemical Sciences I	<ul> <li>John McMurry: Organic Chemistry : 5th Edition: Brooks AND Cole Publication</li> <li>James House: Inorganic Chemistry : Elsevier</li> </ul>
	<ul> <li>Paula Yurkanis Bruice: Organic Chemistry :Pearson</li> <li>P.S Kalsi :Organic Reactions and Their Mechanisms :Third Edition, New Age Ira N. Levine: Physical Chemistry : McGraw-Hill</li> <li>S.C.Pal: Nomenclature of organic chemistry :Alpha publication</li> <li>Peter Atkins &amp; Julio de Paulo: Physical Chemistry : Oxford University Procession</li> </ul>
Chemical	<ul> <li>Morrison AND Boyyd: Organic chemistry :Allyn&amp;Baconp publication</li> </ul>
Sciences II	<ul> <li>Richard O.C. Norman, James M. Coxon: Principles of Organic Synthesis, 3rd Edition:CRC Press</li> </ul>
	<ul> <li>Peter Sykes: A Guidebook to Mechanism in Organic Chemistry:6 Edition: Pearson</li> <li>P.S Kalsi :Organic Reactions and Their Mechanisms :Third Edition, New Age</li> </ul>
	Ira N. Levine: Physical Chemistry : McGraw-Hill

Computational Sciences I	<ul> <li>S.LangLinear Algebra</li> <li>Schaum's outlines on matrices</li> <li>Simmons, G.F., Differential Equations With Applications and Historical Notes,</li> </ul>
	• 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
Computational Sciences I	<ul> <li>Verma, H.C., Concepts of Physics, Volume 1, Bharati Bhavan Publishers &amp; Distributors.</li> <li>Mathur D. S., Elements of Properties of Matter, , S. Chand and Co. Ltd., Reprint 2001.</li> <li>Mathur B.K. and T.P. Pandya, Principles of Optics, Gopal Printing Press, Kanpur.</li> <li>Jenkins F.A., Fundamentals of Optics, Whitte, 4e, 1981, McGraw Hill International.</li> </ul>
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# Learning Objectives for First Year Semester II:

### **RUSBAS201: BIOLOGICAL SCIENCES I**

- To introduce the basics of genetics, linkage, crossover and gene expression.
- To lay down the basics of enzymology and highlight the importance of enzymes as targets for pharmaceuticals.
- To study the biological membrane dynamics and solute transport systems as a pre-requisite for studying transport of drug molecules across the membrane.

### **RUSBAS202: BIOLOGICAL SCIENCES II**

- To understand how laws of thermodynamics are applicable to living systems.
- To do thermodynamic calculations for biochemical reactions.
- To give a detailed overview of carbohydrate, lipid and nucleic acid metabolism.
- To highlight the significance of metabolic pathways for developing new drug compounds for obtaining the desired therapeutic effect.

## **RUSBAS203: CHEMICAL SCIENCES I**

- To lay down the fundamentals of stereochemistry so that students can correlate them with potency and safety of biopharmaceuticals.
- To know the basics of chemical kinetics and thermodynamics.

## RUSBAS204: CHEMICAL SCIENCES II

- To understand basic instruments used in Bioanalytical sciences laboratory.
- To emphasize the need for automation in Bioanalysis.
- To demonstrate the importance of sampling techniques and errors in data analysis.
- To train students in gravimetric analysis and microscaling for organic synthesis,

## **RUSBAS205: COMPUTATIONAL SCIENCES I**

- To study the various types of data and data collection methods like schedule and questionnaire.
- To guide students with respect to statistical calculations of measures of central tendency and signify its importance in obtaining measures of Dispersion
- To train students in analysis of biological data using statistical methods.

## RUSBAS206: COMPUTATIONAL SCIENCES II

- Introduction to the computers, its functionalities and different operating systems.
- To study the different data models and query languages, also introduction to HTML & XML.

## **RUSBAS207: FOUNDATION COURSE II**

- To study the effect of globalization on Indian society and how will it impact the future development.
- To understand Stress, its causes and conflict and try to avoid it in day-to-day life.
- To know the human rights, its origin and evolution.

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. Non-Mendelian inheritance, Linkage and crossing over, Gene	
	expression	
	3. Sex determination in animals, sex linked, sex limited and sex influenced	
	genes	
	4. Variations in chromosome number and structure (e.g. Rice, wheat,	
	Brassica, etc. and Syndromes in Human)	
	5. Concept of genes, chromosomes, Mitosis and Meiosis, Apoptosis	
	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	
	<ol><li>Isoenzymes, abzymes, synzymes, ribozymes,</li></ol>	
	8. Applications of enzymes, immobilized enzymes	
	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	
	201.3: Biological Membranes & Transport	15
	Composition of biological Membranes, Different models of Biological	
	Membranes, Membrane dynamics, Solute transport across Biological	
	Membrane (Types & specific examples)	

Membranes, Membrane dynar Membrane (Types & specific e

Paper Code	Semester II	lectures
RUSBAS202	Biological Sciences II	45
	<b>202.1:</b> 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	.0,
	bond formation or breakdown. c) Internal rearrangement, isomerisation	
	and elimination. d) Group transfer reaction. e)Free radical reaction	2
	Concept of Gibbs free energy, enthalpy, entropy, free energy change ( $\Delta G$ ) and	
	standard free energy change ( $\Delta G'^0$ ) with suitable examples.	
	Laws of thermodynamics with suitable examples.	
	<b>202.2:</b> Carbohydrate Metabolism	15
	Introduction to Metabolism, Glycolysis, Krebs Cycle, Pentose Phosphate	
	Pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Metabolic disorders	
	<b>202.3:</b> 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. Microscopic visualization of Storage carbohydrates from plant sample	
	4. Study of Seed germination and effect of various factors on seed germination	n
	5. Study of Mitosis and Meiosis	
	6. Study of Karyotype(s)	
	7. Extraction and purification of Invertase from yeast.	
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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	0
	Idea of configuration. Stereochemistry of carbon compounds with one and	
	two similar and dissimilar asymmetric carbon atoms: enantiomers,	90
	diastereomers, and racemic mixtures and their properties, threo, erythro	6
	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-	
	unneurupropane, n-butane.	
	Summetry Alternating axis of summetry Chirality without asummetric	
	carbon	
	Stability of cycloalkanes: Strains in cycloalkanes-angle eclinising	
	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-	
	upnenyipropane. Addition montions to olofing i)Catalytic hydrogenetics ii)Providention	
	Audition reactions to orenns-ijuatarytic nyurogenation iijBromination	
	(electrophine and addition) mjsynnydroxylation (molecular addition) with Os04 and KMpO4.	
	0504 aliu Mill04.	



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.	. 0,
Methods of determining order of reaction by Integration method, Graphical	
method, Equi-fraction method, Ostwald's isolation method.	7.9
Chemical Thermodynamics :	
Transition state theory, 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.	
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Tuper coue	Semester n	Lectures
RUSBAS204	Chemical Sciences II	45
	204.1: Basic Instruments in Bioanalytical laboratory	15
	Basic Principle and Instrumentation of :	
	Autoclave, Centrifuge, Conductometer, pH meter, Rotary shaker, Rotary	
	Evaporator, Gas analyzer, TDS meter, Colorimeter, Hot air oven	0
	Vortex, Incubator, Weighing balance, Sonicator, Cyclomixer	
	204.2: Automation in analysis	15
	Introduction to Automation, Need for automation,	
	Automation involved in general laboratory equipments and instruments	
	eg: autopipette, primeter, rotary snaker, ultrasonicator.	
	204.3. Gravimetric Analysis and Treatment of Analytical Data &	15
	Sampling	10
	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	
	analysis Microanalysis Stereochemical and tonochemical analysis Trace	
	analysis, with our analysis, surface analysis, Badioanalytical 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	
	Types or errors, determinate and indeterminate errors, minimization of	
	measures of dispersion and central tendency: mean median average	
	deviation, relative average deviation, standard deviation variance	
	coefficient of variation.[Numerical problems expected]	
	Summary of experimental methods currently available for analysis :	
	History and development	
Rauk	<ul> <li>Autoclave, centratige, conductor primeter, Port inteer, Rotaly Shaker, Rotaly Staker, Incubator, Gas analyzer, TDS meter, Colorimeter, Hot air oven Vortex, Incubator, Weighing balance, Sonicator, Cyclomixer</li> <li>204.2: Automation in analysis</li> <li>Introduction to Automation, Need for automation, Automation involved in general laboratory equipments and instruments eg: autopipette, pH meter, rotary shaker, ultrasonicator.</li> <li>Significance and advantages of automation.</li> <li>204.3: Gravimetric Analysis and Treatment of Analytical Data &amp; Sampling</li> <li>A) Gravimetric analysis:</li> <li>Conditions of precipitation, Nucleation, Particle size, Crystal growth, Co-precipitation, Precipitation from homogeneous solutions, Drying and ignition of precipitate</li> <li>B) Treatment of Analytical Data &amp; Sampling</li> <li>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]</li> <li>Sensitivity, limit of Detection, Detection Power</li> <li>Different types of analysis, Stereochemical and topochemical analysis, Trace analysis, Surface analysis, Radioanalytical methods and activation analysis, Species analysis (Speciation), DNA analysis</li> <li>Terms involved, importance of sampling, sampling techniques, sampling of gases, ambient and stack sampling. 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</li> <li>Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precis</li></ul>	15

