S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus For:

Program: Integrated M.Sc. in Bioanalytical Sciences

(Undergraduate Syllabus)

Program Code: RUSBAS

(Credit Based Semester and Grading System for academic year 2019–2020)

INTEGRATED M.SC DEGREE COURSE IN BIOANALYTICAL SCIENCES
With the option of specialization in Bioanalysis or Bioinformatics or Nutraceuticals

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	RUSBASP101	60	2
RUSBAS102	Biological Sciences II	45	3			
RUSBAS103	Chemical Sciences I	45	3	RUSBASP102	60	2
RUSBAS104	Chemical Sciences II	45	3			
RUSBAS105	Computational Sciences I	30	2	RUSBASP103	60	2
RUSBAS106	Computational Sciences II	30	2			
RUSBAS107	Foundation Course	30	2	-	-	-
TOTAL		270	18	-	180	6
TOTAL CREDITS		24				
		Semester – II				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS201	Biological Sciences I	45	3	RUSBASP201	60	2
RUSBAS202	Biological Sciences II	45	3			
RUSBAS203	Chemical Sciences I	45	3	RUSBASP202	60	2
RUSBAS204	Chemical Sciences II	45	3			
RUSBAS205	Computational Sciences I	30	2	RUSBASP203	60	2
RUSBAS206	Computational Sciences II	30	2			
RUSBAS207	Foundation Course	30	2	-	-	-
TOTAL		**270**	**18**	-	**180**	**6**
TOTAL CREDITS		**24**				

S.Y.B.Sc.						
		Semester – III				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS301	Biological Sciences III	45	3	RUSBASP301	60	2
RUSBAS302	Biological Sciences IV	45	3			
RUSBAS303	Chemical Sciences III	45	3	RUSBASP302	60	2
RUSBAS304	Chemical Sciences IV	45	3			
RUSBAS305	Computational Sciences III	30	2	RUSBASP303	60	2
RUSBAS306	Computational Sciences IV	30	2			
RUSBAS307	Environmental Sciences	30	2	-	-	-
TOTAL		270	18	-	180	6
TOTAL CREDITS		24				
		Semester – IV				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS401	Biological Sciences III	45	3	RUSBASP401	60	2
RUSBAS402	Biological Sciences IV	45	3			
RUSBAS403	Chemical Sciences III	45	3	RUSBASP402	60	2
RUSBAS404	Chemical Sciences IV	45	3			
RUSBAS405	Computational Sciences III	30	2	RUSBASP403	60	2
RUSBAS406	Computational Sciences IV	30	2			
RUSBAS407	Environmental Sciences	30	2	-	-	-
TOTAL		270	18	-	180	6
TOTAL CREDITS		24				

T.Y.B.Sc.						
		Semester – V				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS501	Entrepreneurship Skills Project/Case/Study /Assignment	60	3	RUSBASP501	60	2
RUSBAS502	Biological Sciences V	45	3	RUSBASP502	60	2
RUSBAS503	Chemical Sciences V	45	3	RUSBASP503	60	2
RUSBAS504	Chemical Sciences VI	45	3			
RUSBAS505	Computational Sciences V	30	2	RUSBASP504	60	2
TOTAL		270	18	-	180	6
TOTAL CREDITS		24				
		Semester – VI				
Paper Code	Paper Nomenclature	Lectures(Hrs.)	Credits	Practical Paper Code	Practical (Hrs)	Credits
RUSBAS601	Entrepreneurship Skills Project/Case/Study/ Assignment	60	3	RUSBASP601	60	2
RUSBAS602	Biological Sciences V	45	3	RUSBASP602	60	2
RUSBAS603	Chemical Sciences V	45	3	RUSBASP603	60	2
RUSBAS604	Chemical Sciences VI	45	3			
RUSBAS605	Computational Sciences V	30	2	RUSBASP604	60	2
TOTAL	270	18	-		180	6
TOTAL CREDITS		24				

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 CREDITS		**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	Proteomics and Pharmaceutical Testing	60	4	RPSBASP804	60	2
		240	**16**	**-**	**240**	**8**
TOTAL CREDITS		**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		60	4	RPSBASP903	60	2
	Industrial Training	-	-	RPSBASP904	360	6
Total		**240**	**12**	**-**	**540**	**12**
TOTAL CREDITS		**24**				
		Semester – X				
Paper Code	Paper Nomenclature	Lectures	Credits	Practical Paper Code	Practical	Credits
RPSBAS1001		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 CREDITS		**24**				

Syllabus Objectives

FY Sem I

Biological Sciences I
- To provide a basic idea about internal systems of plants, animals and micro-organisms
- To introduce different animal systems as in-vivo study models

Biological Sciences II
- To study different Biomolecules
- To study physiological processes in Plants and animal systems as a basic knowledge for further research in agriculture and tissue systems.

Chemical Sciences I
- To understand chemistry of solutions, factors affecting its nature, and to know its applications in different fields.
- To build a base for understanding molecular bonding, identification and naming of complex structures of different commercially important natural products/ phytoconstituents.

Chemical Sciences II
- To make students aware about quantitative analysis by titrimetric estimations.
- To introduce organic chemistry and its reaction mechanisms so that they can correlate with biochemistry.

Computational Sciences I
- To study basic arithmetic calculations required in various topics.

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

Foundation Course I
- To know the constitution of India, fundamental duties of Indian citizens
- To analyze the emerging social problems in India, also to study varied aspects of political processes.

FY Sem-II

Biological Sciences I
- To study the basics of genetics and Enzymology.
- To study the biological membranes.

Biological Sciences II
- To understand the principles of bioenergetics.
- To study the various carbohydrate metabolism, lipid metabolism, nucleic acid metabolism pathways.

Chemical Sciences I
- To study the basic concepts of stereochemistry.
- To know the basics of chemical kinetics and thermodynamics.

Chemical Sciences II
- To understand basic instruments used in Bioanalytical sciences lab and need for automation.
- To study about gravimetric analysis.

Computational Sciences I
- To study the various types of data and data collections.
- To study the measures of central tendency and dispersion.

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.

Foundation Course II
- To study the effect of globalization on Indian society.
- To understand Stress, its causes and conflict.
- To know the human rights, its origin and evolution.

SY Sem-III

Biological Sciences III
- To understand the genetic basis of life & developmental biology which will provide a background for molecular biology techniques.
- To understand the basics of pharmacognosy and Ethnobotany which can be employed in development of crude drugs and their Bioanalysis.

Biological Sciences IV
- To study the commercial applications of microorganisms and viruses.
- To study immunology and its applications in understanding autoimmune disorders and to study the various diagnostic tests employed in diagnosis of such disorders.

Chemical Sciences III
- Introduction of different electrodes and basic analytical instruments ,their working and application in the field of Bioanalysis.
- newer methods of synthesis to develop interest in Greener approach of synthesis.

Chemical Sciences IV
- Inception of basic concepts of spectroscopy.
- Introduction to five and six member ring heterocyclic compound for better understanding of structure and biochemical reactions of phytochemicals containing Heterocycles.

Computational Sciences III
- To imbibe the practice of Graphical representation of raw data and know the basics of working of computing systems.

Computational Sciences IV
- To make the students aware about basic statistical tests and concepts behind it, along with its applications in research and other fields.

Environmental Sciences
- An overview of environment, natural resources and its significance
- To study about the measures to minimize the effects of types of disaster
- To understand the need of environmental management, different guidelines, use of technology in environmental management.

SY Sem-IV

Biological Sciences III
- To study Muscle structures, its properties, physiology of muscle contraction, neurotransmitters.
- To study the mutations and repair in genes, also to study the genetic disorders.

Biological Sciences IV
- To study the various biochemical methods of analysis.
- To study the cell to cell communication and its signaling pathways.
- Introduction to Tissue culture in Plants and animals.

Chemical Sciences III
- To understand the basics of pharmaceutical chemistry and bio-organic chemistry.
- To study the polymers, their structures and biomaterials with their applications.

Chemical Sciences IV
- Introduction to nuclear chemistry and its various applications.
- To study the various applications of bio-organic chemistry.
- Advanced learning of separation techniques.

Computational Sciences III
- To learn the various statistical methods for analysis of data.

Computational Sciences IV
- Introduction to bioinformatics, sequencing and its types.

Technical communication skills
- To understand the basics of effective communication.
- To learn the basics of writing along with its specific applications.
- Introducing students to the technical data writing.

TY SEM V

Entrepreneurship Skills
- Introduction to entrepreneurship, different types of enterprises.
- To study the concept of business economics and knowledge management.

Biological Sciences V
- To study the recombinant DNA technology, Also the study of tissue cultures- Plants-Animals.
- Introduction to the Pharmacognosy & Ethanobotany.

Chemical Sciences V
- Introduction to advanced instrumental techniques their application in the field of Bioanalysis.
- Thermodynamics
- Introduction to Bioanalysis ,instruments and equipments and their applications in industry and research.

Chemical Sciences VI
- Idea of pharmaceutical chemistry and drug development.
- To provide knowledge of handling and analysis of biological(human) samples in Microanalysis.
- To understand the concept of surface chemistry, porosity, particle size and catalysis for better understanding of separation and extraction (adsorption and partition)

Computational Sciences V
- To learn different bioinformatic tools, its operation and application.

TY Sem-VI

Entrepreneurship Skills
- To get an idea about launching and organizing an enterprise, its growth strategies & networking and to actively include innovation.

Biological Sciences V
- To get hands on training on Recombinant DNA techniques.
- To study secondary metabolites in plants & its commercial applications.
- To get acquainted with recent drug development process & the field of Pharmaceutical Biotechnology.

