Resolution number AC/II(20-21).2.RUS2

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: BSc

Program Code: RUSBCH

(Credit Based Semester and Grading System for academic year 2020–2021)

PROGRAM OUTCOMES

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

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Bachelor's Degree in SCIENCE program in the subject of BIOCHEMISTRY will be able to:**
PSO 1	Achieve better understanding of the major thrust areas of the disciplines like Chemistry of Biomolecules & their metabolism, Cell biology (Basics, Membrane biochemistry, Cancer), Enzymology, Genetics, Plant Biochemistry, Pharmacology, Microbiology & Immunology.
PSO 2	Gain acumen of the fundamental biochemical processes occurring at the molecular and gene level.
PSO 3	Understand the role of Biochemistry in food, human nutrition and environmental science.
PSO 4	Get insights into multiple important analytical tools for Biochemical testing and apply contextual knowledge and tools of biochemical research for problems solving.
PSO 5	Acquire and empower technical knowledge by connecting disciplinary and interdisciplinary aspects of biochemistry.
PSO 6	Compile and interpret Biological data using Biostatistics and Bioinformatics tools.
PSO 7	Express ideas persuasively through scientific writing and oral presentation which will help in the development of the leadership qualities.
PSO 8	Possess scientific temperament by research project-based learning.
PSO 9	Procure hands-on real time experience in industries.
PSO 10	Get exposure to the strong theoretical and practical understanding of various dimensions of Biochemistry and take up research-oriented courses in the fields of Biochemistry, Nutrition & Dietetics, Molecular Biology, etc.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
FYBSc	I	RUSBCH101	Biomolecules	2
		RUSBCH102	Cell Biology	2
		RUSBCHP101	Practicals based on RUSBCH101	1
		RUSBCHP102	Practicals based on RUSBCH102	1
	II	RUSBCH201	Physiology	2
		RUSBCH202	Basics Of Genetics	2
		RUSBCHP201	Practicals based on RUSBCH201	1
		RUSBCHP202	Practicals based on RUSBCH202	1
SYBSc	III	RUSBCH301	Analytical Techniques in Biochemistry	2
		RUSBCH302	Enzymology	2
		RUSBCH303	Metabolism I	2
		RUSBCHP301	Practicals based on RUSBCH301	1
		RUSBCHP302	Practicals based on RUSBCH302	1
		RUSBCHP303	Practicals based on RUSBCH303	1
	IV	RUSBCH401	Microbiology & Industrial Biotechnology	2
		RUSBCH402	Plant Biochemistry	2
		RUSBCH403	Metabolism II	2
		RUSBCHP401	Practicals based on RUSBCH401	1
		RUSBCHP402	Practicals based on RUSBCH402	1
		RUSBCHP403	Practicals based on RUSBCH403	1
TYBSc	V	RUSBCH501	Membrane Biochemistry & Cancer Biology	2.5
		RUSBCH502	Analytical Techniques & Introduction to Immunology	2.5
		RUSBCH503	Molecular Biology	2.5
		RUSBCH504	Biostatistics & Bioinformatics	2.5
		RUSBCHP501	Practicals based on RUSBCH501	1.5
		RUSBCHP502	Practicals based on RUSBCH502	1.5
		RUSBCHP503	Practicals based on RUSBCH503	1.5
		RUSBCHP504	Practicals based on RUSBCH504	1.5
	VI	RUSBCH601	Human Physiology & Pharmacology	2.5
		RUSBCH602	Food Biochemistry & Environmental Science	2.5
		RUSBCH603	Biochemistry of Metabolism	2.5
		RUSBCH604	Nutritional Biochemistry	2.5
		RUSBCHP601	Project Work	1.5
		RUSBCHP602	Practicals based on RUSBCH602	1.5

		RUSBCHP603	Practicals based on RUSBCH603	1.5
		RUSBCHP604	Practicals based on RUSBCH604	1.5