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.	0
	Methods of Data Collection: i) Primary data: concept of a Questionnaire and a	
	Schedule, ii) Secondary Data	20
	<b>Types of data</b> : 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	
	Univariate frequency distribution of discrete and continuous variables	
	Cumulative frequency distribution	
	<b>Data Visualization:</b> Graphs and Diagrams Histogram Polygon/curve	
	Ogives Bivariate Frequency Distribution of discrete and continuous variables	
	ogives. Divariate i requency 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	

Paper Code	Semester II		
RUSBAS206	Computational Sciences II		
	206.1 Introduction To Computers		
	<ul> <li>History of computers and their generations</li> <li>Basic Organization of Computers: Introduction to Computer, Block diagram of a Computer, parts of Computer &amp; functional Units, their integration and function, Input-output devices</li> <li>Computer architecture &amp; functionalities</li> <li>Computer memory &amp; memory unit</li> <li>Operating System &amp; Interface: OS, tasks performed by OS, DOS, Windows and Linux/UNIX</li> <li>206.2 Data models &amp; languages</li> </ul>	999 10	
	<ul> <li>DBMS: Data models Basics</li> <li>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)</li> <li>Query languages (relational algebra, creating and altering tables, handling data using SQL etc)</li> <li>206.3 HTML &amp; XML</li> </ul>	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		
	<ol> <li>Introduction and overview of general computer operation (Windows a platforms), Use of various search engines, email etc.</li> <li>Introduction of MS-Office:         <ul> <li>a. Different elements of word processing (MS-WORD),</li> <li>b. Spreadsheets (MS EXCEL) and</li> <li>c. PowerPoint presentation (MS POWERPOINT)</li> </ul> </li> <li>Browsers, various search engines and metadata, E-Mail/Web mail etc.</li> <li>Introduction to HTML</li> <li>HTML Tags, HTML Tables</li> <li>HTML Forms, HTML Framesets</li> <li>Webpage designing.</li> </ol>	nd Linux	
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Semester II	Lectures
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	0
manifested in everyday life	
Impact of globalization on Industry: Changes in employment and	20
increasing migration	5
Changes in agrarian sector due to globalization, rise in corporate farming	
and increase in farmer's suicide. Debate regarding Genetically Modified	
Crops.	
Changing lifestules and impact on culture in a globalized world	
207.2 Understanding Stress and Conflict	10
201.2 Olderstanding Stress and connect	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	
	Semester II           Foundation Course-II           207.1 Clobalization and Indian Society           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           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           Concept of human rights: Origin and evolution of the conccept

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# Learning Outcomes for First Year Semester II:

### **RUSBAS201: BIOLOGICAL SCIENCES I**

Students should comprehend fundamental concepts of genetics. They should realize the significance of enzymes with respect to drug design. They should learn the properties and dynamics of plasma membrane as a prerequisite to study transport of drug molecules.

### **RUSBAS202: BIOLOGICAL SCIENCES II**

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. They should accurately demonstrate metabolic pathways in a sequential manner. They should study metabolic pathways with the perspective of their applications in drug design.

## **RUSBAS203: CHEMICAL SCIENCES I**

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

## **RUSBAS204: CHEMICAL SCIENCES II**

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

## **RUSBAS205: COMPUTATIONAL SCIENCES 1**

Students should be able to choose the correct statistical test to analyze biological data.

## **RUSBAS206: COMPUTATIONAL SCIENCES II**

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.

## **RUSBAS207: FOUNDATION COURSE II**

Students should be aware of the current trends in globalization. They should realize the importance of stress management to live a healthy life. They should be aware about basic human rights.

## List of Reference books for F.Y.B.Sc. Semester II:

Paper	Reference books					
Foundation	Micheal Vaz, Madhu Nair, Meeta Seta; Foundation Course, Semester - II;					
course	Manan Prakashan					
	K.T. Basanti:Social Problems (foundation Course),Seth Publication					
Biological	Robert Copeland : Enzyme: 2nd edition: Wiley publication					
Sciences I	• 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.					
	<ul> <li>Fairbanks, Daniel J. and Anderson, W. R.: Genetics. Wadsworth Publication.</li> </ul>					
	• William S. Kluge and Cummings, M.R.: Concepts of Genetics, Pearson Edu.					
Biological	• David Hopkin Lewis, Storage Carbohydrates in Vascular Plants: Distribution,					
Sciences II	Physiology, and Metabolism					
	• U. Satyanarayana, U. Chakrapani – Biochemistry					
	• Micheal M. Cox and David L. Nelson, Lehninger Principles of Biochemistry					
Chemical	P. S. Kalsi: Stereochemistry:New Age International Ltd					
Sciences I	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					
Chemical	<ul> <li>Dand Harvey : Modern Analytical Chemistry : Mc Grow Hill Publishers</li> </ul>					
Sciences II	<ul> <li>Hobart.H.Williard, Lyne.L.Merrit, John. A. Dean, Frank. A. Settle. Jr. :</li> </ul>					
	CInstrumental 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					
Computational	B.K.Mahajan: Methods in Biostatistics					
Sciences I	David Asquith: Statistics- from Concept to Practice.					
	Arora & Malhan: Biostatistics- Himalayan Publishing House.					
Computational	Andrew Leach:Chemoinformatics					
Sciences II						

# S.Y.B.Sc Syllabus at a glance

SEMESTER III			SEMESTER IV			
RUSBAS301: BIOLOGICAL SCIENCES III (45L)			RUSBAS401: BIOLOGICAL SCIENCES III (45L)			
301.1	Central Dogma of Molecular Biology	15 L	401.1	Biology of Muscles and Nerve Conduction	15L	
301.2	Developmental Biology	15L	401.2	Genetic Mutation & Repair	15L	
301.3	Pharmacognosy & Ethnobotany	15 L	401.3	Genetic disorders	15L	
			1			
RUSBA	S302: BIOLOGICAL SCIENCES IV	(45L)	RUSBA	RUSBAS402: BIOLOGICAL SCIENCES IV		
302.1	Industrial Microbiology	15L	402.1	Biochemical methods of Analysis	15L	
302.2	Virology & Interaction of microbes with humans	15L	402.2	Cell communication and Cell signaling	15L	
302.3	Introduction to Immunology	15L	402.3	Tissue Culture- Plants & Animals	15L	
		•				
RUSBA	S303: CHEMICAL SCIENCES III (4	5L)	RUSBA	S403: CHEMICAL SCIENCES III (	(45L)	
303.1	Electrochemistry	15L	403.1	Introduction to Pharmaceutical chemistry	15L	
303.2	Newer methods of organic synthesis & Name Reactions (Mechanism and Applications)	15L	403.2	Introduction to Bio-organic Chemistry	15L	
303.3	Instrumental methods of analysis	15L	403.3	Material Chemistry: Polymers and Biomaterials	15L	
			I			
RUSBA	S304: CHEMICAL SCIENCES IV (4	·5L)	RUSBAS404: CHEMICAL SCIENCE IV (45L)			
304.1	Basic Spectroscopy	15L	404.1	Nuclear chemistry	15L	
304.2	Heterocyclic Compounds	15L	404.2	Aspects of Bio-Inorganic Chemistry	15L	
304.3	Methods of Separations I	15L	404.3	Methods of Separations-II	15L	
RUSBA	S305: COMPUTATIONAL SCIENC	ES III	RUSBA	S405: COMPUTATIONAL SCIEN	CES III	
(30L) 305 1	Algorithms	101	(30L) 405 1	Analysis of Varianco	101	
305.1	Granhs	101	405.2	Design Of Experiments	101	
305.3	Numerical methods	10 L 10 L	405.3	Latin Square Design (LSD)	10 L 10 L	
RUSBA	S306: Computational Sciences IV	(30L)	RUSBA	S406: Computational Sciences I	V (30L)	
306.1	Correlation, Simple linear Regression Analysis	10L	406.1	Introduction to Bioinformatics	10L	
306.2	Probability Theory	10 L	406.2	Basics to sequencing	10 L	

306.3	Basics of Theory of Estimation and Testing of	10 L	4063	Pairwise Sequence Alignment	10 L
	hypothesis				
RUSBAS307: Environmental Sciences (30L)		RUSBAS407: Technical Communications Skills			
		(30L)			
307 1	Environment: An overview	101	407 1	Basics of effective	10L
507.1	and Natural Resources	101	107.1	communication	
	Disaster-Natural and Man-				90
307.2	made & Environmental Issues and Movements.	10L	407.2	Mechanics of Writing	10L
307.3	Environmental Management	10L	407.3	Technical writing	10L
201	Ruik		jto		
# Learning Objectives for Second Year Semester III:

#### **RUSBAS301: BIOLOGICAL SCIENCES III**

- To enlighten students about the genetic basis of life as a prerequisite to study molecular biology techniques.
- To lay down the fundamental concepts of developmental biology
- To comprehend the basics of pharmacognosy and ethanobotany which can be employed in development of crude drugs and their bioanalysis.