Chemical Sciences V
- To study advances in spectroscopic techniques like Atomic spectroscopy, Molecular fluorescence and phosphorescence spectroscopy, Infra- Red spectroscopy & Raman spectroscopy.

Chemical Sciences VI
- To study Nuclear Magnetic Resonance and hyphenated techniques like GC-MS, GC-IR, HPLC-MS & its commercial applications.
- To get hands on training on biochemical methods of analysis like ELISA, Microarray & Electrophoretic techniques.

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

F.Y.B.S.c Syllabus at a Glance

SEMESTER I			SEMESTER II		
RUSBAS101: BIOLOGICAL SCIENCES I (45L)			RUSBAS201: 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
RUSBAS102: BIOLOGICAL SCIENCES II (45L)			RUSBAS202: BIOLOGICAL SCIENCES II (45L)		
102.1	Introduction to Biomolecules 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
RUSBAS103: CHEMICAL SCIENCES I(45L)			RUSBAS203: CHEMICAL SCIENCES I(45L)		
103.1	Ionic equilibrium, pH and 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
RUSBAS104: CHEMICAL SCIENCES II(45L)			RUSBAS204: CHEMICAL SCIENCE II(45L)		
104.1	Stoichiometry and 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
RUSBAS105: COMPUTATIONAL SCIENCES I (30L)			RUSBAS205: COMPUTATIONAL SCIENCES I (30L)		
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
RUSBAS106: COMPUTATIONAL SCIENCES I (30L)			RUSBAS206: COMPUTATIONAL SCIENCES II(30L)		
106.1	Alternating current theory & transient response of circuit.	10L	206.1	Introduction to Computers	10L
106.2	Optics	10L	206.2	Data Model & languages	10L
106.3	Material Science, Crystal Geometry & X-Ray Techniques	10L	206.3	HTML & XML	10L
RUSBAS107: FOUNDATION COURSE I (30L)			RUSBAS207: FOUNDATION COURSE II (30L)		
107.1	The Indian Constitution	10L	207.1	Globalization and Indian Society	10L
107.2	Growing Social Problems in India	10L	207.2	Understanding Stress and Conflict	10L
107.3	Significant aspects of political processes	10L	207.3	Human Rights	10L

Paper Code		Semester I	lectures
RUSBAS101		**Biological Sciences I**	**45**
	101.1:	Type Specimens	**15**
		1. Significance of Studying type specimen 2. *E.coli*, Yeast & Neurospora 3. Sunflower, Maize & Arabidopsis 4. Mice, Zebra Fish, Guinea Pig 5. Non-human primates *6. Homo sapien sapiens*	
	101.2:	Introduction to Microbiology	**15**
		1. Microbes & their Environment 2. Biodiversity and types of Microorganisms 3. Significance and Scope of Microbiology 4. Visualization of Microorganisms: Staining, Simple and Compound Microscopy 5. Introduction to concepts of asepsis, sterilization and disinfection	
	101.3:	Anatomy of plants and Animals	**15**
		1. Plant Anatomy:　(8L) 　　a. Tissue and Tissue systems in Plants 　　b. Meristems, Classification of Meristems 　　c. Permanent tissues and classification of permanent tissue 　　d. Cell differentiation 　　e. Specialized cells of plants 　　f. Importance of plant anatomy in Bioanalytical Sciences 2. Animal Anatomy:　(7L) 　　a. Tissue and Tissue systems in Animals 　　b. Classification of Animal tissues 　　c. Cell differentiation 　　d. Specialized cells of Animals 　　e. Importance of Animal anatomy in Bioanalytical sciences	

Paper Code		Semester I	lectures
RUSBAS102		**Biological Sciences II**	**45**
	102.1:	Introduction to Biomolecules, Carbohydrates & Nucleic Acids	**15**

		1. Introduction to Biomolecules (3L)
		  a. Overview of chemical and physical attributes of Biomolecules.
		  b. Classification of Biomolecules.
		  c. Significance of Biomolecules in nature and science.
		2.Carbohydrates (8L)
		  a. Classification
		  b. Monosaccharides:- Isomerism, reactions & derivations.
		  c. Disaccharides:- Properties.
		  d. Homopolysaccharides:- Structure(Starch, Inulin, Glycogen, Cellulose) and Functions,
		  e. Heteropolysaccharides:- Examples and functions.
		3. Nucleic Acids (4L)
		  a. Chemistry of nucleic acids, pyrimidines and purines, nucleosides, nucleotides.
		  b. Structure and properties of DNA, stability of nucleic acid structures, Chargaff's rules, Watson and Crick model.
		  c. Structure and function of RNA, types of RNA.
		  d. Confirmations of DNA-A,B,Z forms of DNA.	

	102.2:	Proteins, Lipids & Vitamins	**15**

		1. Proteins
		  a. Building blocks of proteins: Amino acids, structure, classification, physical and chemical properties of amino acids & peptides.
		  b. Classification, Physical and chemical properties of proteins, levels of structural organization, stability of protein structures, Ramchandran plot.
		2. Lipids
		  a. Classification of fatty acids and lipids
		  b. Physical and Chemical properties.
		  c. Functions of fatty acids, glycolipids, phospholipids.
		  d. Cholesterol: Structure and function.
		3.Vitamins
		  a. Storage and Occurrence
		  b. Structure, properties, daily human requirement.
		  c. Metabolic pathways
		  d. Deficiency and treatment.	

	102.3:	Physiological Processes in Plants & Animals	**15**

		1.Plants:
		    a. Seed germination
		    b. Photosynthesis: Light reactions, Carbon fixation reactions C3, C4 & CAM pathways
		    c. Photorespiration
		    d. Storage of plants, Oil seeds.
		 2.Animals:
		    a. Respiratory system
		    b. Digestive System
		    c. Excretory systems
		    d. Circulatory System
		    e. Nervous System
		    f. Reproductive System	

RUSBASP101	**PRACTICALS**		
	1. Washing ,Sterilization of glassware 2. Various types of Media preparation for Microbial growth & Aseptic Transfer 3. Isolation of bacteria 4. Staining techniques: Gram staining, Endospore staining, Metachromatic staining 5. Estimation of oil from oil seeds 6. Qualitative analysis of Biomolecules- Carbohydrates, Proteins, Nucleic Acids, Lipids		

Paper Code		Semester I	lectures
RUSBAS103		**Chemical Sciences I**	**45**
	103.1:	Ionic Equilibrium, pH and Buffers	**15**
		1. Acid- Base concept 2. *HSAB* concept 3. Ostwald's Dilution Law , Activity coefficient ,Solubility, Complex formation and organic complexes, Oxidation and reduction equilibria, Hydrolysis of salts and Solubility product 4. Definition – pH, pK, pKw, Isoelectric pH, Buffer, Buffering Capacity 5. Derivations: Ionic product of water, Hendersen–Hasselbalch equation, Relation between pI, pKa1 and pKa2 for a neutral, acidic and basic amino acid. 6. Titration and Ionization of Glycine, Lysine and Aspartic acid; pKa , pHM, and pI values of these amino acids 7. Physiological Buffers : Preparation, properties and uses of Carbonate-Bicarbonate, Phosphate, and citrate buffers *8.* Preparation and Numerical based on pH and Buffer	
	103.2:	IUPAC and Aromaticity	**15**
		1. Rules of IUPAC nomenclature 2. IUPAC nomenclature of basic functional groups, aliphatic poly functional compounds, including monocyclic compounds, on the basis of IUPAC priority order. (Line formulae expected) 3. IUPAC nomenclature of Spiro, Biphenyls, Bicyclic compounds 4. SMILES Notation 5. Aromaticity: Characteristic properties of aromatics compounds, Huckel's rule, aromaticity and antiaromaticity, resonance energy. 6. Aromatic hydrocarbons: (a) Benzenoid hydrocarbons; benzene, naphthalene, anthracene, phenanthrene. (b) Non-benzenoid: Cyclopropenium, cyclopentadienyl, cycloheptatrieniumcation	
	103.3:	Introduction to Molecular Bonding	**15**
		1. Concept of atoms and molecules atomic structure orbitals 2. Concept of electronic configuration- a)Pauli's exclusion principle b)Hund's rule c)Aufbau principle 3. Types of bonds and bonding, chemical bonding theory 4. Valence-Bond theory and Molecular orbital theory 5. Concept of hybridization and its types 6. Polar covalent bonds and Electronegativity, Drawing chemical structures, Molecular models	

Paper Code		Semester I	lectures
RUSBAS104		**Chemical Sciences II**	**45**
	104.1	**Stoichiometry and Preparation of Standard Solutions, Titrimetric analysis**	**15**
		1. Methods of expressing concentration of solutions-molarity, normality, molality, mole fraction, dilution of solutions, interconversion between different concentration units, concept of milliequivalents, millimols, ppm and ppb	
		2. Primary and secondary standards, preparation of standard solutions, calculation of concentration of commercial samples of acids and bases, Use of computers in chemical calculations.	
		3. 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.	
		4. Principles of acid-base, oxidation–reduction, and complexometric titrations.	
		5. 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	
		6. Acid-base Titrations: Construction of titration curves and choice of indicators in the titration of 　　I) 　Strong acid and strong base 　　II) 　Strong acid and weak base 　　III) 　Weak acid and strong base 　　IV) 　Weak acid and weak base	
		7. Precipitation titrations: Argentimetric titrations, construction of the titration curve, Volhard'smethod, Mohr's method	
	104.2	Fundamentals of Organic Reactions &Mechanism I	**15**
		1. Electronic effects in organic molecules: Polarization or Inductive effect Nature; polarity of a covalent bond, dipole moment and its effect on properties of molecules, such as melting point/boiling point, solubility; Polarizability effect	
		2. Hyperconjugation and Tautomerism	
		3. Bonds weaker than a convalent bond: Hydrogen bond – nature, effect of on melting point/boiling point, solubility in water; Van der waals forces.	
		4. General Idea to types of reaction: Introduction and few examples of following types of reaction expected Addition, Elimination, Substitution, Condensation, Rearrangement, Pericyclic reactions, Oxidation-reduction	
		5. Concept of Electrophilicity, Nucleophilicity, acidity and basicity of organic molecules	