Course Code: RUSBCH101

Course Title: Biomolecules

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the classification, structures, biological significance of biomolecules - carbohydrates, proteins & lipids which forms the foundation of Biochemistry
CO 2	Acquire knowledge in quantitative & qualitative estimation and understanding the role and functions of biomolecules.
CO 3	Describe the chemistry that governs physical, chemical properties and reactions of carbohydrates, proteins and amino acids & lipids.
CO 4	Comprehend the classification and structures of several monosaccharides, disaccharides and polysaccharides, and explain their functions.
CO 5	Elucidate the structures of amino acid, peptide bond formation and classes of amino acids, identify the four levels of protein structure and summarize the function for a range of proteins.
CO 6	Categorize lipids, identify structure and functions of fats, phospholipids and cholesterol, and explain the structural differences between saturated, monounsaturated and polyunsaturated fatty acids with the functional implications.
CO 7	Enhance their ability to learn important reactions taking place in the biotic world to study metabolic pathways which will be utilized in higher classes of this program.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biomolecules RUSBCH101	Credits/ Lectures 2 Credits
I	**1**	**Carbohydrates**	**15L**
	1.1	Definition, Occurrence and functions of carbohydrates	2L
	1.2	Classification (Monosaccharides, Oligosaccharides, Polysaccharides)	
	1.3	Monosaccharides	3L
	1.3.1	Concept of aldoses and ketoses	
	1.3.2	Structures and significance of biologically important monosaccharides: glucose, fructose, galactose, mannose, and ribose.	
	1.4.1	Physical Properties: Chirality: Isomerism D & L, Stereoisomerism: Enantiomers and Diastereomers, Epimers and Anomers, Optical Isomers, Mutarotation	2L
	1.4.2	Chemical reactions: Oxidation to acidic sugars (Aldonic, Aldaric and Uronic acids) (with respect to glucose) Reduction to sugar alcohols (In boiling alkali, Enediol formation) (with respect to glucose and fructose) Osazone formation (with respect to glucose and fructose) Orcinol formation (with respect to ribose)	3L
	1.5	Disaccharides Occurrence and structure of Maltose, Lactose and Sucrose Chemical reaction: Formation of glycosidic bonds	2L
	1.6	Polysaccharides Classification based on structure, occurrence, properties and biological importance Composition: Homopolysaccharides and Heteropolysaccharides with examples Storage: Starch and Glycogen – action of amylase on starch Structural: Cellulose and Chitin	3L

	2	**Amino acids & Proteins**	**15L**
	2.1	Amino acid	3L
	2.1.1	Structure- D & L forms of all 20 amino acids	
	2.1.2	Detailed classification based on: Polarity, Nutritional classification (Essential & Non-essential)	
	2.2.1	Physical Properties: Zwitter ion, pI of amino acids and Amino acids as ampholytes	3L
	2.2.2	Chemical reactions of amino acids with Ninhydrin, Sanger's reagent, Edman's reagent and Dansyl chloride	
	2.3	Non-standard amino acids	2L
	2.4	Functions of amino acids (in brief)	
	2.5	Comparative overview of D- and L-amino acids	
II	2.6	Peptides and Proteins ASBC- APS classification on the basis of shape, Function and physical properties & solubilities (Simple, conjugated & derived proteins) Nutritional classification (Complete & incomplete proteins) Properties and colour reactions of proteins	2L
	2.7	Overview of Protein structure	3L
	2.8	A) Primary structure -Formation and characterization of the peptide bond B) Secondary structure -Alpha helix and beta sheet C)Tertiary and Quaternary structures- an introduction with one example of each	
	2.9	Protein denaturation	1L
	3	**Lipids**	**15L**
	3.1.1	Definition and function of lipids	2L
	3.1.2	Classification (Simple, Complex and Derived lipids)	
	3.2	Fatty Acids and Triacylglycerols	3L
III	3.2.1	Classification & Chemistry Saturated fatty acids - classification of C2 to C20 (even carbon). Common and IUPAC names Unsaturated fatty acids MUFA, PUFA (2,3,4 double bonds) Omega – 3, 6, 9 fatty acids Triacylglycerol - simple and mixed (names and structure)	
	3.2.2	Chemical Reactions of fats Saponification, Iodination, Ozonolysis, Auto-	4L