#### **RUSBAS302: BIOLOGICAL SCIENCES IV**

- To study the commercial applications of microorganisms and viruses.
- To introduce the basic concepts of immunology and autoimmune disorders.
- To train students in performing and interpreting various diagnostic tests such as blood grouping, Widal, VDRL, ELISA.
- To train the students with industrial applications of microbiology such as total viable count, disinfection and sterility testing.

#### **RUSBAS303: CHEMICAL SCIENCES III**

- Introduction of different electrodes and basic analytical instruments, their working and application in the field of Bioanalysis.
- To train students in operation and handling of pH meter and conductometer.
- Introduction of newer methods of synthesis to develop interest in Greener approach of synthesis.

#### **RUSBAS304: CHEMICAL SCIENCES IV**

- Inception of basic concepts of spectroscopy to highlight its importance in bioanalysis.
- Introduction to five and six member ring heterocyclic compounds and underline their importance in phytochemicals and pharmaceuticals.
- To imbibe the basic concept of separation of analytes as a prerequisite for chromatographic assays.

### **RUSBAS305: COMPUTATIONAL SCIENCES III**

- To develop analytical and mathematical skills with the help of algorithms
- To showcase its application in analysis of data.
- To train students in Graphical representation of raw data.

### **RUSBAS306: COMPUTATIONAL SCIENCES IV**

- To make the students aware about basic statistical tests and concepts behind it,
- To underline the applications of testing of hypothesis in research and other fields.

### **RUSBAS307: ENVIRONMENTAL SCIENCES**

- To sensitize students regarding conservation of resources and protection of environment, natural resources.
- To study about the measures to minimize the effects of different types of disaster
- To make students aware about recent advances in environmental management.

Paper Code	Semester III	Lectures
RUSBAS301	Biological Sciences III	45
	<b>301.1:</b> 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	0
	prokaryotes, (lac operon and trp operon)	
	301.2: Developmental Biology	015
	differentiation enortagia	5
	Agoing regeneration and wound healing	
	Process of Fertilization in humans, Camete Collection and Storage <i>in vivo</i> &	
	<i>In vitro</i> Fertilization Technique	
	<b>301.3</b> : 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	
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Paper Code	Semester III	Lectures
RUSBAS302	Biological Sciences IV	45
	<b>302.1:</b> Industrial Microbiology	15
	Sources of antimicrobial agents: plants and microorganisms, Antimicrobial	
	Agents Used <i>In vivo</i> and their commercial production.	
	Antimicrobial Drug Resistance and Drug Discovery	
	Important microbes in Food & Drug industry, Pathogenic Organisms in Food	. 0,
	& Pharma Industry	
	Commercial significance of Microbes: Biopolymers, Biosurfactants,	50
	<b>302.2:</b> Virology & Interaction of microbes with humans	15
	<b>Virology</b> : Introduction Scope and Current trends in virology	10
	Structures and life cycles of bacterionbages plant and animal viruses	
	Interactions of microbes with Humans – Influenza Stanbylococcus	
	Plasmodium Candida	
	Control of Viruses and Eukarvotic Pathogens	
	<b>302 3:</b> Introduction to Immunology	15
	Concept of antigen antibody. Types of immunity Antigen Antibody	15
	Concept of antigen, antibody, Types of minimunity, Antigen-Antibody	
	Autoimmuno disordore (minimum true) and their menogement	
	DDACTICALS	
RUSDASP 301	PRACTICALD	
	a) Blood grouping	
	b) Isoagglutinin titre- Widal, VDRL tests, Use of diagnostic tests- ELISA	
	demonstration	
	c) Total viable count of the provided sample.	
	d) Direct microscopic counts of provided sample using Breeds count	
	method and Haemocytometer	
	e) Study of growth curve of <i>E.coli</i>	
	f) Physical and chemical methods of disinfection	
	g) Study of Normal flora of human body, common microbial	
	contaminants in foods: S. aureus, S. typni, B. subtilis	
	h) Study of microbial Biosurfactants (demo)	
	1) Analysis of Crude drugs by Microscopy	
<b>~</b> ' <b>0</b> '		

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	.0,
	not expected).	
	Kohlrausch's law and its application to determine Molar conductance at	7.9
	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	
	<b>303.2</b> Newer methods of organic synthesis & Name Reactions	15
	(Mechanism and Applications)	
	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 and	
	nepneiometry,	
	Sample preparations for above methods, advantages, disadvantages	
	rossible errors and Precautions in each instrumentation technique	



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Paper Code	Semester - Paper	Lectures
RUSBAS304	Chemical Sciences IV	45
	<b>304</b> .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	. 0,
	Beer-Lambert's law, Concept of absorbance, transmittance and molar	
	absorptivity, deviation of Beer-Lambert's equation and its limitations,	20
	Quantization of energy, Bohr frequency condition	0
	Single beam colorimeter – Principle, components and working.	
	Regions of electromagnetic spectrum and process associated with each	
	<b>UV- VIS</b> : 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	
	<b>304</b> .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.	
	<b>Reactions of heterocycles:</b> 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.	
4	<b>Pyrrole</b> : 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,	
00	Oxidation of alkyl pyridines and action of sodamide (Chichibabin	
	reaction). N methylation of pyridine. Quaternization of	
*	piperdine, pyrrolidine and Hormann elimination	
	of the quaternary saits.	
1		

	<b>304.3:</b> Methods of Separations-I	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.	7.9
	Solvent extraction, use of immiscible solvents	
	Applications of separation techniques in Bioanalysis.	
RUSBASP302:	PRACTICALS	
	Conductometry:	
	1. Determination of Cell constant of conductivity cell	
	<b>2.</b> Verification of Ostwald's dilution law	
	<b>3.</b> Investigate the titration of mixture of HCl and Oxalic acid by	
	NaOH.	
	<b>4.</b> Investigate the Conductometric titration of Oxalic acid with	
	Standard NaOH solution	
	5. Determination of the mixture composition of Acetic acid and HCl	
	by Conductometric titration	
	6. Determination of relative strength of Chloro-acetic acid and	
	Acetic acid by Conductivity measurement.	
	pH-Metry:	
	7. Identification of an acid by acid-base titration pH-metrically	
	<b>8.</b> pH titration of sodium carbonate against HCl to demonstrate the	
	selection of indicators for two inflections.	
	Organic Derivative:	
	<b>9.</b> Acetylation of Salicylic acid	
	10. Nitration of Salicylic acid	
	<b>11.</b> Hydrolysis of Ethyl benzoate	
Rami	arain	

Paper Code	Semester III	Lectures
RUSBAS305	Computational Sciences III	30
	305.1 Algorithms	10
	<ol> <li>Definition and characteristics of an algorithm, selection and interactive constructs in pseudocode. Data structures like array.</li> <li>Sorting, insertion sort, bubble sort</li> <li>Searching algorithms, linear search and binary search</li> <li>Algorithms on integers, algorithm on matrices.</li> </ol>	eos
	<ol> <li>305.2 Graphs</li> <li>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)</li> <li>Representing graphs and graph isomorphism, their application</li> <li>Elementary combinatories: Sets; functions; relations (equivalence relations)</li> <li>Permutations and combinations with respect to applications.</li> </ol>	10
	<ul> <li>305.3 Numerical Methods</li> <li>1. Finding roots of equations- <ul> <li>a. Bisection method</li> <li>b. Iteration method</li> <li>c. Newton Raphson method</li> <li>d. Secant method</li> </ul> </li> <li>2. Finding solutions of system of linear equations and numerical approximations- <ul> <li>a. LU decomposition (Doolittle's method, Crout's method)</li> </ul> </li> <li>3. Inverse of matrix by Cholesky method</li> </ul>	10

a. LU decomposi 3. Inverse of matrix by (

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.	0
	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	$\mathcal{C}$
	Parameters)	
	5. Relationship between regression coefficients and correlation	P
	coefficient, cause and effect relationship, Spurious correlation.	
	6. Concept and use of coefficient of determination (R <sup>2</sup> ).	
	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)	
	<b>306.3 Basics of Theory of Estimation and Testing of hypothesis</b>	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	
	Dowor	
	3 Small cample tests-Independent sample t-test paired t-test	
	5. Sman sample tests-independent sample t-test, paned t-test. Concept of p-value (Use of Excel and SPSS)	
RUSBASP303	PRACTICALS	
	1 Working with various forms of graphs	
	2. Introduction of MS-Office:	
	Different elements of word processing (MS-WORD)	
	Spreadsheets (MS EXCEL) and	
	PowerPoint presentation (MS POWERPOINT)	
0.0.	3. Browsers, various search engines and metadata, E-Mail/Web mail etc.	

Paper Code	Semester III	Lectures
RUSBAS307	Environmental Sciences	30
	307.1 Environment: An overview and Natural Resources	10
	Environment: An overview	
	1. Environment – Structure and components – Topology – Natural and	
	Human.	0
	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	$\mathcal{C}$
	depository of resources, products and waste.	
	4. Sustainable use of resources – a multidisciplinary approach –	Þ
	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	
	207.2 Disaster Netwol and Man made & Environmental issues and	
	507.2 Disaster – Natural and Man-made & Environmental issues and Movements	10
	1 Concept of disaster Natural and man made	10
	1. Concept of disaster - Natural and main-made	
	2. Natural hazaru/Disasters. Causes and Consequences – Earthquake	
	3 Man-made disasters - Causes and Consequences - nuclear accident	
	oil snill and leakage industrial accident	
	4 Disaster Management cycle – Pre-disaster disaster occurrence and	
	nost-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	

## Learning Outcomes for Second Year Semester III:

### **RUSBAS301: BIOLOGICAL SCIENCES III**

Students should comprehend central dogma of molecular biology as a prerequisite to study techniques like cloning, PCR, RFLP, etc. They should understand the applications of ethanobotany and pharmacognosy in drug development.