		104.3: Fundamentals of Organic Reactions & Mechanism II	15
		1. Mechanism and applications of Pinacol-Pinacolone 2. Rearrangement, Schmidt Reaction, Benzilic acid Rearrangement. 3. Lossen Rearrangement, Knoevenagel Condensation, Reimer-Teimann Reaction, Hunsdiecker reation and Sand-Meyer Reaction 4. Aldol condensation, Diels Alder reaction, Birch reduction	
RUSBASP102:	PRACTICALS		

	1. Construct various shapes of molecule, and measure bond angles.
	2. Stoichiometric calculations and preparation of primary and secondary standard solutions.
	3. Volumetric analysis (Calculation of % error expected)
	   A. Acid – Base titration
	   B. Estimation of Iron using Internal Indicator
	   C. Estimation of Vitamin C from various samples
	   D. Estimation of Calcium (Complexometric Titration)
	   E. Estimation of Total Hardness
	   F. Estimation of iodine in iodised common salt using iodometry.
	4. Preparation of various buffers and measurement of pH using pH meter and pH paper. Calculation of % error expected
	   A. Carbonate-Bicarbonate Buffer
	   B. Ammonia –Ammonium Chloride Buffer
	   C. Acetic acid—Sodium acetate Buffer
	5. Calibration of glassware
	   A. Burette
	   B. Pipette
	   C. Standard Flask		

Paper Code		Semester I	Lectures
RUSBAS105		Computational Sciences I	(30L)
	105.1	**System of linear equations and Matrices**	**10**
		1. Matrices over R (order 2 & 3): Matrix operations (addition, subtraction, scalar multiplication, matrix multiplication, transpose of a matrix (it's properties), inverse by elementary row transformation, adjoint method, solution of system of equation both homogenous and non-homogenous using matrix (concept of Rank to be introduced) 2. Determinants: Determinant of a matrix of order 2 and 3, elementary properties of determinants, solving a system of linear equations (up to 3 variables) using Crammer's rule and application to medicines, pharmaceuticals, food and vitamins.	
	105.2	**Calculus**	**10**

		1. Derivatives and its application (one variable)
		Definition by first principle method, rules addition, subtraction, multiplication, division (only statements)
		2. Application of derivatives:
		a. Rate measure (Physics, Chemistry, Industrial aspects),
		b. Approximation and errors,
		c. Mean value theorems (without proof)
		  --Rolle's theorem
		  --Lagrange's mean value theorem
		  --Cauchy's mean value theorem
		d. Extreme values using first and second derivatives (application type problem)	

	105.3	**Ordinary Differential Equation and Applications**	**10**
		1. First order differential equations: a. Review of separable differential equations, homogenous and non- homogenous differential equation. b. Linear differential equations and Bernoulli differential equations. c. Modeling with first order equations: examples from financial mathematics, chemistry, environmental sciences, population growth and decay. 2. 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	

Paper Code		Semester I	Lectures
RUSBAS106		Computational Sciences II	(30L)
	106.1	**Alternating current theory & transient response of circuit.**	**10**
		1. AC circuit containing pure R, pure L and pure C 2. Representation of sinusoids by complex numbers, 3. Series L-R, C-R and LCR circuits. Resonance in LCR circuit (both series and parallel) 4. Power in ac circuit. Q-factor. 5. Series LR, CR, LCR circuits. 6. Growth and decay of currents/charge.	
	106.2	**Optics**	**10**
		1. 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. 2. 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. 3. Fraunhofer diffraction: expression for the resultant of N simple harmonic vibrations of equal amplitude, the same period and phases increasing in an arithmetic progression, use of this expression to study a single slit, a double slit, and a plane diffraction grating(transmission type), comparison of prism and grating spectra. 4. Introduction to polarization: pictorial representation of polarized light, polarization by scattering and by reflection, Brester's law, Malus's law, double refraction in calcite and quartz, experimental determination of $\mu 0$ 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. Compton Effect and its experimental verification, energy dependence of photoelectric effect and Compton Effect	

RUSBASP103	PRACTICALS	
	1. Focal length of a lens system 2. High pass Filter 3. Low pass filter 4. Divergence of Laser Beam [Demonstration] 5. Surface Tension 6. Stefan's law 7. LCR series 8. LCR Parallel 9. Photo cell [Demonstration]	

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

Paper Code			Semester II	lectures
RUSBAS202			**Biological Sciences II**	**45**
	202.1:		Principles of Bioenergetics	**15**
			1. Concept of catabolism, anabolism & metabolism.	
			2. Types of Metabolic pathways converging (catabolism), diverging (anabolism) and cyclic.	
			3. Types of biochemical reactions- a) Oxidation- reduction. b) Carbon-carbon bond formation or breakdown. c) Internal rearrangement, isomerisation and elimination. d) Group transfer reaction. e)Free radical reaction	
			4. Concept of Gibbs free energy, enthalpy, entropy, free energy change (ΔG) and standard free energy change (Δ G'^0) with suitable examples.	
			5. Laws of thermodynamics with suitable examples.	
	202.2:		Carbohydrate Metabolism	**15**
			Introduction to Metabolism, Glycolysis, Krebs Cycle, Pentose Phosphate Pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis	
	202.3:		**Lipid Metabolism, Nucleic Acid Metabolism & Amino Acid Metabolism**	**15**
			Lipids: a) Lipid Metabolism b) Lipid Metabolism Disorders *Nucleic Acid*: a) Synthesis of Purines & Pyrimidines (*De novo & Salvage pathway*) b)Catabolism of Purines & Pyrimidines *Amino Acid* :a) Synthesis of Amino acids b) Urea Cycle	
RUSBASP201	**PRACTICALS**			
	1. Estimation of reducing sugars from suitable samples			
	2. Enzymology:			
	- Extraction of amylase from starch using buffers. - Extraction and purification of Invertase from yeast. - Effect of amylase activity on starch - Determination of Km value - Determination of optimum pH - Determination of Optimum temperature			
	3. Storage of carbohydrates(starch granule staining)			
	4. Study of Seed germination and effect of various factors on seed germination			
	5. Study of Mitosis and Meiosis			
	6. Study of Karyotype			
	7. Volutin granules staining, Lipid granules staining			

Paper Code		Semester II	lectures
RUSBAS203		**Chemical Sciences I**	**45**
	203.1:	Stereochemistry-I	**15**
		1. Optical and Geometrical isomers: Study of enantiomers, diastereoisomers, Geometrical isomerism due to restricted rotation around C-C double bond and Substituted cycloalkanes 2. Idea of configuration. Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms: enantiomers, diastereomers, and racemic mixtures and their properties, threo, erythro and mesoisomers. 3. Represantation of configuration by 'flying wedge formula' and projection formulate- Fischer, Newman and Sawhorse. The interconversion of formula 4. Conformational analysis of ethane, propane, 2-methylpropane, 2,2-dimethulpropane, n-butane. 5. Molecular chirality and element of symmetry: Plane of Symmetry, Centre of Symmetry, Alternating axis of symmetry. Chirality without asymmetric carbon 6. Stability of cycloalkanes: Strains in cycloalkanes-angle, eclipising, transannular (3 to 6 membered).Conformations of cyclohexane, mono and di- alkylcyclohexanes and their relative stabilities.	
	203.2:	Stereochemistry-II	**15**
		1. 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. 2. Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de). Topicity-enantiotopic and diastereotopic atoms, groups and faces. 3. Stereochemistry of – A. Substitution reactions- SN1, SN2, SNi (reaction of alcohol with thionyl chloride). B. E2-anti-elimination-Base induced dehydrohalogenation of 1-bromo-1,2- diphenylpropane. C. Addition reactions to olefins-i) Catalytic hydrogenation ii) Bromination (electrophilic anti addition) (iii) Synhydroxylation (molecular addition) with OsO4 and KMnO4.	

203.3:	Chemical Kinetics and Chemical Thermodynamics	15
	Chemical Kinetics:	
	1. 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.	

	2. Methods of determining order of reaction by
	     a) Integration method
	     b) Graphical method
	     c) Equi-fraction method
	     d) Ostwald's isolation method.	

	Chemical Thermodynamics :	
	3. Transition state theory, Hammond's postulate, Principle of microscopic reversibility, Kinetics vs thermodynamic control.	
	4. Product analysis, Kinetic studies, Stereochemical outcome, Detection and trapping of intermediates, Crossover experiments, Kinetic isotope effect –primary kinetic & secondary kinetic isotope effect.	