		oxidation, Action of heat on glycerol and choline, Rancidity Definition & significance - Acid number, Saponification number, Iodine number, Reichert - Meissel number	
	3.3	Compound Lipids Functions of glycerophospholipids Phosphosphingolipids (ceramide, sphingomyelin) Glycolipids / Cerebrosides (gluco & galactocerebrosides)	4L
	3.4	Steroids and Lipoproteins Steroids - Cholesterol structure and biochemical significance Lipoproteins – Types (Chylomicrons, VLDL, LDL and HDL) and biochemical significance	2L
		Practicals – RUSBCHP101	1 Credit
	1	Safety measures in laboratories.	
	2	Qualitative tests for carbohydrates	
	3	Qualitative test for amino acids, proteins.	
	4	Qualitative tests to detect the unknown carbohydrates and proteins from the given solution	
	5	Isoelectric precipitation of casein	
	6	Qualitative test for lipids	
	7	Saponification value of fat	
	8	Determination of the acid value of a fat	
	9	Estimation of Glycine by Soronsen's method	
	10	Determination of the iodine value of a fat	

References:

1. Lehninger, Albert L, Biochemistry, Kalyani Publishers
2. Zubay, Geoffrey L., Biochemistry; Wm. C. Brown publishers
3. Stryer, Lubert; W.H.; Biochemistry; Freeman publishers
4. U. Satyanarayan, U. Chakrapani; Biochemistry. Elsevier
5. Plummer, David T.; Introduction to practical biochemistry; Tata Mc. Graw and Hill publishers.
6. Biochemical methods by S Sadashivam & A Minackam, New Age International publisher.
7. Sawhney, S.K. and Singh, Randhir; Introductory practical biochemistry; Narosa Publishing House

Course Code: RUSBCH102

Course Title: Cell Biology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the structure and basic components of prokaryotic and eukaryotic cells and gain insights into its broad classification and differentiation.
CO 2	Acquire knowledge about morphology, types and functions of different types of cell organelles – Mitochondria, Chloroplast, Nucleus, Ribosomes, Endoplasmic Reticulum, Golgi Complex, Lysosomes and Peroxisomes
CO 3	Appraise the role of cytoskeleton and understand its different components, function and distribution.
CO 4	Illustrate the mechanism of cell to cell interaction and cell division, to explain structural and functional aspects of the cells.
CO 5	Provide in depth knowledge of cell cycle and its check points also to learn structure and functions of chromosomes and phases of cell cycle & division.
CO 6	Identify and describe the parts of microscope. To study the distinguishing features, principle components and applications of various types of light and electron microscope.
CO 7	Develop an analytical insight to understand the principle and methodology of centrifugation, different types & application of centrifuge and rotors.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Cell Biology RUSBCH102	Credits/ Lectures 2 Credits
I	**1**	**Cell Organelles**	**15L**
	1.1	Broad classification of cell types: prokaryotic and eukaryotic cells and their characteristics.	1L
	1.2	Cell wall and Cell membrane	3L
	1.3	Cell Organelles	3L
	1.3.1	Nucleus: Structure & Function of the nucleus, nuclear envelope, nuclear pore complex, nuclear matrix and nucleolus	
	1.3.2	Mitochondria & chloroplast: Structure, function, endosymbiont theory, genome	3L
	1.3.3	Ribosome: Structure & Function	
	1.3.4	Endoplasmic reticulum: RER and SER, Function	3L
	1.3.5	Golgi apparatus: Organization and function Brief overview of cotranslational and post-translational transport of proteins	
	1.3.6	Lysosome: Development of different forms of lysosomes, role in cellular digestion	3L
	1.3.7	Peroxisome: assembly, functions (H_2O_2 metabolism, fatty acid oxidation), glyoxysomes	
II	**2**	**Cytoskeleton, Cell-cell interaction & Cell cycle**	**15L**
	2.1	Introduction and Importance of Cytoskeleton	3L
	2.2	Types (Microtubules, Microfilaments & Intermediate Filaments)	
	2.2.1	Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies)	
	2.2.2	Microfilaments: Actin & Myosin, Cytoplasmic streaming	2L
	2.2.3	Intermediate Filaments: Anchoring cell junctions	
	2.3	Motor Proteins – Kinesins, Dyneins & Myosins	1L
	2.4	Cell - Cell Interaction	2L
	2.4.1	Cell-Cell Interactions and Cell-Matrix Interactions	
	2.2.4	Components of Extracellular Matrix: Collagen and Non-Collagen Components	
	2.4.3	Tight Junctions; Gap Junctions; Chemical synapses and Plasmodesmata	2L