### **RUSBAS302: BIOLOGICAL SCIENCES IV**

Students should be able to classify viruses with respect to their properties. 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. Students should realize the importance of sterility with respect to biopharmaceuticals. They should be able to perform and interpt sterility tests.

### **RUSBAS303: CHEMICAL SCIENCES III**

Students should apply theoretical principles of electrochemistry in analysis of solutions using pH meter and Conductometer. 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.

### **RUSBAS304: CHEMICAL SCIENCES IV**

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

## **RUSBAS305: COMPUTATIONAL SCIENCES III**

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.

## **RUSBAS306: COMPUTATIONAL SCIENCES IV**

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.

## **RUSBAS307: ENVIRONMENTAL SCIENCES**

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

### List of Reference books for S.Y.B.Sc. Semester III:

Paper	Reference books
Environment Studies	•
Biological Sciences III	<ul> <li>Buns, G. W.: Science of Genetics - An introduction to heredity, Macmillan, New York.</li> <li>Fairbanks, Daniel J. and Anderson,W. R.:Genetics, Wadsworth Publication.</li> <li>William S. Kluge and Cummings, M.R.:Concepts of Genetics, Pearson Edu.</li> <li>Kalthoff, Klaus: Analysis of Biological Development, The University of Texas at Austin. Mc GRAW-HiLL, INC.</li> <li>Peter Russell - Genetics</li> <li>Buns, G. W.: Science of Genetics - An introduction to heredity, Macmillan, New York</li> <li>Berril, N. J., Mc. Graw Hill: Developmental Biology, New York.</li> <li>Brookbank, J.W. and Harpar: Developmental Biology, Raw Publishers, New York.</li> <li>Subramoniam: Molecular Developmental Biology, Narosa Publishing House, New Polhi 2008</li> </ul>
Biological Sciences IV	<ul> <li>Flint - Virology</li> <li>Kindt, Goldsby, Osborne - Kuby Immunology</li> <li>S. Pathak and U. Palan – Immunology and Fundamental</li> <li>Micheal J. Pelczar, Jr., E.C.S. Chan, Noel R. Krieg – Microbiology</li> <li>Lasing, M. Prescott, Harley, Klein, Microbiology</li> </ul>
Chemical Sciences III	<ul> <li>Hobart.H.Williard, Lyne.L.Merrit, John.A.Dean, Frank.A.Settle.Jr. : Instrumental Methods of Analysis: CBS Publisher.</li> <li>Douglas.A.Skoog, F.James Holler, Stanley R Crouch : Principlels of analytical : 6th editionn : Thomson/Brooks/Cole</li> <li>David Harvey : Modern Analytical Chemistry : Mc Grow Hill Publishers</li> <li>Douglas.A.Skoog, F.James Holler, Stanley R Crouch : Principlels of analytical : 6th editionn : Thomson/Brooks/Cole</li> <li>David Harvey : Modern Analytical Chemistry : Mc Grow Hill Publishers</li> <li>Douglas.A.Skoog, F.James Holler, Stanley R Crouch : Principlels of analytical : 6th editionn : Thomson/Brooks/Cole</li> <li>SomenathMitra : Sample preparation Technique in Analytical Chemistry : Wiley interscience</li> </ul>
Chemical	<ul> <li>Allen J. bard:Electrochemical Methods</li> <li>P.S Kalsi: Organic chemistry and their mechanism : New Age International</li> <li>Dand Harvey : Modern Analytical Chemistry : Mc Grow Hill Publishers</li> </ul>

	<ul> <li>Hobart. H. Williard, Lyne. L. Merrit, John. A. Dean, Frank. A. Settle. Jr. : Instrumental Methods of Analysis: CBS Publisher.</li> <li>David Harvey : Modern Analytical Chemistry : Mc Grow Hill Publishers</li> <li>Douglas. A. Skoog, F. James Holler, Stanley R Crouch : Principlels of analytica 6th edition : Thomson/Brooks/Cole</li> <li>Donald Pavia, Gary Lampman, George Kriz, James Vyvyan: Introduction to Spectroscopy: 4th Edition: Brooks/Cole</li> </ul>
Computational Sciences III	<ul> <li>John Joule and Keith Mills: Heterocyclic Chemistry</li> <li>Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein</li> <li>"Algorithms Unlocked" by Thomas H. Cormen</li> <li>"The Algorithm Design Manual" by Steven S. Skiena.</li> <li>A Textbook of Graph Theory 2nd Edition, Kindle Edition by R. Balakrishnan (Author), K. Ranganathan (Author, Contributor)</li> </ul>
Computational Sciences IV	<ul> <li>Probability and measurement by P. Billingsley</li> <li>Introduction to probability theory by Das</li> <li>Testing Statistical Hypotheses: Lehmann, Erich L., Romano, Joseph P.</li> <li>Introduction to Linear Regression Analysis (Wiley Series): Douglas C. Montgomery , Elizabeth A. Peck, G. Geoffrey Vining</li> </ul>
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# Learning Objectives for Second Year Semester IV:

### **RUSBAS401: BIOLOGICAL SCIENCES III**

- To lay down the fundamentals of muscle and nerve conduction, genetic mutation and repair, genetic disorders.
- To highlight the significance of neurotransmitters as potential drug targets.
- To introduce gene therapy as a possible cure for inborn errors of metabolism.

### **RUSBAS402: BIOLOGICAL SCIENCES IV**

- Inception of the basic concepts of biochemical analysis, cell signaling and tissue culture techniques.
- To compare and contrast immunological techniques like RIA, ELISA and immunohistochemistry. and develop analytical approach with respect to data interpretation.
- To appreciate the ability of cells to communicate with the surroundings and understand the integrated network of biochemical pathways.
- To understand the design and layout of animal and plant tissue culture laboratories.

### **RUSBAS403: CHEMICAL SCIENCES III**

- To understand the basics of pharmaceutical chemistry and bio-organic chemistry.
- To learn the wide scope of the applications of organic synthesis, polymers and biomaterials with an emphasis on bioanalytical applications.

### **RUSBAS404: CHEMICAL SCIENCE IV**

- Inception of basic concepts of radioactivity and underline the applications of radioisotopes in diagnostics and therapeutics.
- To learn the importance of inorganic metals like iron, calcium and sulfer in biology.
- To understand how to exploit physicochemical properties of analytes for their separation.
- To gain hands on training on basic separation techniques.

## **RUSBAS405: COMPUTATIONAL SCIENCES III**

- To facilitate analysis of variance for different statistical data.
- To aid in design of experiments like CRD, RBD, LSD, for biological data which requires statistical treatment, thereby decreasing the variability in results and increasing the accuracy of analysis.

## **RUSBAS406: COMPUTATIONAL SCIENCES IV**

- To introduce students to bioinformatics and different databases.
- To emphasize on advances in sequencing, use of scoring matrices and its applications in the field of bioanalysis.

## **RUSBAS407: TECHNICAL COMMUNICATIONS SKILLS**

- To understand the basics of effective communication.
- To learn the basics of writing along with its specific applications.