Paper Code	Semester II	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 analyser, TDS meter Colorimeter, Hot air oven, Vortex, Incubator, Weighing balance, Sonicator, Cyclomixer	
	204.2: Automation in analysis	**15**
	1. Need for automation 2. Automation in laboratory by the use of autopipette, autosampler 3. Automation in clinical chemistry 4. Immuno-based analyzer, Hematology analyzer, Miscellaneous analyzer	
	204.3: Gravimetric Analysis and Treatment of Analytical Data & Sampling	**15**
	A) Gravimetric analysis: 1. Conditions of precipitation 2. Nucleation, Particle size, Crystal growth, Co-precipitation, Precipitation from homogeneous solutions, Drying and ignition of precipitate B) **Treatment of Analytical Data & Sampling** 1. 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] 2. Sensitivity, limit of Detection, Detection Power 3. Different types of analysis : (Introduction only) Elemental and elementary analysis, Microanalysis, Stereochemical and topochemical analysis, Trace analysis, surface analysis, Radioanalytical methods and activation analysis, Species analysis (Speciation), DNA analysis 4. 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 5. 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. 6. Summary of experimental methods currently available for analysis : History and development	

RUSBASP202:	**PRACTICALS**	

	1. Chemical Kinetics & Chemical Thermodynamics:
	    A. To determine the rate of acid hydrolysis of methyl acetate and determination of order by graphical method.
	    B. To determine the order of the acid hydrolysis of methyl acetate by the method of equi fractional time. Second order reaction between-a)$K_2S_2O_8$ and KI (With equi-molar concentrations)
	    b $K_2S_2O_8$ and KI (With unequal concentrations)
	2. Complete identification of an organic compound: Identification by micro-scale techniques following – Preliminary tests, Solubility, Type, Elemental detection, Group tests, Physical Constant determination
	3. Bromination of Acetanilide using CAN
	4. Gravimetric Analysis:
	    A. Estimation of mixture of $BaSO_4$ and NH_4Cl
	    B. Estimation of mixture of Na_2CO_3 and $NaHCO_3$	

Paper Code			Semester II	Lectures
RUSBAS205			Computational Sciences I	30
	205.1		**Types of Data and Data Condensation**	**10**
			1. Concept of Population and Sample. Finite, Infinite Population, Notion of SRS, SRSWOR and SRSWR 2. Different types of scales: Nominal, Ordinal, Interval and Ratio. 3. Methods of Data Collection: i) Primary data: concept of a Questionnaire and a Schedule, ii) Secondary Data 4. Types of data: Qualitative and Quantitative Data; Time Series Data and Cross Section Data, Discrete and Continuous Data Tabulation 5. Dichotomous classification- for two and three attributes, Verification for consistency 6. Association of attributes: Yule's coefficient of association Q. Yule's coefficient of Colligation Y, Relation between Q and Y (with proof). 7. Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution 8. Data Visualization: Graphs and Diagrams: Histogram, Polygon/curve, Ogives. Bivariate Frequency Distribution of discrete and continuous variables	
	205.2		**Measures of central tendency**	**10**
			1. Concept of central tendency of data, Requirements of good measures of central tendency. 2. Location parameters: Median, Quartiles, Deciles, and Percentiles 3. Mathematical averages Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, Mode, Trimmed mean. 4. Empirical relation between mean, median and mode: • Merits and demerits of using different measures & their applicability.	
	205.3		**Measures of Dispersion, Skewness & Kurtosis**	**10**
			1. Concept of dispersion, Requirements of good measure 2. Absolute and Relative measures of dispersion: Range, Quartile Deviation, Inter Quartile Range, Mean absolute deviation, Standard deviation. 3. Variance and Combined variance, raw moments and central moments and relations between them. Their properties 4. 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.	

Paper Code		Semester II		Lectures
		5. Box Plot: Outliers		
Paper Code		**Semester II**		**Lectures**
RUSBAS206:		**Computational Sciences II**		**30**
	206.1	**Introduction To Computers**		**10**
		1. History of computers and their generations 2. Basic Organization of Computers: Introduction to Computer, Block diagram of a Computer, parts of Computer & functional Units, their integration and function, Input-output devices 3. Computer architecture & functionalities 4. Computer memory & memory unit 5. Operating System & Interface: OS, tasks performed by OS , DOS, Windows and Linux/UNIX		
	206.2	**Data models & languages**		**10**
		1. DBMS: Data models Basics 2. 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) 3. Query languages (relational algebra, creating and altering tables, handling data using SQL etc)		
	206.3	**HTML & XML**		**10**
		1. Introduction to HTML and XML, basic HTML tags 2. Tables , hyperlinks, Image Insertion, marquee image mapping, Frame set 3. HTML forms, Get and Post methods 4. Basics of XML 5. XML syntax and semantics		
RUSBASP203	**PRACTICALS**			

| | | 1. Introduction and overview of general computer operation (Windows and Linux platforms), Use of various search engines, email etc.
 2. Introduction of MS-Office:
 • Different elements of word processing (MS-WORD),
 • Spreadsheets (MS EXCEL) and
 • PowerPoint presentation (MS POWERPOINT)
 4. Browsers, various search engines and metadata, E-Mail/Web mail etc.
 5. Introduction to HTML
 6. HTML Tags, HTML Tables
 7. HTML Forms, HTML Framesets
 8. Webpage designing. | |

Paper Code		Semester II	Lectures
RUSBAS207:		Foundation Course-II	30
	207.1	Globalization and Indian Society	10
		1. Understanding the concepts of liberalization, privatization and globalization 2. Growth of Information Technology and Communication and its impact manifested in everyday life 3. Impact of globalization on Industry: Changes in employment and increasing migration 4. Changes in agrarian sector due to globalization, rise in corporate farming and increase in farmer's suicide. Debate regarding Genetically Modified Crops. 5. Increasing Urbanization, problems of housing, health and sanitation 6. Changing lifestyles and impact on culture in a globalized world	
	207.2	Understanding Stress and Conflict	10
		1. Causes of stress and conflict in individuals and society 2. Agents of socialization and the role played by them in developing the individual 3. Significance of values, ethics and prejudices in developing the individual 4. Stereotyping and prejudice as significant factors in causing conflicts in society 5. Aggression and violence as the public expression of conflict 6. Types of conflicts and use of coping mechanisms for managing individual stress	

		7. Maslow's theory of self-actualization 8. Different methods of responding to conflicts in society 9. Conflict-resolution and efforts towards building peace and harmony in society	
	207.3	**Human Rights**	**10**
		1. Concept of human rights: Origin and evolution of the concept 2. The Universal Declaration of Human Rights 3. Human rights constituents with special reference to Fundamental Rights stated in the constitution 4. Development projects and Human Rights Violations	

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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
RUSBAS302: BIOLOGICAL SCIENCES IV (45L)			**RUSBAS402: BIOLOGICAL SCIENCES IV (45L)**		
302.1	Industrial Microbiology	15L	402.1	Biochemical methods of Analysis	15L
302.2	Virology	15L	402.2	Cell communication and Cell signalling	15L
302.3	Introduction to Immunology	15L	402.3	Tissue Culture- Plants & Animals	15L
RUSBAS303: CHEMICAL SCIENCES III (45L)			**RUSBAS403: CHEMICAL SCIENCES III (45L)**		
303.1	Electrochemistry	15L	403.1	Phytochemistry	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	15L	403.3	Material Chemistry: Polymers and Biomaterials	15L
RUSBAS304: CHEMICAL SCIENCES IV (45L)			**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
RUSBAS305: COMPUTATIONAL SCIENCES III (30L)			**RUSBAS405: COMPUTATIONAL SCIENCES III (30L)**		
305.1	Algorithms	10L	405.1	Analysis of Variance	10L
305.2	Graphs	10 L	405.2	Design Of Experiments	10 L
305.3	Numerical methods	10 L	405.3	Latin Square Design (LSD)	10 L

RUSBAS306: Computational Sciences IV (30L)			RUSBAS406: Computational Sciences IV (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 hypothesis	10 L	406.3	Pairwise Sequence Alignment	10 L

RUSBAS307: Environmental Sciences (30L)			RUSBAS407: Technical Communications Skills (30L)		
307.1	Environment: An overview and Natural Resources	10L	407.1	Basics of effective communication	10L
307.2	Disaster-Natural and Man-made & Environmental Issues and Movements.	10L	407.2	Mechanics of Writing	10L
307.3	Environmental Management	10L	407.3	Technical writing	10L

			Semester III	Lectures
RUSBAS301			**Biological Sciences III**	**45**
	301.1:		Central Dogma of Molecular Biology	**15**
			1. Introduction to central dogma in biology 2. Concept of the genetic code 3. Replication in prokaryotes 4. Transcription & Translation in prokaryotes 5. Post translational modification 6. Regulation of gene expression in prokaryotes (lac operon and trp operon)	
	301.2:		Developmental Biology	**15**
			1. Development of organ system – limb 2. Developmental signals – polarity, differentiation, apoptosis 3. Ageing, regeneration and wound healing 4. General fertilization process. 5. Gamete Collection and Storage(Artificial insemination) 6. *In Vitro* Fertilization Technique	
	301.3:		Pharmacognosy & Ethnobotany	**15**
			A) Pharmacognosy: 1. Plants in medicine- The scope & practice on pharmacognosy 2. sources of crude drugs 3. Production of crude drugs 4. Deterioration of stored drugs & Quality control of crude drug 5. Current Trends in pharmacognosy 6. Good Cultivation practices B) **Ethnobotany:** Principles & Importance of Ethnobotany	
Paper Code			**Semester III**	**Lectures**
RUSBAS302			**Biological Sciences IV**	**45**
	302.1:		Industrial Microbiology	**15**
			1. Sources of antimicrobial agents: plants and microorganisms 2. Antimicrobial Agents Used *In vivo* and their commercial production. 3. Antimicrobial Drug Resistance and Drug Discovery 4. Important microbes in Food & Drug industry 5. Pathogenic Organisms in Food & Pharma Industry 6. Commercial significance of Microbes: Biopolymers, Biosurfactants.	
	302.2:		Virology	**15**
			1. Introduction to Virology, Scope and Current trends in virology 2. Structures and life cycles of bacteriophages, plant and animal viruses	