	2.5	Role & Importance of Cell Interaction	
	2.6	Cell Cycle	2L
	2.6.1	Overview of Cell Cycle	
	2.6.2	Phases of Cell Cycle	
	2.6.3	Role of checkpoints	2L
	2.6.4	Regulation of cell cycle - Cyclins & CDKs	
	2.6.5	Cell Division (Mitosis and Meiosis)	1L
III	**3**	**Tools of Cell Biology (Microscopy & Centrifugation)**	**15L**
	3.1	Microscopy	3L
	3.1.1	Introduction and basic concept of Magnification, Resolving power, Numerical aperture, Limit of resolution, refractive index and role and RI of oil	
	3.1.2	Parts and functions of Compound microscope	
	3.1.3	Light microscope- Bright Field, Dark field, Phase contrast, Fluorescence microscopy (Immunofluorescence and FISH), Confocal Microscopy	4L
	3.1.4	Electron Microscopy	
	3.2	Centrifugation	2L
	3.2.1	Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient	
	3.2.2	Types and applications of centrifuges – Clinical, High speed, Ultra centrifuge - preparative and analytical.	3L
	3.2.3	Centrifuge rotors: vertical, fixed angle, swinging bucket	3L
	3.2.4	Types of centrifugation and its applications– Differential, Rate zonal, Isopycnic	
		Practicals – RUSBCHP102	1 Credit
	1	To study the parts of a microscope	
	2	Cytochemical staining of proteins by Methylene blue	
	3	Cytochemical staining of polysaccharides by PAS	
	4	To study different stages of mitosis by temporary preparation in onion root tip	
	4	To study of cell organelles by using electron micrographs	
	6	To isolate mitochondria by differential centrifugation	
	7	Staining and visualization of mitochondria by Janus Green Stain	
		Effect of hypotonic, isotonic and hypertonic	

	8 9	solutions on the cells Visualization of nuclear fraction by acetocarmine stain	

References:

1. Zubay, Geoffrey L., Biochemistry; Wm. C. Brown publishers
2. Stryer, Lubert; W.H.; Biochemistry; Freeman publishers
3. U. Satyanarayan, U. Chakrapani; Biochemistry. Elsevier
4. Stanier,Ingraham et al ,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
5. Analytical Biochemistry by David Holme
6. Biophysical Chemistry, Avinash Upadhyay
7. Keith Wilson & John Walker, Practical Biochemistry, principle and technique, Cambridge University, 5th edition
8. Plummer, David T.; Introduction to practical biochemistry; Tata Mc. Graw and Hill publishers.
9. Boyer, Rodney F., Modern experimental biochemistry
10. Sawhney, S.K. and Singh, Randhir; Introductory practical biochemistry ; Narosa Publishing House

Modality of Assessment (SEMESTER I)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 2 out of 3	04	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 2 out of 3	04	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 2 out of 3	04	UNIT III
Q3. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I & II
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I & II
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester I

Course	101			102			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course Code: RUSBCH201