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	
	Drug addiction Neuropathics	
	401 2 Genetic Mutation & Renair	15
	Types of mutation – Point and gross, Spontaneous and Induced, Types of	10
	Mutagens and effects, Cell survival strategies: repair mechanisms, Inborn	
	errors of metabolism with examples	
	401.3 Genetic disorders	15
	Phenylketonuria, Albinism, Lesch-Nyhan Syndrome, Tay-Sachs Disease,	
	Sickle-Cell Anemia, Cystic Fibrosis, Carrier detection, Huntington's Disease,	
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Duchenne muscular Disorder, Hemophilia, Thalassemia, Down Syndrome.	
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Paper Code	Semester IV	Lectures
RUSBAS402	Biological Sciences IV	45
	402.1 Biochemical methods of Analysis	15
	Extraction & Analysis of Biomolecules. Use of Analytical instruments for	
	Qualitative & Quantitative analysis, Immunohistochemistry,	
	ELISA and RIA	
	402.2 Cell communication and Cell signaling	15
	Hormones and classification of hormones, Hormone secreting glands,	
	organization of endocrine system, Physiological role of – pancreatic	7.9
	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. Isolation of antibiotic producers	
	2. Antibiotic spectrum studies by Kirby Bauer Method	
	3. Protein estimation by Lowry's Method	
	4. Total Sugar estimation by Anthrone's method	
	5. UV survival curve of <i>E.coli</i> : photo reactivation and dark repair.	
	6. Study of pollen biology	
	7. Visit to Animal tissue culture & Plant tissue culture laboratory.	
	8. Radio immunosorbent assav (demo)	
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Paper Code	Semester IV	Lectures
RUSBAS403	Chemical Sciences III	45
	<b>403</b> .1 Introduction to Pharmaceutical Chemistry	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	0
	Pharmacokinetics)	
	<b>403</b> .2 Introduction to Bio-Organic Chemistry	15
	Overview of $\alpha$ -Amino acids: Structure, configuration, Essential amino acids and	
	their abbreviations, classification, Properties: pH dependency of ionic structure	
	and isoelectric point, Methods of preparations of $\alpha$ -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 al- and tri- peptides for nomenciature and synthesis).	
	structures and properties of crown ethers, cryptanus, cyclophanes, calixarenes,	
	colivaranes And cyclodextrins. Synthesis of crown effects, cryptands and calivaranes. Molecular recognition and catalysis molecular solf-assembly.	
	<b>403 3</b> Material Chemistry: Polymers And Riomaterials	15
	<b>Polymers:</b> Introduction: General idea of structure, namings, types of polymers	15
	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.	
	<b>Biomaterial:</b> 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 - Stanless steel, Co-based alloys, 11 and 11-based alloys.	
	corresion behavior and the importance of passive films for tissue adhesion	
	Hard tissue replacement implant: Orthonedic implants Dental implants Soft	
	tissue replacement implants: Percutaneous and skin implants. Vascular	
	implants, Heart valve implants-Tailor made composite in medium.	
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Paper Code	Semester IV	Lectures
RUSBAS404	Chemical Sciences IV	45
	404.1 Nuclear chemistry 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, Radiometric Titrations 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	15
8-0,	Cancer Radio Therapy404.2 Aspects of Bio-Inorganic ChemistryIntroduction-Metals in biological systems, Electron transfer in biologicalsystems: Cytochrome and Iron sulphur proteinMetalloenzyme/protein, Role of calcium in biology, Metals in medicinePlatinum binding to DNA	15
	<b>404.3</b> Methods of Separations-II Principle of adsorption and partition chromatography.	15

	Thin Layer Chromatography: choice of adsorbent, choice of solvent, preparation of chromatogram, sample, Rf value and its applications. Paper chromatography, solvent used, Rf value, factors which affect Rf value.	
RUSBASP402	PRACTICALS	1
	Separation of Organic mixtures:	
	1.Water soluble + Water insoluble (Solid + Solid)	
	2.Water insoluble + Water insoluble (Solid + Solid)	
	Solvent Extraction:	0
	1.Determination of Fe and Cu from their mixture	7.9
	2.To determine the partition co-efficient of I2 between water and CCl4 and w	ater at
	given temperature	·
	Viscosity measurements:	
	1. To determine the molecular weight of polyvinyl alcohol using viscometer.	
	Colorimetry: 1.To test the validity of the Beer-Lambert's Law and to determine	ne :a) λmax
	b)Molar absorptivity constant	-
	2.To determine indicator constant of a given indicator by Colorimetric measu	irements
	3. Spectrophotometry: Turbidometric analysis of cough syrup	
	onorne	
Paper Code	Semester IV	Lectures

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):	
	<b>3</b> . Mathematical Model, Assumptions, Expectation of various sums of	
	squares, F-test, Analysis of variance table. (Concept only-No	
	derivations)	
	4. Least square estimators of the parameters, Variance of the	
<b>^O·</b>	estimators, 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,	
	KDD 405.2 Letin Square Decign (LSD)	10
	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.

	<ol> <li>Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts.</li> <li>Efficiency of the design relative to RBD, CRD.</li> <li>Missing plot technique for one missing observation in case of LSD.</li> </ol>	
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Paper Code	Semester IV	Lectures
RUSBAS406	Computational Sciences IV	30
	<ol> <li>Introduction to Bioinformatics</li> <li>Introduction to Bioinformatics &amp; Databases</li> <li>Application of Bioinformatics</li> <li>INSDC</li> <li>Major Bioinformatics resources: NCBI, EBI, ExPASy</li> <li>Nucleic acid: GENBANK, EMBL, DDBJ</li> </ol>	10
	<ul> <li>6. Protein structure: domains, motifs (Pfam/Prosite)</li> <li>7. Protein sequence databases: UniProt, PIR, SWISSPROT, TrEMBL</li> <li>8. Literature database : PUBMED</li> <li>9. Genome database: GSS, Genome</li> <li>10. Specialized database: OMIM</li> <li>11. Protein structure databases: PDB</li> <li>12. Metabolic Pathway database: KEGG</li> </ul>	
Ram	<ul> <li>6. Protein structure: domains, motifs (Pfam/Prosite)</li> <li>7. Protein sequence databases: UniProt, PIR, SWISSPROT, TrEMBL</li> <li>8. Literature database : PUBMED</li> <li>9. Genome database: GSS, Genome</li> <li>10. Specialized database: OMIM</li> <li>11. Protein structure databases: PDB</li> <li>12. Metabolic Pathway database: KEGG</li> <li>406.2 Basics to Sequencing</li> <li>1. Molecular biology basics</li> <li>2. Genomics</li> <li>3. Proteomics</li> <li>4. DNA sequencing technology: Whole-genome shotgun sequencing strategies</li> <li>5. Protein sequencing methods</li> <li>6. Sequence File formats</li> </ul>	10

	<ol> <li>Basic Concepts of sequences similarity, Identity and homology</li> <li>Definition of homologs, orthologs, paralogs</li> <li>Concepts of sequence alignments</li> <li>Pairwise sequence alignment methods</li> <li>DOT Matrix analysis</li> <li>Scoring matrices: Basic concepts of scoring matrix, PAM and BLOSUM series and principles based on which these matrices are derived</li> </ol>
RUSBASP403	<ul> <li>PRACTICALS</li> <li>1. INSDC- NCBI, EMBL, DDBJ</li> <li>2. Sequence databases- EMBL-EBI, GenBank, UniProt</li> <li>3. Structure databases- PDB</li> <li>4. Domain database: Prosite, PRINT, Pfam.</li> <li>5. Specialized database: KEGG, PUBMED, OMIM</li> <li>6. Use of Rasmol</li> </ul>
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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	
	<b>c)</b> Myths about communication	
	<b>2</b> . Communication : It's interpretation	
	a) Verbal Communication	
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	<b>b</b> ) Non-verbal Communication	
	c) Barriers to Communication	
	3. Case study	
	4. Listening skills	
0'0	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
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Learning Out	comes for Second Year Semester IV

## Learning Outcomes for Second Year Semester IV:

#### **RUSBAS401: BIOLOGICAL SCIENCES III**

Students should be able to 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. They should be able to describe the functioning of nerve and muscles and understand the importance of neurotransmitters as potential target for drugs.

#### **RUSBAS402: BIOLOGICAL SCIENCES IV**

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. Students should grasp the complex nature, co-ordination and integration of biochemical pathways. They should be able to design animal and plant tissue culture laboratories.

#### **RUSBAS403: CHEMICAL SCIENCES III**

Students should study pharmaceutical chemistry and bio-organic chemistry with the perspective of their applications in Bioanalytical sciences. They should be aware of the advances in biopolymers and biomaterials.

#### **RUSBAS404: CHEMICAL SCIENCE IV**

Students should grasp the concept of radioactivity and understand its applications in diagnostics and therapeutics. Students should understand importance of inorganic metals in maintenance of health. They should comprehend basics of separation techniques as a prerequisite to study advanced and hyphenated separation techniques.

#### **RUSBAS405: COMPUTATIONAL SCIENCES III**

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.

#### **RUSBAS406: COMPUTATIONAL SCIENCES IV**

Students should effectively use bioinformatics databases and tools to study DNA and protein sequences, protein structure and metabolic pathways.

### **RUSBAS407: TECHNICAL COMMUNICATIONS SKILLS**

Students should know the expected format and standards of professional writing. Students should be adept and confident in writing skills like letters, resume, abstract, bookreview, etc.

## List of Reference books for S.Y.B.Sc. Semester IV:

Paper	Reference books
Technical	• The Essentials of Technical Communication : Elizabeth Tebeaux , Sam Dragga
Communication	• A Field Guide for Science Writers: Deborah Blum
Skills	
	0
Biological	<ul> <li>Fundamentals of Cytogenetics and Genetics: Mahabal Ram</li> </ul>
Sciences III	Human Cytogenetics: Constitutional Analysis :Denis Rooney
	Mutation Kindle Edition :Robin Cook
<u><u> </u></u>	<ul> <li>The Concise Book of Muscles, Second Edition :Chris Jarmey</li> </ul>
	• Nerve and Muscle (Studies in Biology) 3rd Edition: R. D. Keynes (Author), D. J.
	Aidley (Author)
Biological	• Plant Tissue Culture : Basic and Applied : Timir Baran Jha / Biswajit Ghosh
Sciences IV	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