		3. Interactions of microbes with Humans – *Influenza*, *Staphylococcus*, *Plasmodium*, *Candida* 4. Control of Viruses and Eukaryotic Pathogens.	
	302.3:	Introduction to Immunology	**15**
		1. Concept of antigen, antibody 2. Types of immunity 3. Antigen-Antibody Reactions (MHC, APC introduction) 4. hypersensitivity and its types 5. Autoimmune disorders (*minimum two*) and their management	
RUSBASP301	**PRACTICALS**		
	1. Blood grouping 2. Isoagglutinin titre- Widal, VDRL tests 3. Use of diagnostic tests- ELISA demonstration 4. Total viable count of the provided sample. 5. Direct microscopic counts of provided sample using Breeds count method and Haemocytometer 6. Study of growth curve of *E.coli* 7. Physical and chemical methods of disinfection 8. Normal flora of human body *9.* Study of common microbial contaminants in foods : *S. aureus, S. typhi, B. subtilis* 10. Study of microbial Biosurfactants (demo) 11. Analysis of Crude drugs by Microscopy		

Paper Code		Semester III	Lectures
RUSBAS303		**Chemical Sciences III**	**45**
	303.1	**Electrochemistry**	**15**

		1. Nature of electrolytes in solution: Variation of molar conductance with concentration for weak and strong electrolytes (derivation of equation is not expected).
		2. Kohlrausch's law and its application to determine Molar conductance at infinite dilution of a weak electrolyte, Dissociation constant of a weak electrolyte, Solubility of sparingly soluble salts, Migration of ions, ionic mobilities.
		3. Nernst theory, EMF, cells, activity, ionic strength, Membrane potential-applications
		4. Conversion of chemical energy to electrical energy. Galvanic cells, reversible and irreversible cells.
		5. Types of reversible electrodes:
		    a. Electrodes of first type: Metal – metal ion electrode
		    b. Redox electrodes
		    c. Gas electrode
		    d. Glass electrode
		6. Classification of cells – Chemical and concentration cells, concentration cells with transference, concentration cells without transference, liquid junction potential, use of salt bridge.
		7. Applications, strengths and limitations of electrochemical analysis	

	303.2	**Newer methods of organic synthesis & Name Reactions (Mechanism and Applications)**	**15**
		1. Newer methods of organic synthesis: Introduction to the use of following organic synthesis Ultrasound, Microwaves, PTC 2. 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**	**15**
		Introduction, principle, instrumentation, working and applications of: 1. Conductometry and conductometric titrations 2. Potentiometry and potentiometric titrations 3. pH measurements and pH electrode and combination electrode 4. Ion selective electrodes 5. Turbidometry and nephelometry 6. Possible errors and Precautions in each instrumentation technique	

Paper Code		Semester - Paper	Lectures
RUSBAS304	**Chemical Sciences IV**		**45**
	304.1: Basic Spectroscopy		**15**
		1. Introduction: Electromagnetic spectrum (EMR), Units of wavelength and frequency and their inter conversions.	
		2. Interaction of EMR with matter: Nature of radiation, energy of molecules- electronic, vibrational and rotational	
		3. Beer-Lambert's law, deviation of Beer-Lambert's equation and its limitations.	
		4. Terms used – absorbance, transmittance and molar absorptivity.	
		5. Absorption of radiation by molecules.	
		6. Single beam colorimeter – Principle, components and working.	
		7. Quantization of energy, Bohr frequency condition	
		8. Regions of electromagnetic spectrum and process associated with each region.	
		9. UV- VIS : Basic theory, Solvents, Nature of UV-Visible spectrum, Concept of Chromophore, Auxochrome, Bathochromic Shift, Hyper chromic and Hypochromic effect, Chromophore-Chromophore interactions and Chromophore-Auxochrome interactions	
		10. Sample Preparation, Evaluation of errors and applications of Colorimetry, Turbidimetry , Nephelometry and UV-Visible spectroscopy	
	304.2: Heterocyclic Compounds		**15**
		1. **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.	
		2. **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.	
		3. **Reactions of heterocycles:** The following reactions of furan, pyrrole and thiophene: Halogenation , Nitration, Sulphonation, Vilsmeir formylation reaction, Friedel-Crafts reaction.	
		4. **Furan**: Diels-Alder reaction. Ring opening of furan.	
		5. **Pyrrole**: Acidity and basicity of pyrrole - Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and	

38

		piperidine. Sulphonation of pyridine, with and without catalyst. Reduction.Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction).Nmethylation of pyridine. Quaternization of piperdine, pyrrolidine and Hofmann elimination of the quaternary salts.	
	304.3: Methods of Separations-I		**15**
		1. 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. 2. Purification of solid organic compounds, recrystallisation, use of miscible solvents, use of drying agents and their properties, sublimation. 3. Purification of liquids. Experimental techniques of distillation, fractional distillation, distillation under reduced pressure. 4. Extraction, use of immiscible solvents, solvent extraction. 5. Applications of separation techniques in Bioanalysis.	
RUSBASP302:	PRACTICALS		
	Conductometry: 1. Determination of Cell constant of conductivity cell 2. Verification of Ostwald's dilution law 3. Investigate the titration of mixture of HCl and Oxalic acid by NaOH. 4. 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 8. pH titration of sodium carbonate against HCl to demonstrate the selection of indicators for two inflections. **Organic Derivative:** 9. Nitration of Nitrobenzene 10. Reduction of Benzophenone to Benzhydrol 11. 2,4-DNP of benzaldehyde 12. Oxidation of Benzaldehyde with KMnO4 13. Acetylation of Salicylic acid 14. Nitration of Salicylic acid 15. Hydrolysis of Ethyl benzoate		

Paper Code	Semester III	Lectures
RUSBAS305	**Computational Sciences I**	**30**
305.1	**Algorithms**	**10**
	1. Definition and characteristics of an algorithm, selection and interactive constructs in pseudocode. Data structures like array. 2. Sorting, insertion sort, bubble sort 3. Searching algorithms, linear search and binary search 4. Algorithms on integers, algorithm on matrices.	
305.2	**Graphs**	**10**
	1. Introduction to graphs: types of graph(simple graph, multigraph, pseudograph, directed graph, with an example of each), some special simple graphs(complete graph, cycle, wheel in graph, loop, bipartite graph, regular graph) 2. Representing graphs and graph isomorphism, their application 3. Elementary combinatories: Sets; functions; relations (equivalence relations) 4. Permutations and combinations with respect to applications.	
305.3	**Numerical Methods**	**10**

	1. Finding roots of equations-
	    a. Bisection method
	    b. Iteration method
	    c. Newton Raphson method
	    d. Secant method
	2. Finding solutions of system of linear equations and numerical approximations-
	    a. LU decomposition (Doolittle's method, Crout's method)
	3. Inversre of matrix by Cholesky method	

Paper Code	Semester III	Lectures
RUSBAS306	**Computational Sciences IV**	**30**
306.1	**Correlation, Simple linear Regression Analysis**	**10**
	1. Visualizing relationship using Scatter Diagram,	
	2. Karl Pearson's Product moment correlation coefficient and its properties.	
	3. Spearman's Rank correlation.(With and without ties)	
	4. Concept of Simple linear regression. Principle of least squares. Fitting a straight line by method of least squares (Linear in Parameters)	
	5. Relationship between regression coefficients and correlation coefficient, cause and effect relationship, Spurious correlation.	
	6. Concept and use of coefficient of determination (R^2).	
	7. Measures of association with the help of Tau A, Tau B, Tau C, Gamma and Lambda, Somer's d	
306.2	**Probability Theory**	**10**
	1. Trial, random experiment, sample point and sample space.	
	2. Definition of an event, mutually exclusive and exhaustive events.	
	3. Classical (Mathematical) and Empirical definitions of Probability -Discrete random variable	
	4. Random variable- Discrete and Continuous	
	5. Standard Discrete Probability Distribution Functions Binomial, Poisson (Concept Only)	
	6. Standard Continuous Probability Distribution Functions: Normal, t, Chi-square and F distribution (Concept only)	
306.3	**Basics of Theory of Estimation and Testing of hypothesis**	**10**
	1. Point and Interval estimate of single mean, single proportion from sample of large size.	
	2. Statistical tests: Concept of hypothesis, Null and Alternative Hypothesis, Types of Errors, Critical region, Level of significance, Power	
	3. Small sample tests-Independent sample t-test, paired t-test. Concept of p-value. (Use of Excel and SPSS)	
RUSBASP303	**PRACTICALS**	
	1. 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)	
	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 Environment: An overview**	**10**
	1. Environment – Structure and components – Topology – Natural and Human.	
	2. Ecosystem as part of Environment – Functioning and levels of organization – Linkage with society and economy.	
	3. Emerging issues of development – Environment as a source and depository of resources, products and waste.	
	4. Sustainable use of resources – a multidisciplinary approach – importance of Environmental Studies.	
	5. Definition, importance and classification of natural resources.	
	6. Resource rich and resource poor regions – emerging gaps	
	7. Distribution patterns, utilization and conservation of water, forest and energy resources	
307.2	**Disaster – Natural and Man-made & Environmental issues and Movements**	**10**
	1. Concept of disaster – Natural and man-made	
	2. Natural hazard/Disasters: Causes and Consequences – Earthquake and Tsunami, Cyclone, Flood and Drought (a case study)	
	3. Man-made disasters – Causes and Consequences – nuclear accident, oil spill and leakage, industrial accident	
	4. Disaster Management cycle – Pre-disaster, disaster occurrence and post-disaster- Role of technology	
	5. Environmental problems – Causes and Effects	
	6. Global issues – Global climate changes, Threats to Biodiversity, tremendous pollution, population and ozone depletion (a case study)	
	7. Regional issues – Acid rain, Desertification (a case study)	
	8. Major environmental movements in India	
307.3	**Environmental Management**	**10**
	1. Environmental management – concept and need – relevance of Environmental education	
	2. Constitutional and legal provisions in India – International efforts towards environmental protection – role of WTO	
	3. Environmental Statement, ISO 14000, ISO 16000, Environmental Impact Assessment	
	4. Role of technology in environmental management (GIS, GPS, Remote sensing as tools)	
	5. Carbon bank and Carbon credit	