Course Title: Physiology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Enumerate the biological significance and functions of water, acids, bases and buffers.
CO 2	Gain knowledge about the principles of pH measurement, acid-base, buffers and biological buffers its properties and determination of pH using electrodes.
CO 3	Explain difference between weak and strong acids/bases, recognize different ways of expressing concentrations of a solution.
CO 4	Develop practical aspects on study of water, acid, bases and buffers to understand the standardization of laboratory reagents and prepare buffer solutions at a given pH and concentration.
CO 5	Categorize fundamentals and application of physiology to study biological systems and regulate life processes.
CO 6	Comprehensively study digestion for absorption of nutrients through the digestive system.
CO 7	Summarize the flow of respiratory and excretory system and to broadcast its functioning.
CO 8	Holistically understand the different organ systems with respect to their biochemical events that co-ordinate working of the organ system.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Physiology RUSBCH201	Credits/ Lectures 2 Credits
I	**1**	**Water and Acids, bases & buffers**	**15L**
	1.1	Water	
	1.1.1	Water and its biological significance, water as a universal solvent.	
	1.1.2	Hydrogen bonding and structure	
	1.1.3	Concepts of mole, molar, molar equivalent and normal, Dalton	2L
	1.1.4	Ionization of water, weak acids and weak bases	
	1.1.5	Numericals based on the above concept	
	1.2	Acid and Bases	4L
	1.2.1	Definitions and Introduction of pH Scale, Measurements, Indicators, Strong and Weak Electrolytes	
	1.2.2	Titration Curve of glycine	
	1.2.3	Working of pH meter and glass electrode	1L
	1.3	Buffers	2L
	1.3.1	Mechanism of Buffer Action, Buffering Capacity	
	1.3.2	Preparation of Buffer Solutions – Acidic and Basic Expression of Hendersen–Hasselbalch equation, Henderson equation of acidic and basic buffer solution	4L
	1.3.3	Numericals based on the above concept	
II	**2**	**Digestion & Absorption**	**15L**
	2.1	Histology and Functions of gastro intestinal tract (GIT)	5L
	2.2	Organs and Glands associated with GIT	
	2.3	Secretions and Juices of GIT (Saliva, Gastric juice, Intestinal juice, pancreatic and Bile juice)	3L
	2.4	Introduction to digestion	3L
	2.4.1	Mechanism of Digestion and Absorption of carbohydrates, Lipids & Proteins	
	2.4.2	Physiology of Disorders related to digestive system - Peptic ulcer, Lactose Intolerance, Celiac disease, Pancreatitis	3L
III	**3**	**Respiration & Excretion**	**15L**
	3.1	Respiration	3L
	3.1.1	Components of Respiratory system and their	

		functions	
	3.1.2	Breathing - inspiration and expiration	
	3.1.3	Composition of air and partial pressure of gases	
	3.1.4	Physical exchange of gases - Transport of oxygen and carbon dioxide in blood	4L
	3.1.5	Respiratory disorders – Asthma, pharyngitis, laryngitis, hay fever, pneumonia, occupational lung disease (silicosis & asbestosis), cyanosis, respiratory acidosis and alkalosis	
	3.2	Excretion	3L
	3.2.1	Components of the Excretory system, Functional anatomy of kidney	
	3.2.2	Ultrastructure of nephron: Malpighian Body & Renal tubule	
	3.2.3	Juxta-Glomerular apparatus, Ultrafiltration, GFR (Pressures involved & Regulation)	3L
	3.2.4	Mechanism and Regulation of Urine formation	
	3.2.5	Normal & Abnormal constituents of urine	2L
	3.2.6	Excretory disorder: Nephritis	
		Practicals – RUSBCHP201	1 Credit
	1	Preparation & standardization of laboratory reagents	
	2	Quantitative estimation of normality of FAS	
	3	Demonstration of pH meter	
	4	Preparation of buffers, phosphate and acetate buffers	
	5	Determination of pKa of glycine	
	6	Study of the human digestive system	
	7	Determination of achromic point of salivary amylase	
	8	Estimation of total and free gastric juice acidity	
	9	Study of the human respiratory system using virtual lab	
	10	Study of the human excretory system using virtual lab	
	11	Biochemical profile of urine (Physical characteristics & Qualitative assay)	
	12	Titrable acidity using Neutral red or Phenol red	

References:

1. Keith Wilson & John Walker, Practical Biochemistry, principle and technique, Cambridge University, 5th edition
2. Frelfelder D- Physical Biochemistry

3. Skoog Douglas A – Principles of Instrumental Analysis Harcourt Brace publishers, London
4. Human Physiology –Chatterjee.C.C, Medical Allied Agency
5. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi
6. Textbook of Medical Physiology: Gyton and Hall, Elsevier publishers
7. Sawhney, S.K. and Singh, Randhir: Introductory practical biochemistry , Narosa Publishing House
8. Textbook of medical laboratory technology: Dr. Praful Godkar, Bhalani Publishing House