	<ul> <li>Biochemical Methods of Analysis: Saroj Dua</li> <li>Jan Froshnov: Animal Tissue culture</li> </ul>
Chemical	<ul> <li>F.A.Carey : R.J Sunderberg : Advanced organic chemistry : Plenum</li> </ul>
Sciences III	• J. W. Steed, J. L. Atwood Supramolecular Chemistry: 2nd edition: John Wiley &
	Sons 2009
	Carsten Schmuck, Helma Wennemers: 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
	LB Park: Biomaterials - Science and Engineering: Plenum Press 1984
	Pharmaceutical Chemistry Watson (Author)
Chemical	<ul> <li>P S Kalsi:Bioorganic, Bioinorganic and Supramolecular Chemistry: New Age</li> </ul>
Sciences IV	International
	• Peter Atkins & Julio de Paulo: Physical Chemistry : Oxford University Press
	Ira N. Levine: Physical Chemistry : McGraw-Hill
	• Marie Claire Cantone, Christoph Hoeschen : Radiation Physics for Nuclear
	Medicine: Springer
	• Douglas A. Skoog, Flames Holler, Stanley R Crouch : Principles of analytical :
	6th edition · Thomson/Brooks/Cole
Computational	Designing experiments and analyzing data: Maxwell & Delaney
Sciences III	Statistical principle in experiment design: Winer and Kirk
Computational	Latin Square Design: David J. Saville Graham R. Wood
Sciences IV	• Computational Biology and Bioinformatics :Ka-Chun Wong • Chapter 1 Advanced Data Mining Technologies in Bioinformatics
	• W3 Schools: HTML and XML
Ç	Complete Reference to HTML and XML
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RUSBASS	501: ENTREPRENEURSHIP SKILLS	I (40L)	RUSBAS	S601: ENTREPRENEURSHIP SKILLS	II (40L)
501.1	The Entrepreneur	10L	601.1	Enterprise	10L
501.2	Conceptual Frame Work	10L	601.2	Growth Strategies, Networking & Innovation	10L
501.3	Business Economics	10L	601.3	Principles of Corporate Management	10L
501.4	Knowledge Management	10L	601.4	Innovation	10L
RUSBASS	502: BIOLOGICAL SCIENCES V (45L	.)	RUSBAS602: BIOLOGICAL SCIENCES V (45L)		
502.1	Recombinant DNA Technology	 15L	602.1	Phytochemical Analysis	 15L
502.2	Phytochemistry	15L	602.2	Techniques in Recombinant DNA	15L

				Technology		
502.3	Extraction Technologies for Phytochemicals	15L	602.3	Introduction to Biopharmaceuticals & Biosimilars	15L	
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RUSBASS	503: CHEMICAL SCIENCES V (45L)	I	RUSBAS603: CHEMICAL SCIENCES V (45L)			
503.1	Methods of Separations-III	15L	603.1	Spectroscopy –II	15L	
503.2	Bioanalysis	15L	603.2	Pericyclic Reactions	15L	
503.3	Thermodynamics	15L	603.3	Electro-Analytical and Thermal methods	15L	
RUSBASS	504: CHEMICAL SCIENCES VI (45L)		RUSBAS604: CHEMICAL SCIENCES VI (45L)			
504.1	Basic Pharmaceutical Chemistry	15L	604.1	Spectroscopy –III	15L	
504.2	Micro analysis and Surface		604.2	Introduction to Mass	15L	
	analysis	15L		Spectroscopy and its hyphenated		
				techniques		
504.3	General Metabolism and Nutrition	15L	604.3	Biochemical Methods of Analysis	15L	
RUSBAS505:COMPUTATIONAL SCIENCES V (45L)		(45L)	RUSBAS605:COMPUTATIONAL SCIENCES V (45L)			
505.1	Dynamic Programming Algorithm	15L	605.1	Protein structure prediction	15L	
505.2	Multiple sequence alignment	15L	605.2	Cheminformatics	15L	
505.3	Molecular Phylogenetics	15L	605.3	Computational Drug designing	15L	

# Learning Objectives for Third Year Semester V:

#### **RUSBAS501: ENTREPRENEURSHIP SKILLS I**

- Introduction to entrepreneurship, different types of enterprises.
- To study the concept of business economics and knowledge management.
- To inculcate entrepreneurship skills with the help of case study, industrial visit or project report.

#### **RUSBAS502: BIOLOGICAL SCIENCES V**

- To introduce concepts of molecular biology such as vectors, restriction enzymes and cloning.
- To learn design and applications of recombinant bacteria, plants and animals.
- To understand the design and layout of animal and plant tissue culture laboratories
- To be aware about current ethical guidelines with respect to cloning.
- To study and appreciate rich traditions involving medicinal plants and study phytochemicals as possible candidates for modern drugs

#### **RUSBAS503: CHEMICAL SCIENCES V**

- Introduction to advanced instrumental techniques like HPLC and GC along with their application in the field of bioanalysis.
- To give a general overview of clinical trials.
- To emphasize the importance of safety while handling biological matrices.
- To delineate routine diagnostic tests in hospitals and advanced instrumentations for the same.

#### **RUSBAS504: CHEMICAL SCIENCES VI**

- To give a detailed overview of pharmaceutical chemistry.
- To accentuate the role of bioanalyst in a pharmaceutical industry.
- To understand challenges involved in trace analysis and analysis of complex matrices.
- To give a general overview of metabolism and nutrition and apply Bioanalytical techniques for characterization of nutritional value.

## **RUSBAS505: COMPUTATIONAL SCIENCES V**

• To learn different bioinformatics tools, its operation and application.



Paper Code	Semester V	Lectures
RUSBAS501	ENTREPRENEURSHIP SKILLS	40L
	501.1 The Entrepreneur	10
	1. Entrepreneurial motivation – dynamics of motivation.	
	2. Entrepreneurial competency – Concepts.	
	3. Developing Entrepreneurial competencies - requirements and	0.
	understanding the process of entrepreneurship development, self	0
	factors affecting entrepreneur's role	50
	501.2 Concentual Frame Work	10
	<ol> <li>Concept, need and process in entrepreneurship development.</li> <li>Role of enterprise in national and global economy</li> <li>Types of enterprise – Merits and Demerits</li> <li>Covernment policies and schemes for enterprise development.</li> </ol>	
	5. Institutional support in onterprise development and management	
	501.3 Rusiness Economics	10
	<ol> <li>Demand analysis, concept &amp; types of demand ,law of demand</li> <li>Utility analysis, concept &amp; types of utility ,law of utility</li> </ol>	10
	3. Introduction to Cost & Revenue , its types	
	4. STP (segmentation / targeting / positioning)	
	5. Sources of Growth-Concept and Importance of Knowledge Economy	
	GATS	
	<b>501.4</b> Knowledge Management	10
	1. Introduction	
	2. History and Evolution	
	3. Pillars of Knowledge Management	
	4. Scope & Significance Technology & Knowledge Management.	
	5. Chucal Success Factors of NM 6. Case Studies	
	7. P's of Marketing	
RUSBASP501	PRACTICALS	
	Case Study/Assignment/Project Report/Industrial Visit	
Raun		

Paper Code	Semester V	Lectures
RUSBAS502	Biological Sciences V	45
	<b>502.1:</b> Recombinant DNA Technology	15
	Concept of Transposons, Plasmids, Vectors, Cosmids, Restriction Enzymes	
	Transgenic Bacteria, Plants and Animals : Commercial applications with	
	suitable examples (Any Two), Cloning- current Status, Regulations, Ethics	0
	etc	
	502.2: Phytochemistry	15
	Primary and secondary metabolites from plants, Classification of Plant	6
	Secondary metabolites, Functions of Plant Secondary Metabolites, Chemistry	
	of Phenolics, Terpenoids, Alkaloids, Phytochemicals as Drugs, Key factors	
	affecting synthesis of secondary metabolites, Commercial applications	
	<b>502.3:</b> 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	
	PDACTICALS	
RUSBASP502		
1. Extraction	of phytoconstituents by maceration, percolation, steam distillation and us	ing soxhlet
extractor		
2. Qualitative	tests for Phyloconstituents	
5. Stalluaruiz	of alkaloide by gravimetry	
5 Quantitation	of tanning by colorimetry	
6 Study of an	timicrohial activity of phytoconstituents	
7 Extraction	of Genomic DNA from suitable plant or microbial material	
8. Microsconi	c evaluation of plants	
9. Replica pla	te technique	
10. Problems o	n Restriction enzyme digestion	
Ran	narain	

Paper Code	Semester V	Lectures
RUSBAS503	Chemical Sciences V	45
	<b>503</b> .1 Methods of Separations-III	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,	0
	Detectors. Reversed phase and normal phase chromatography	~~
	Gas Chromatography, Gas Solid and Gas liquid Chromatography and its	5
	Cas Chromatography Instrumentation Carrier gas supply Injectors	5
	Columns Packed and canillary columns Column oven and temperature	
	programming different detectors	
	503.2 Bioanalysis	15
	Introduction to Bioanalysis. Different sample matrices and special	10
	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	
	503.3 Thermodynamics	15
	First law of thermodynamics, internal energy, enthalpy, isothermal and	
	adiabatic processes, P-V-T relation for adiabatic process, Second law of	
	thermodynamics, need for the law, Carnot's cycle, mechanical efficiency,	
	Concept of entropy, physical significance of entropy, entropy changes	
	Cibbs free energy and Helmheltz's free energy variation of Cibbs's free	
	onorgy with temperature and procesure Cibb's Helmholtz equation	
	Physical equilibria involving nure substances Clavneron's equation and	
	variation of vanour pressure with temperature Clausius-Clauperon	
	equation and its applications. Partial molal properties, partial molal volume	
	and chemical potential. Gibbs-Duhem equation.	
	Variation of chemical potential with pressure and temperature, fugacity,	
	activity and their relationship with chemical potential, activity and activity	
	coefficient.	
	Thermodynamic derivation of Law of mass action, Kp, Kc and their inter-	
	relation, Van't Hoff's reaction isotherm and reaction isochore.	
$\sim$		
<ul><li>V</li></ul>		