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Paper Code	Semester IV	Lectures
RUSBAS401	**Biological Sciences III**	**45**
401.1	**Biology of Muscles and Nerve Conduction**	**15**
	1. Muscle structure 2. Physiological and biochemical basis of muscle contraction 3. Gibbs-Donnan Membrane Equilibrium and Physiology of nerve conduction Synapse & Synaptic conduction, Neurotransmitters. 4. Drug addiction, Neuropathies	
401.2	**Genetic Mutation & Repair**	**15**
	1. Types of mutation – Point and gross, Spontaneous and Induced 2. Types of Mutagens and effects 3. Cell survival strategies: repair mechanisms 4. Inborn errors of metabolism with examples	
401.3	**Genetic disorders**	**15**
	1. Phenylketonuria 2. Albinism 3. Lesch-Nyhan Syndrome 4. Tay-Sachs Disease 5. Sickle-Cell Anemia 6. Cystic Fibrosis 7. Carrier detection 8. Huntington's Disease 9. Duchenne muscular Disorder 10. Hemophilia 11. Thalassemia 12. Down Syndrome	

Paper Code	Semester IV	Lectures
RUSBAS402	**Biological Sciences IV**	**45**
402.1	**Biochemical methods of Analysis**	**15**
	1. Extraction & Analysis of Biomolecules.	
	2. Use of Analytical instruments for Qualitative & Quantitative analysis	
	3. Immunohistochemistry	
	4. ELISA and RIA	
402.2	**Cell communication and Cell signaling**	**15**
	1. Hormones and classification of hormones	
	2. Hormone secreting glands, organization of endocrine system,	
	3. Physiological role of – pancreatic hormones-(insulin, glucagon), thyroxine, glucocorticoids, epinephrine	
	4. Signal transduction pathways, 2nd messengers, and bacterial chemotaxis	
402.3	**Tissue Culture- Plants & Animals**	**15**
	A) Plant Tissue culture:	
	1. Concept Of Plant Tissue Culture	
	2. Nutrient Requirement, Callus Induction, Micropropagation	
	3. Callus Culture, Suspension Culture, Batch Culture	
	4. Application Of Plant Tissue Culture	
	B) Animal Tissue culture:	
	1. Concept of Animal Tissue culture	
	2. Nutritional requirements of animal tissues (including significance of serum in media)	
	3. Role of media components in production of tissue culture products	
	4. Concept of cell line & its classification with specific examples	
	5. Application of Animal Tissue Culture	
RUSBASP401	**PRACTICALS**	
	1. Isolation of antibiotic producers	
	2. Antibiotic spectrum studies by Kirby Bauer Method	
	3. Lowry's Method for protein estimation	
	4. Total Sugar estimation by Anthrone's method	
	5. UV survival curve of *E.coli*: photo reactivation and dark repair.	
	6. Study of pollen biology	
	7. Visit to Animal tissue culture & Plant tissue culture laboratory.	
	8. Radio immunosorbent assay (demo)	

Paper Code	Semester IV	Lectures
RUSBAS403	**Chemical Sciences III**	**45**
403.1	Introduction to Pharmaceutical Chemistry	**15**
	1. Scope of pharmacology 2. Source, Nature and Nomenclature of Drugs 3. Factors influencing Dosage and Drug Action 4. Introduction to drug action: Absorption , Distribution, Metabolism, excretion of Drug (Drug Disposition and Pharmacokinetics)	
403.2	Introduction to Bio-Organic Chemistry	**15**
	1. Overview of α-Amino acids: Structure, configuration, Essential amino acids and their abbreviations, classification, Properties: pH dependency of ionic structure and isoelectric point. 2. Methods of preparations of α-Amino acids: Strecker synthesis, amidomalonate synthesis, Erlenmeyer azalactone synthesis. 3. Polypeptides and Proteins: Polypeptides: Peptide bond. Nomenclature and representation of polypeptides. Merrifields solid phase peptide synthesis (example of di- and tri- peptides for nomenclature and synthesis). 4. Structures and properties of crown ethers, cryptands, cyclophanes, calixarenes, rotaxanes and cyclodextrins. Synthesis of crown ethers, cryptands and calixarenes. 5. Molecular recognition and catalysis, molecular self-assembly.	
403.3	Material Chemistry: Polymers And Biomaterials	**15**
	Polymers: 1. Introduction: General idea of structure. namings, types of polymers, tacticity, polymerization processes with examples, radical and ionic mechanisms of polymerizations. Characteristic properties of polymers. General ideas of resins, plastics, rubber, idea of plasticizers, stabilizers, stabilizers, fillers. 2. Structure, preparation and applications of PE (types and Ziegler – Natta process), PP, Teflon, PVC, PC, polyacrylates, PAN, Neoprene, Terylene, Nylons, Phenol/Melamine/Urea-formaldehyde Resins, polyurethane, polycarbonate, epoxy resins (structures of the monomers and those of the polymers are expected. Biomaterial: 1. 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. 2. Metallic implant materials - Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with biometal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.	

Paper Code	Semester IV	Lectures
RUSBAS404	**Chemical Sciences IV**	**45**
404.1	**Nuclear chemistry**	**15**

	1. Basic nuclear chemistry: Overview,Definitions/Terms involved.
	2. Use of radioisotopes as tracers in: Chemical investigations- reaction mechanism, Age determination- dating by Carbon-14
	3. Activation analysis- basic principles, fast neutron activation analysis, radio-chemicalmethod in activation analysis
	4. Isotopic dilution method- principle and applications.
	5. Auto, x-ray and gamma radiography, Radiometric Titrations
	6. Applications of radio-analytical techniques:
	    A. Introduction to Nuclear medicine: Therapeutic Radioisotopes, Radiopharmaceuticals for therapy, Tissue targeting
	    B. Radiopharmaceutical quality control
	    C. 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
	    D. Alpha particle emitters: Actinium, Bismuth, and Other Alpha Emitters
	7. Cancer Radio Therapy	

404.2	Aspects of Bio-Inorganic Chemistry	**15**
	1. Introduction-Metals in biological systems 2. Electron transfer in biological systems: Cytochrome and Iron sulphur protein 3. Metalloenzyme/protein 4. Role of calcium in biology 5. Metals in medicine 6. Platinum binding to DNA	
404.3	Methods of Separations-II	**15**
	1. Principle of adsorption and partition chromatography. 2. Thin Layer Chromatography: choice of adsorbent, choice of solvent, preparation of chromatogram, sample, Rf value and its applications. 3. Paper chromatography, solvent used, Rf value, factors which affect Rf value.	
RUSBASP402:	PRACTICALS	
	Separation of Organic mixtures: 1.Water soluble + Water insoluble (Solid + Solid) 2.Water insoluble + Water insoluble (Solid + Solid) Solvent Extraction: 1.Determination of Fe and Cu from their mixture 2.To determine the partition co-efficient of I_2 between water and CCl4 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 :a) λmax b)Molar absorptivity constant 2.To determine indicator constant of a given indicator by Colorimetric measurements	

	3. Spectrophotometry: Turbidometric analysis of cough syrup	

Paper Code	Semester IV	Lectures
RUSBAS405:	**Computational Sciences I**	**30**
	405.1 Analysis of Variance	**10**

	1. Introduction, One way classification with equal & unequal observations per class,
	    2. Two way classification with one observation per cell.
	    3. Three way classification	

	405.2 Design Of Experiments	**10**

	1. Concepts of Experiments, Experimental unit, Treatment, Yield, Block,
	    2. Replicate, Experimental Error, Precision.
	Completely Randomized Design (CRD) & Randomized Block Design (RBD):
	    3. Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. (Concept only-No derivations)
	    4. Least square estimators of the parameters, Variance of the 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, RBD	

	405.3 Latin Square Design (LSD)	**10**

	1. Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table.
	    2. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts.
	    3. Efficiency of the design relative to RBD, CRD.
	    4. Missing plot technique for one missing observation in case of LSD.	

Paper Code	Semester IV		Lectures
RUSBAS406:	**Computational Sciences II**		**30**
	406.1 **Introduction to Bioinformatics**		**10**
		1. Introduction to Bioinformatics & Databases 2. Application of Bioinformatics 3. INSDC **4.** Major Bioinformatics resources: NCBI, EBI, ExPASy **5.** Nucleic acid: GENBANK, EMBL, DDBJ **6.** Protein structure: domains, motifs (Pfam/Prosite) **7.** Protein sequence databases: UniProt, PIR, SWISSPROT, TrEMBL **8.** Literature database : PUBMED **9.** Genome database: GSS, Genome **10.** Specialized database: OMIM **11.** Protein structure databases: PDB **12.** Metabolic Pathway database: KEGG	
	406.2 **Basics to Sequencing**		**10**
		1. Molecular biology basics 2. Genomics 3. Proteomics 4. DNA sequencing technology: Whole-genome shotgun sequencing strategies 5. Protein sequencing methods **6.** Sequence File formats	
	406.3 **Pairwise Sequence Alignment**		**10**
		1. Basic Concepts of sequences similarity, Identity and homology **2.** Definition of homologs, orthologs, paralogs **3.** Concepts of sequence alignments **4.** Pairwise sequence alignment methods **5.** DOT Matrix analysis **6.** Scoring matrices: Basic concepts of scoring matrix, PAM and BLOSUM series and principles based on which these matrices are derived	
RUSBASP403	PRACTICALS		
		1. INSDC- NCBI, EMBL, DDBJ 2. Sequence databases- EMBL-EBI, GenBank, UniProt 3. Structure databases- PDB 4. Domain database: Prosite, PRINT, Pfam. 5. Specialized database: KEGG, PUBMED, OMIM 6. Use of Rasmol	

Paper Code	Semester IV		Lectures
RUSBAS407:	**Technical Communication Skills**		**30**
	407.1	**Basics of effective communication**	**10**
		1. **Basics of effective communication** **a)** Concepts **b)** Process **c)** Myths about communication 2. **Communication : It's interpretation** **a)** Verbal Communication **b)** Non-verbal Communication **c)** Barriers to Communication 3. **Case study** 4. Listening skills	
	407.2	**Mechanics of writing**	**10**
		1. **Writing basics** a) Spelling rules b) Punctuation c) Abbreviations d) Proof Reading 2. **Letters** a) Application Letter b) Bank Letters c) Business Letters d) Letters to the Editor e) E-Communication 3. **Resume writing** 4. **Interview skills** 5. **Reports** a) Experimental Report b) Field Work Report c) Industrial Visit Report 6. **Group discussion**	
	407.3	**Technical writing**	**10**
		1. Assignment Writing 2. Written Scientific Communication 3. Book review 4. Minutes of the meeting 5. **PowerPoint presentation skills**	

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T.Y.B.Sc Syllabus at a Glance

SEMESTER V			SEMESTER VI		
RUSBAS501: ENTREPRENEURSHIP SKILLS I (40L)			RUSBAS601: ENTREPRENEURSHIP SKILLS II (40L)		
501.1	The Entrepreneur	15L	601.1	Launching and Organizing An Enterprise	15L
501.2	Conceptual Frame Work	15L	601.2	Growth Strategies, Networking & Innovation	15L
501.3	Business Economics	15L	601.3	Innovation	15L
501.4	Knowledge Management	15L	601.4	Principles of Corporate Management	15L
RUSBAS502: 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 Technology	15L
502.3	Extraction Technologies for Phytochemicals	15L	602.3	Introduction to Biosimilars & Biopharmaceuticals	15L
RUSBAS503: CHEMICAL SCIENCES V (45L)			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
RUSBAS504: 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 analysis	15L	604.2	Hyphenated Techniques	15L
504.3	General Metabolism and Nutrition	15L	604.3	Biochemical Methods of Analysis	15L
RUSBAS505:COMPUTATIONAL SCIENCES V (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	Chemoinformatics	15L
505.3	Molecular Phylogenetics	15L	605.3	Computational Drug designing	15L

Paper Code	Semester V	Lectures
RUSBAS501	**ENTERPRENEURSHIP SKILLS**	**40L**
	501.1 The Entrepreneur	**10**
	1. Entrepreneurial motivation – dynamics of motivation. 2. Entrepreneurial competency – Concepts. 3. Developing Entrepreneurial competencies - requirements and understanding the process of entrepreneurship development, self awareness, interpersonal skills, creativity, assertiveness, achievement, factors affecting entrepreneur'' role.	
	501.2 Conceptual Frame Work	**10**
	1. Concept need and process in entrepreneurship development. 2. Role of enterprise in national and global economy 3. Types of enterprise – Merits and Demerits 4. Government policies and schemes for enterprise development 5. Institutional support in enterprise development and management	
	501.3 Business Economics	**10**
	1. Demand analysis, concept & types of demand ,law of demand 2. Utility analysis, concept & types of utility ,law of utility 3. Introduction to Cost & Revenue , its types 4. STP (segmentation / targeting / positioning) 5. Sources of Growth–Concept and Importance of Knowledge Economy 6. WTO: Functions and Agreements with Reference to TRIPS, TRIMS and GATS.	
	501.4 Knowledge Management	**10**
	1. Introduction 2. History and Evolution 3. Pillars of Knowledge Management 4. Scope & Significance Technology & Knowledge Management. 5. Critical Success Factors of KM 6. Case Studies 7. P's of Marketing	
RUSBASP501	**PRACTICALS**	
	Case Study/Assignment/Project Report/Industrial Visit	

Paper Code	Semester V		Lectures
RUSBAS502	**Biological Sciences V**		**45**
	502.1: Recombinant DNA Technology		**15**
		1. Concept of Transposons, Plasmids, Vectors, Cosmids	
		2. Restriction Enzymes	
		3. Transgenic Bacteria, Commercial applications with suitable examples	
		4. Transgenic Plants suitable Examples(Bt Cotton, Golden Rice)	
		5. Transgenic Animals	
		6. Cloning- current Status, Regulations, Ethics etc	
	502.2: Phytochemistry		**15**
		1. Primary and secondary metabolites from plants	
		2. Classification of Plant Secondary metabolites	
		3. Functions of Plant Secondary Metabolites	
		4. Chemistry of Phenolics, Terpenoids, Alkaloids	
		5. Phytochemicals as Drugs	
		6. Key factors affecting synthesis of secondary metabolites	
		7. Commercial applications	
	502.3: Extraction Technologies for Phytochemicals		**15**
		1. Extraction of phytoconstituents	
		2. Choice of solvent for extraction	
		3. classical and modern methods of extraction	
		a. Percolation & Maceration	
		b. Soxhlet extraction	
		c. Steam Distillation & Rotary vacuum evaporator	
		d. Liquid- Liquid & Solid Phase Extraction	
		e. Ultrasonication	
		f. Microwave Assisted Extraction	
		g. Supercritical Fluid extraction	
RUSBASP502	**PRACTICALS**		

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

Paper Code	Semester V	Lectures
RUSBAS503	**Chemical Sciences V**	**45**
	503.1 Methods of Separations-III	**15**
	1. Liquid Chromatography and its development to HPLC and its applications 2. HPLC Instrumentation, Pumps, solvent delivery system, isocratic and gradient programming modes, Sample introduction system, Columns, Detectors. Reversed phase and normal phase chromatography 3. Gas Chromatography, Gas Solid and Gas liquid Chromatography and its applications 4. Gas Chromatography Instrumentation, Carrier gas supply, Injectors, Columns, Packed and capillary columns, Column oven and temperature programming, different detectors.	
	503.2 Bioanalysis	**15**
	1. Introduction to Bioanalysis 2. Different sample matrices and special precautions to be taken while handling clinical samples 3. Biochemical analysis of clinical samples: Glucose, calcium, kidney test, liver test, electrolytes, proteins, complete blood count. 4. Advanced instrumentation in Bioanalysis: Flowcytometer, blood gas analyzer, automatic haematology analyzer, blood glucose analyzer, alcohol breath analyzer	
	503.3 Thermodynamics	**15**
	1. 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 accompanying change of state and transtition. 2. Gibbs free energy and Helmholtz's free energy, variation of Gibbs's free energy with temperature and pressure, Gibb's-Helmholtz equation. 3. Physical euilibbria involving pure substances, Clayperon's equation and variation of vapour pressure with temperature, Clausius-Clayperon equation and its application. Partial molal properties, partial molal volume and chemical potential, Gibbs-Duhem equation. 4. Variation of chemical potential potential with pressure and temperature, fugacity, activity and their relationship with chemical potential, activity and activity coefficient. 5. Thermodynamic derivation of Law of mass action, Kp, Kc and their inter-relation, van't Hoff's reaction isotherm and reaction isochore.	