Paper Code	Semester V	Lectures		
RUSBAS504	Chemical Sciences VI			
	<b>504</b> .1 Basic Pharmaceutical Chemistry	15		
	Definition of a drug, Requirements of an ideal drug, Classification of drugs			
	(based on therapeutic action)			
	Nomenclature of drugs: Generic name, Brand name, Systematic name	0		
	Definition of the following medicinal terms: Pharmacon, Pharmacophore,			
	Prodrug, Half-life efficiency, LD50, ED50, Therapeutic Index.	0		
	Brief idea of the following terms: Receptors, Drug-receptor interaction,	7, 7		
	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-			
	identification modification of structure or functional group			
	Different types of chemical transformation of drugs with specific examples			
	Synthesis and therapoutic use of Diclofonac sodium (DES) Accelefonac			
	Paracetamol Phenytoin Asnirin Atenolol Laevodona Cinroflovacin			
	Metronidazole Dansone Ethambutol			
	504.2 Micro analysis and Surface analysis	15		
	Microanalysis ·	10		
	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			
	504.3: 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,			
0,0	glycemic index			
	Free radicals and anti-oxidants: reactive oxygen species- generation and			
	damage, tree radical scavenger systems, inflammation, respiratory, skin			
	and age related diseases, atherosclerosis, lipid per oxidation, preventive			
	and chain breaking anti-oxidants			

#### RUSBASP503 PRACTICALS

- 1. Column Chromatography of Separation of mixture of dyes/Separation of Plant Pigments (Spinach)
- 2. Paper chromatography for Separation of Plant Pigments (Spinach)/ Separation of Amino acids
- 3. Thin Layer Chromatography of Alkaloids
- **4.** Ion Exchange Chromatography of Estimation of sodium using cation exchanger/Estimation of Mg using anion exchange resin column

Paper Code	Semester V	Lectures		
RUSBAS505	COMPUTATIONALSCIENCES-V			
	<ol> <li>505.1 Dynamic Programming Algorithm</li> <li>Global and local alignment</li> <li>Needleman &amp; Wunch, Smith &amp; Waterman algorithms for Pairwise alignment</li> <li>Use of pairwise alignments for analysis of Nucleic acid and Protein Sequences and interpretation of results.</li> <li>Overview of BLAST, its variants &amp; working, BLAST algorithm</li> </ol>	15		
	<ul> <li>5. PSI BLAST and PHI BLAST: Working and interpretation of result</li> <li>505.2 Multiple sequence alignment</li> <li>1. Concept of multiple sequence alignment (MSA)</li> <li>2. Algorithm in MSA and its application</li> <li>3. Multiple sequence alignment methods</li> <li>4. PSSM</li> <li>5. MSA Tool: Clustal Omega- Working</li> </ul>	15		
	<ol> <li>505.3 Molecular Phylogenetics</li> <li>Phylogenetic analysis</li> <li>Basic concepts in taxonomy and phylogeny.</li> <li>Definition and description of Phylogenetic trees and various methods</li> <li>Clustering method – UPGMA &amp; NJ</li> <li>Cladistic method – Maximum Parsimony</li> <li>Phylogenetic Analysis software Phylip/PAUP</li> </ol>	15		
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			
8.0				

## Learning Outcomes for Third Year Semester V:

### **RUSBAS501: ENTREPRENEURSHIP SKILLS I**

Students will be motivated to start their own enterprise. They should be aware of the required skillset for an entrepreneur and also realize the challenges in this area.

### **RUSBAS502: BIOLOGICAL SCIENCES V**

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

### RUSBAS503: CHEMICAL SCIENCES V

Students will be introduced to theory and instrumentation of HPLC and GC. They should be able to analyze and interpret simple chromatograms. They should realize the importance of safe handling of biomatrices. They should be familiar with routine diagnostic tests and advanced instrumentation in pathological testing.

### **RUSBAS504: CHEMICAL SCIENCES VI**

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

## **RUSBAS505: COMPUTATIONAL SCIENCES V**

Students will comprehend the logic behind dynamic programming algorithms. Students should effectively use bioinformatics algorithms like BLAST and FASTA for sequence alignment and phylogenetic studies.

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#### List of Reference books for T.Y.B.Sc. Semester V:

Paper	Reference books
Entrepreneurship	Eric Ries: The Lean Startup
Skills	Kimiz Dalkir: Knowledge Management in theory and Practice
	Jugaad Innovation: Radjou, Prabhu, Ahuja
<b>Biological Sciences V</b>	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
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
	Understanding thermodynamics: Van Ness
	The Laws of Thermodynamics: Peter Atkins
Chemical Sciences VI	Pharmaceutical Analysis: David Lee
	• Excipients and Delivery Systems of Pharmaceutical formulations:
	Karsa, Stephenson
	<ul> <li>Microanalysis of solids: Yacobi, Holt, Kazmerski</li> </ul>
	Surface Analysis Methods in Material Science: Brett Sexton, R.C.Smart
	Introduction to nutrition and Metabolism: David A. Bender
Computational	<ul> <li>Algorithms and Data structure: Niklaus Wirth</li> </ul>
Sciences V	The Art of Computer Programming: Donald E. Knuth
	<ul> <li>Multiple Squence Aligment Methods: Russell and Springer</li> </ul>
	Molecular Evolution and Phylogenetics: Masatoshi Neiand Sudhir Kumar
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# Learning Objectives for Third Year Semester VI:

### **RUSBAS601: ENTREPRENEURSHIP SKILLS II**

- To get an idea about launching and organizing an enterprise, its growth strategies & networking
- To actively include innovation by studying its basic principles.

#### **RUSBAS602: BIOLOGICAL SCIENCES V**

- To study significance of secondary metabolites in plants with respect to their applications in drug development.
- To give practical training for qualitative detection of phytochemicals.
- To realize the wide scope of recombinant DNA techniques in diagnostics, research, forensics and bioanalysis.
- To demonstrate practical applications of PCR and RFLP.
- To get acquainted with recent drug development process.
- To introduce biopharmaceuticals as a novel and advanced branch of pharmaceuticals.

### **RUSBAS603: CHEMICAL SCIENCES V**

- To imbibe the theoretical concepts of atomic spectroscopy, Molecular fluorescence and phosphorescence spectroscopy, Infra- Red spectroscopy & Raman spectroscopy.
- To illustrate the different types of Pericyclic reactions.
- To understand the applications of electro analysis and thermal analysis in the field of bioanalysis.

### **RUSBAS604: CHEMICAL SCIENCES VI**

- To apply theoretical concepts of IR and NMR spectroscopy to interpret spectral data.
- To get general overview of hyphenated techniques as a pre-requisite to understand advanced instrumentation.
- To compare and contrast biochemical techniques like SDS-PAGE, native PAGE and 2-D gel electrophoresis with respect to their advantages and limitations.
- To familiarize with the concept of microarrays and realize their potential as futuristic diagnostic tools.

### **RUSBAS605: COMPUTATIONAL SCIENCES V**

- To study protein structure prediction
- To explore area of Cheminformatics, study its tools and applications.
- To gain knowledge about computational drug designing.

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,	0
	problems.	0
	2. Enterprise selection, market assessment, enterprise feasibility study,	00
	SWOT Analysis.	
	s. Resource mobilisation - mance, technology, raw material, site and	
	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	
	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	10
	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	
8-31.		

Paper Code	Semester VI	Lectures
RUSBAS602	Biological Sciences V	45
	<b>602.1:</b> Phytochemical Analysis	15
	Classical methods of analysis (Gravimetric & Titrimetric),	
	Chromatographic & Spectroscopic analysis of phytoconstituents	
	Chromatographic fingerprints, Phytochemical variations in plants	0
	Analysis of herbal formulation, Effect of drying on phytoconstituents	
	<b>602.2:</b> Techniques in Recombinant DNA Technology	15
	RFLP, AFLP, PCR, RAPD, Nucleic acid probes, Southern Blotting, Northern	6-
	Blotting, Edible Vaccines, Biosensors and Biochips	
	<b>602.3:</b> Introduction to Biopharmaceuticals & Biosimilars	15
	Introduction to Biopharmaceuticals, Sources of Biopharmaceuticals (E.	
	<i>Coli</i> , 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 PCR, RFLP	
	2.Preparation of antigens for vaccine production (TAB vaccine)	
	3.Sterility testing of biopharmaceuticals	
	4.Preservation of microbial cultures	
	5.Study of Biosimilars & analysis of Biosimilar drugs	
	6. Study of secondary metabolites produced by plants and their qualitative	
	detection	
	7. Bacterial endotoxin test	
	8. Analysis of Plant Secondary Metabolite by suitable techniques	