Paper Code	Semester V	Lectures
RUSBAS504	**Chemical Sciences VI**	**45**
	504.1 Basic Pharmaceutical Chemistry	**15**
	1. Definition of a drug, Requirements of an ideal drug, Classification of drugs (based on therapeutic action)	
	2. Nomenclature of drugs: Generic name, Brand name, Systematic name	
	3. Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD50, ED50, Therapeutic Index.	
	4. Brief idea of the following terms: Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	5. Routes of drug administration with advantages and disadvantages	
	6. Formulations, Different dosage forms(emphasis on sustained release formulations)	
	7. Introduction to Drug Discovery, Design and Development: Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation	
	8. Drug development from Natural Sources: Anti-infective agents, Anti-cancer agents, CNS agent	
	9. Development of drug: The Pharmacophore identification, modification of structure or functional group.	
	10. Different types of chemical transformation of drugs with specific examples.	
	11. Synthesis and therapeutic use of Diclofenac sodium (DFS), Aceclofenac,Paracetamol,Phenytoin,Aspirin,Atenolol,Laevodopa ,Ciprofloxacin,Metronidazole,Dapsone,Ethambutol	
	504.2 Micro analysis and Surface analysis	**15**
	Microanalysis :	
	1. Problems associated with trace analysis	
	2. Special extraction procedures for separating analyte/s from the complex matrix	
	3. Extraction of organic/inorganic analyte from organic/inorganic matrix.	
	4. Special techniques and care to be taken during micro analysis	
	Surface analysis :	
	1. Surface chemistry, Phenomenon of adsorption, Adsorption isotherms	
	2. Surface area by BET method	
	3. Pore size distribution	
	4. Particle size analysis	
	5. Catalysis, Heterogeneous and homogenous catalysis	

	504.3:	General Metabolism and Nutrition	**15**
		1. Overview of Mineral metabolism and abnormalities of Mineral metabolism with respect to calcium, iron, iodine, fluoride, manganese, selenium 2. Energy metabolism and nutrition: concepts of calorific value, Respiratory quotient, BMR, RDA, Nutritional indices, proximate principles of diet, protein energy malnutrition, obesity, BMI, diseases related to obesity, glycemic index 3. Free radicals and anti-oxidants: reactive oxygen species-generation and damage, free radical scavenger systems, inflammation, respiratory, skin and age related diseases, atherosclerosis, lipid per oxidation, preventive and chain breaking anti-oxidants	
RUSBASP**503**	PRACTICALS		

1. Column Chromatography of Separation of mixture of dyes/Separation of Plant Pigments (Spinach)
2. Paper chromatography of 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
5. Gravimetric Analysis of Estimation of Nickel as Ni-DMG

Paper Code	Semester V	Lectures
RUSBAS505	**COMPUTATIONALSCIENCES-V**	**45**
	505.1 **Dynamic Programming Algorithm**	**15**
	1. Global and local alignment 2. Needleman &Wunch, Smith & Waterman algorithms for Pairwise alignment 3. Use of pairwise alignments for analysis of Nucleic acid and Protein Sequences and interpretation of results. 4. Overview of BLAST, its variants & working, BLAST algorithm 5. PSI BLAST and PHI BLAST: Working and interpretation of result	
	505.2 **Multiple sequence alignment**	**15**
	1. Concept of multiple sequence alignment 2. Algorithm in MSA and its application 3. Multiple sequence alignment methods 4. PSSM 5. MSA Tool: Clustal Omega- Working	
	505.3 **Molecular Phylogenetics**	**15**
	1. Phylogenetic analysis 2. Basic concepts in taxonomy and phylogeny. 3. Definition and description of Phylogenetic trees and various methods 4. Clustering method –UPGMA & NJ 5. Cladistic method – Maximum Parsimony 6. Phylogenetic Analysis software Phylip/PAUP	
RUSBASP504	PRACTICALS	

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

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Paper Code		Semester VI	Lectures
RUSBAS601		**ENTERPRENEURSHIP SKILLS**	**60**
	601.1	**Launching and Organizing An Enterprise**	**15**
		1. Environment scanning – Information, sources, schemes of assistance, problems. 2. Enterprise selection, market assessment, enterprise feasibility study, SWOT Analysis. 3. Resource mobilisation - finance, technology, raw material, site and manpower. 4. Costing and marketing management and quality control. 5. Feedback, monitoring and evaluation.	
	601.2	**Growth Strategies, Networking & Innovation**	**15**
		1. Performance appraisal and assessment 2. Profitability and control measures, demands and challenges 3. Need for diversification 4. Future Growth – Techniques of expansion and diversification, vision strategies 5. Concept and dynamics 6. Methods, Joint venture, co-ordination and feasibility study	
	601.3	**Principles of Corporate Management**	**15**
		1. Principles 2. Functions of management 3. Quality Circles 4. MBO 5. Management by Wandering	
	601.4	**Innovation**	**15**
		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	

Paper Code	Semester VI	Lectures
RUSBAS602	**Biological Sciences V**	**45**
	602.1: Phytochemical Analysis	**15**
	1. Classical methods of analysis (Gravimetric & Titrimetric) 2. Chromatographic & Spectroscopic analysis of phytoconstituents 3. Chromatographic fingerprints 4. Phytochemical variations in plants 5. Analysis of herbal formulations 6. Effect of drying on phytoconstituents	
	602.2: Techniques in Recombinant DNA Technology	**15**
	1. RFLP, AFLP 2. PCR 3. RAPD 4. Nucleic acid probes 5. Southern Blotting, Northern Blotting 6. Edible Vaccines 7. Biosensors and Biochips	
	602.3: Introduction to Biosimilars & Biopharmaceuticals	**15**
	1. Introduction to Biopharmaceuticals, Sources of Biopharmaceuticals (*E. Coli,* Animal cells, Additional systems) 2. Upstream & Downstream processing 3. Product Analysis 4. Therapeutic Hormones, Recombinant Blood Products &Therapeutic Enzymes **5.** 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	

Paper Code		Semester VI- Paper	Lectures
RUSBAS603		**Chemical Sciences V**	**45**
	603.1	Spectroscopy –II	**15**

1. **Atomic Spectroscopy:**
   Absorption and emission spectra, energy level diagrams, process involved in atomization, flame photometry, flame atomizer, types of burners, monochromators and detectors, atomic absorption spectroscopy; flame and electrothermal atomizer, sources,   instrumentation, quantitative applications of atomic absorption and   flame photometry, calibration curve method, standard addition and   internal standard method.

2. **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, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift.

3. **Vibrational spectrum: (IR):**
   Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonicoscillator, energy   levels, zero point energy, conditions for obtaining vibrational spectrum,   selection rule, nature of spectrum.

4. **Vibrational-Rotational spectrum of diatomic molecule**
   Vibrating rotor, energy levels, selection rule, nature of spectrum, R and   P branches, an harmonic oscillator: energy levels, selection rule, fundamental band, overtones.
   Application of vibration rotation spectrum   in determining Force constant, determination and significance.
   Introduction to infrared spectra of simple molecules like H_2O and CO_2

5. **Raman Spectroscopy:**
   Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum , Stoke's lines, anti- Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion.(Example of CO_2molecule)

603.2	Pericyclic Reactions	15
	1. Three kinds of Pericyclic reactions	
	2. Molecular orbital and Orbital symmetry	
	3. Electrocyclic reactions (FMO-Approach)	
	4. 1,3-Dipolar cycloadditions	
	5. Cheletropic Reactions	
	6. Cycloaddition reactions (FMO-Approach)	
	7. Sigmatropic rearrangements	
	8. The ENE reaction	
	9. Pericyclic reactions in Biological systems	
	10. Summary of the selection rules for Pericyclic reactions.	
603.3	Electro-Analytical and Thermal methods	15
	Electro-Analytical methods:	
	1. Overview of electrode process, Electro-capillary curve and electro-capillary maximum potential.	
	2. Microelectrodes: mercury electrodes: Stationary mercury drop electrode (SMDE).Hanging mercury drop electrode (HMDE), Mercury film electrode (MFE), Carbon paste electrode and chemically modified electrodes.	
	3. Introduction to three electrode system, modern polarography and voltammetry :necessity and development of new voltammetric techniques and their comparison with classical DC polarography	
	4. Voltammetricmethods:Sampled DC polarography (TAST), Linear sweepvoltammetry (LSV), Cyclic voltammetry(CV), diagnostic criteria of cyclic voltammetry	
	Thermal methods:	
	5. Thermogravimetry (TG): Principle and Instrumentation, factors affecting thermogravimetric curves, Interpretation of thermogravimetric curves. applications of thermogravimetry	
	6. Differential thermal analysis (DTA) and Differential scanning calorimetry (DSC): Principle and instrumentation, heat flux and power compensated DSC, Interpretation of DTA and DSC curves applications of DTA and DSC	

Paper Code		Semester – Paper	Lectures
RUSBAS604		**Chemical Sciences VI**	**45**
	604.1	Spectroscopy –III	**15**
		1. **Infrared Spectrometry:** Diatomic Molecules. Polyatomic Molecules. Characteristic Vibration Frequencies. Factors Affecting Group Frequencies. Qualitative Analysis – The Identification of Structural Features. Quantitative Analysis. Sampling Procedures. Near Infrared Spectrometry. Applications of Infrared Spectrometry. 2. **NMR Spectrometery:** Chemical shift, Shielding and deshielding of protons, low resolution N.M.R. spectrum of methanol and ethanol. PMR Spectroscopy: Basic theory of NMR, Nature of PMR spectrum, Chemical shift (∂ unit), Standard for PMR, Solvents used, Factors affecting Chemical Shift: Inductive effect, Anisotropic effect (with reference to C=C, CΞC, C=O and benzene ring), Spin-spin coupling and coupling constant. Proton exchange application of deuterium exchange, Application of PMR in structure determination.	
	604.2	Hyphenated Techniques	**15**
		1. Introduction to hyphenated techniques 2. Need for hyphenation 3. Possible hyphenated techniques 4. Interfacing devices 5. Components of MS system (An overview) 6. Applications of LC-MS and GC-MS	
	604.3	Biochemical Methods of Analysis	**15**
		1. Electrophoresis: PAGE, SDS-PAGE, Western Blotting, 2D gel electrophoresis, AGE 2. ELISA 3. Centrifugation 4. Microarray	

RUSBASP603	**Practical**
	Separation of Organic mixtures:-

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

Separation Techniques:-
1. **HPTLC -** To develop the fingerprinting pattern of natural products
2. **HPLC -** Separation of modern drug (Diclofenac sodium) from their combination formulation.
3. **GC -** Separation of solvent mixtures (Methanol and Ethanol, Toluene and Methanol)

Spectroscopic Techniques:-
1. AAS
2. IR analysis of simple organic molecule**s**
3. NMR (Demo)

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

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 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	

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