8. Analysis of Plant Secondary Metabolit

Paper Code	Semester VI- Paper	Lectures
RUSBAS603	Chemical Sciences V	45
	603.1 Spectroscopy –II	15
	Atomic Spectroscopy:	
	Absorption and emission spectra, energy level diagrams, process involved	
	in atomization, flame photometry, flame atomizer, types of burners,	0
	monochromators and detectors, atomic absorption spectroscopy, flame	
	and electro thermal atomizer, sources, instrumentation, quantitative	0
	applications of atomic absorption and flame photometry, calibration curve	7, 7
	method, standard addition and internal standard method.	
	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, narmonic oscillator: energy levels, selection rule, lundamental	
	determining Fores constant	
	Introduction to infrared greaters of simple molecules like H-O and CO.	
	Paman Spectroscopy:	
	Scattering of electromagnetic radiation Payloigh scattering Paman	
	scattering nature of Raman spectrum Stoko's lines. Anti- Stoko's lines	
	Raman shift quantum theory of Raman spectrum, comparative study of ID	
	and Raman spectra rule of mutual exclusion (Example of CO molecule)	
	and Kaman spectra, rule of mutual exclusion. (Example of CO <sub>2</sub> molecule)	

and Raman spectra, rule

	1 7
603.2 Pericyclic Reactions	15
I nree kinds of Pericyclic reactions, Molecular orbital and Orbital	
symmetry, Electrocyclic reactions (FMO-Approach), 1,3-Dipolar	
cycloadditions, Chelotropic Reactions, Cycloaddition reactions (FMO-	
Approach) Sigmatropic rearrangements, The ENE reaction, Pericyclic	
reactions in Biological systems, Summary of the selection rules for	0
Pericyclic reactions.	
603.3 Electro-Analytical and Thermal methods	015
Electro-Analytical methods:	7,0
Overview of electrode process, Electro-capillary curve and electro-	
capillary maximum potential.	
Microelectrodes: mercury electrodes: Stationary mercury drop electrode	
(SMDE), Hanging mercury drop electrode (HMDE), Mercury film electrode	
(MFE), Carbon paste electrode and chemically modified electrodes.	
Introduction to three electrode system, modern polarography and	
voltammetry: necessity and development of new voltammetric techniques	
and their comparison with classical DC polarography	
Voltammetric methods: Sampled DC polarography (TAST). Linear sweep	
voltammetry (LSV). Cyclic voltammetry (CV), diagnostic criteria of cyclic	
voltammetry	
Thermal methods:	
Thermogravimetry (TC): Principle and Instrumentation factors affecting	
thermogravimetric curves. Interpretation of thermogravimetric curves	
applications of thormogravimetry	
Differential thermal analysis (DTA) and Differential economic calculations	
(DCC) Drin sinks and in strum as to tion, heat flow and us a subscription in the set flow and us a subscript	
(DSC): Principle and Instrumentation, neat flux and power compensated	
USC, Interpretation of DTA and DSC curves applications of DTA and DSC	

DSC, Interpretation of DTA and DSC curves

Paper Code	Semester – Paper	Lectures
RUSBAS604	Chemical Sciences VI	45
	604.1 Spectroscopy –III	15
	Infrared Spectroscopy: 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.	0
	NMR Spectroscopy: 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 ( $\partial$ unit), Standard for PMR, Solvents used, Factors affecting Chemical	
	Shift: Inductive effect, Anisotropic effect (with reference to $C=C$ , $C=C$ , $C=C$	
	and benzene ring), Spin-spin coupling and coupling constant. Proton	
	exchange application of deuterium exchange, Application of PMR in structure	
	determination.	15
	bu4.2 Introduction to Mass Spectroscopy and its hypnenated techniques	15
	introduction to mass spectroscopy: Concept of mass to charge ratio, study of	
	ionization atmospheric prossure ionization techniques thermospray	
	ionization, atmospheric pressure ionization techniques, thermosphay	
	fragmentation natterns / fragmentation nathways	
	Hyphenation: Need of hyphenation. Interfacing devices	
	Applications of Liquid Chromatography-Mass Spectroscopy and Gas	
	chromatography-Mass spectroscopy	
	604.3 Biochemical Methods of Analysis	15
	Electrophoresis: PAGE, SDS-PAGE, Western Blotting, 2D gel electrophoresis.	
	AGE, ELISA, Centrifugation, Microarray	

AGE, ELISA, Centrifugation, Microarray

<ul> <li>eparation of Organic mixtures:- <ol> <li>Volatile liquid + Non-volatile liquid ( Liquid + Liquid ) by fractional distillation method</li> <li>Volatile liquid + Water insoluble solid (Liquid + Solid) by distillation method.</li> </ol> </li> <li>eparation Techniques:- <ol> <li>High Performance Thin Layer Chromatography - To develop the fingerprinting pattern of natural products</li> <li>High Performance Liquid Chromatography - Separation of modern drug (Diclofenac sodium) from their combination formulation.</li> <li>Gas Chromatography - Separation of solvent mixtures (Methanol and Ethanol, Toluene and Methanol)</li> </ol> </li> <li>pectroscopic Techniques:- <ol> <li>Atomic absorption spectroscopy (AAS)</li> <li>Infrared (IR) analysis of simple organic molecules</li> <li>Nuclear Magnetic Resonance (Demo)</li> </ol> </li> <li>lame photometric determination of Li/Na/K by Calibration Curve and Standard ddition methods</li> </ul>
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<ul> <li>method</li> <li>2. Volatile liquid + Water insoluble solid (Liquid + Solid) by distillation method.</li> <li>eparation Techniques:- <ol> <li>High Performance Thin Layer Chromatography - To develop the fingerprinting pattern of natural products</li> <li>High Performance Liquid Chromatography - Separation of modern drug (Diclofenac sodium) from their combination formulation.</li> </ol> </li> <li>Gas Chromatography - Separation of solvent mixtures (Methanol and Ethanol, Toluene and Methanol)</li> <li>pectroscopic Techniques:- <ol> <li>Atomic absorption spectroscopy (AAS)</li> <li>Infrared (IR) analysis of simple organic molecules</li> <li>Nuclear Magnetic Resonance (Demo)</li> </ol> </li> <li>Hame photometric determination of Li/Na/K by Calibration Curve and Standard ddition methods</li> </ul>
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<ul> <li>a. Nuclear Magnetic Resonance (Demo)</li> <li>Clame photometric determination</li> <li>Flame photometric determination of Li/Na/K by Calibration Curve and Standard ddition methods</li> </ul>
S. Nuclear Magnetic Resonance (Denio) <b>Jame photometric determination</b> Flame photometric determination of Li/Na/K by Calibration Curve and Standard ddition methods
Flame photometric determination of Li/Na/K by Calibration Curve and Standard ddition methods
ddition methods
arain Ruia

Paper Code	Semester VI	Lectures
RUSBAS605	Computational Sciences-V	45
	605.1 Protein structure prediction	15
	1. Protein structure basics	
	2. Computational prediction methods	
	3. Homology modeling	
	4. Protein threading	
	5. Fold recognition	0
	6. Tools used for prediction	
	605.2 Cheminformatics	15
	1. Cheminformatics Introduction	
	2. Chemical structure storage formats	
	3. Cheminformatics tools	
	4. Applications	
	605.3 Computational Drug designing	15
	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	
	0	
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V-		

## Learning Outcomes for Third Year Semester VI:

### **RUSBAS601: ENTREPRENEURSHIP SKILLS II**

Students will be keenly interested in developing innovative ideas which may be commercially viable. They should start building knowledgebase and skill set which will be useful to start a new enterprise in future.

### **RUSBAS602: BIOLOGICAL SCIENCES V**

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. They should be able to interpret results of molecular biology experiments like PCR and RFLP. They should appreciate and study biopharmaceuticals as an upcoming branch in pharmaceuticals.

### **RUSBAS603: CHEMICAL SCIENCES V**

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. They should study applications of thermal analysis for characterization of pharmaceutical products.

### **RUSBAS604: CHEMICAL SCIENCES VI**

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. 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.

## **RUSBAS605: COMPUTATIONAL SCIENCES V**

Students will comprehend the programming logic for protein structure prediction, Cheminformatics and drug design. They should effectively use bioinformatics tools like Modeller, MarvinSketch and iGemDock for basic structural characterization.

#### List of Reference books for T.Y.B.Sc. Semester VI:

Paper	Reference books
EntrepreneurshipSkills	Jugaad Innovation: Radjou, Prabhu, Ahuja
Biological Sciences V	The Medisinal 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
Chemical Sciences V	<ul> <li>Introduction to Molecular Spectroscopy: Gordon M. Barrow</li> </ul>
	Molecular Luminescence Spectroscopy Methods and Applications
	John Wiley and sons
	Concept Instrumentation and techniques in Atomic Absorption
	Spectroscopy: Perkin Elmer
	<ul> <li>Principles of instrumental analysis: Douglas a. Skoog</li> </ul>
	Photochemistry and pericyclic reactions: Jagdamba Singh
	Thermal methods of analysis; Haines
Chemical Sciences VI	<ul> <li>Principles of instrumental analysis: Douglas a. Skoog</li> </ul>
	Introduction to Spectroscopy: Donald L. Pavia
	Organic Spectrocsopy: William Kemp
	<ul> <li>Introduction to hyphenated techniques and applications in</li> </ul>
	pharmacy: Patel
	Biochemical methods ;S. Sadasivam,A. manickam
Computational Sciences V	Cheminformatics: Johann Gastieger
	Bioinformatics and drug Discovery: Richard S. Larson

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