Course Code: RUSBCH202

Course Title: Basics of Genetics

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Describe the structure and function of nucleic acid strengthening the basic information of DNA and RNA, understanding nitrogenous bases, their bond formation & reactions of nucleic acids.
CO 2	Gain insights about types, structure and properties of nucleic acids
CO 3	Elaborate on central dogma to overview the process of Replication, Transcription and Translation
CO 4	Learn basic concepts of genetics and transmission of genetic information.
CO 5	Explain derivatives from Mendel's model of the inheritance of traits.
CO 6	Study of Human Pedigree analysis in understanding the inheritance of genes in humans
CO 7	Critically understand the components of DNA and the process of sequencing structural properties of chromosome.
CO 8	Recognize normal and abnormal karyotypes, describing the abnormalities in chromosomal number.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Basics of Genetics RUSBCH202	Credits/ Lectures 2 Credits
I	**1**	**Nucleic acids**	**15L**
	1.1.1	Introduction to nucleic acids	3L
	1.1.2	Structure - Purine & Pyrimidine bases, ribose, deoxyribose, nucleosides and nucleotides (ATP, CTP, GTP, TTP, UTP)	
	1.2	Formation of phosphodiester bond and shorthand representation of polynucleotide strand	1L
	1.3	RNAs (various types in prokaryotes and eukaryotes) mRNA, hnRNA, rRNA, snRNA & snoRNA - general account, tRNA - clover leaf model, Ribozymes	3L
	1.4	DNA	2L
	1.4.1	Physical evidence of DNA helical structure. Chargaff's rules (chemical evidence), Watson-Crick model of DNA & its features	
	1.4.2	Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density, UV absorption), Hypochromism, hyperchromism, denaturation of DNA.	3L
	1.5	Reactions of nucleic acids (with DPA and Orcinol)	1L
	1.6	Central Dogma of Life (Overview: Replication, Transcription, Translation & Reverse Transcription)	2L
II	**2**	**Mendelian Inheritance & Chromosomal Abnormalities**	**15L**
	2.1.1	Concept of alleles, genotype & Phenotype	2L
	2.1.2	Mendel's experimental design	
	2.2.1	Monohybrid cross- principle of segregation, Confirmation of principle using back cross	3L
	2.2.2	Dihybrid cross- principle of independent assortment	
	2.3	Deviation from Mendelian genetics	3L
	2.3.1	Multiple allele- ABO blood group, Drosophila eye colour, Relation of multiple allele with molecular genetics	
	2.3.2	Inheritance pattern of single gene- Wild type allele, Mutant allele, Dominant mutant allele & their effect on phenotype	2L
	2.4	Numericals based on above concepts	2L

	2.5.1	Concept of Genes and Chromosomes	3L
	2.5.2	Chromosomal abnormalities (Down's Syndrome, Klinefelter's Syndrome, Turner's Syndrome, Cri-du-chat syndrome, Philadelphia Chromosome)	
III	**3**	**Genome Organization & Human pedigree analysis**	**15L**
	3.1	Prokaryotic Genome: Organization of circular chromosome	1L
	3.2	Eukaryotic chromosomes: Organization of DNA into chromosomes (upto Solenoid structure)	2L
	3.3	DNA supercoiling, Topoismerase, Chromatin structure, Euchromatin, Heterochromatin, structure of condensed chromatin, Nucleosomes [Centromere, kinetochrome, telomere], Acetylation & deacetylation of histones, Role of Telomerase	5L
	3.4	Comparison of chromosomal structure in prokaryotes and eukaryotes	1L
	3.5	Transformation: Definition and transformation in *S.pneumoniae*	1L
	3.6	Transduction: Definition; Explain general features with one example	1L
	3.7	Conjugation: Mechanism, F+, F- and Hfr strain	1L
	3.8	Human Pedigree Analysis	3L
	3.8.1	Standard symbols used in pedigree analysis	
	3.8.2	Applications of pedigree analysis – Autosomal recessive and dominant traits, X-linked recessive and dominant traits, Y-linked traits	
	3.8.3	Problems based on this concept	
		Practicals – RUSBCHP202	1 Credit
	1	Qualitative test for nucleic acids	
	2	Cytochemical staining of RNA by Methyl Green Pyronin	
	3	Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes	
	4	Demonstration of induction of polyploidy in onion roots	
	5	Smear technique to demonstrate sex chromatin in buccal epithelial cells	
	6	Problems on Mendelian genetics –Mono & dihybrid cross, Back cross, Test cross	
	7	Isolation and spooling of DNA from onion/ moong	
	8	Study of abnormal human karyotype and pedigrees (dry lab)	

References:

1. Voet, D. and Voet, J.G. (2004) Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA. Biochemistry by Zubay, Geoffrey L.; Wm. C. Brown publishers
2. Zubay, Geoffrey L., Biochemistry; Wm. C. Brown publishers
3. Peter J. Russel , i-Genetics
4. Benamin Lewin, Gene VII , Oxford University Press
5. M.W. Strickberger, Genetics
6. Biochemical methods by S. Sadashivam & A. Minackam, New Age International publisher.Experiments in Molecular Biology - Biochemical Applications - Zachary F. Burton, Jon M. Kaguni

Modality of Assessment (SEMESTER II)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 2 out of 3	04	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 2 out of 3	04	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 2 out of 3	04	UNIT III
Q3. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I & II
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I & II
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester II

Course	201			202			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course Code: RUSBCH301

Course Title: Analytical Techniques in Biochemistry

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Demonstrate broad knowledge in basic analytical instrumentation with deep knowledge in its core concepts and its applications.
CO 2	Understand the principle, Instrumentation, working of spectroscopic techniques (Flame photometry & AAS) and its applications in various research fields
CO 3	Acquire knowledge about the basics and latest developments in Biochemical investigation tools and importance of plant and animal model in biochemical investigation
CO 4	Demonstrate skill to explain about principle, Bioinstrumentation and applications of protein purification techniques like Electrophoresis (IEF, 2D PAGE) and Chromatography and their applications in various research fields.
CO 5	Acquire cognitive, technical and creative skills which enables students to gain an established knowledge and practice concerning basic analytical instrumentation and measurement techniques
CO 6	Capable to choose and apply suitable analytical technique to identify different biomolecules
CO 7	Develop skill in carrying out research projects by employing the basic biochemical and molecular techniques.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Analytical Techniques in Biochemistry RUSBCH301	Credits/ Lectures 2 credits
I	**1**	**Spectroscopic techniques**	**15L**
	1.1	Concept of Electromagnetic radiation, Electromagnetic spectrum, Emission, Luminescence, Scattering, Transmittance, Absorbance	2L
	1.2	Flame Photometry	3L
	1.3	Principle, Components, Structure of flame, Interferences in analysis, Applications	2L
	1.4	Atomic Absorption Spectroscopy	5L
	1.5	Principle, Instrumentation and Applications	3L
II	**2**	**Biochemical Investigations**	**15L**
	2.1	Approaches to and levels of biochemical investigations	2L
	2.2	Whole animal and plant studies – the advantages and disadvantages of model systems for biochemical investigation (*E.coli*, Yeast, *Dictyostelium*, *C. elegans*, *Drosophila*, *Arabidopsis*)	4L
	2.3	Organ & Tissue studies	3L
	2.4	Isolated and cultured tissue and cell techniques : isolation, culture and counting of cells	
	2.5	Cell Fractionation:	3L
	2.5.1	Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme, organic solvent), temperature	
	2.5.2	Choice of suspension medium (isotonic & hypotonic solution, PBS) and separation methods	3L
	2.5.3	Problems of cell fractionation	
III	**3**	**Protein Purification Techniques**	**15L**
	3.1	Protein Isolation Selection of a Protein Source Methods of Solubilization Stabilization of Proteins Assay of Proteins	3L
	3.2	General Strategy of Protein Purification Solubilities of Proteins Effects of Salt Concentrations Effects of Organic Solvents Effects of pH	3L

		Crystallization	
	3.3	Ultracentrifugation- Preparative Ultracentrifugation	1L
	3.4	Chromatographic Separations- Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography	4L
	3.5	Electrophoresis- Gel Electrophoresis, SDS PAGE, Isoelectric Focusing	4L
		Practicals – RUSBCHP301	1 Credit
	1	Study of spectrophotometer	
	2	Determination of absorption maxima (λmax)	
	3	Estimation of glucose by DNSA method	
	4	Estimation of proteins using UV-absorbance and Biuret method	
	5	Estimation of proteins using Lowry method	
	6	Demonstration of flame photometer	
	7	Demonstration of separation of protein by SDS PAGE	
	8	Separation of proteins by gel filtration chromatography	
	9	Demonstration of separation of proteins using anion-exchange chromatography	
	10	Ammonium sulphate fractionation of proteins	
	11	Virtual lab – Study of model organisms in research	
	12	Isolation & Partial purification of an enzyme (Cell lysis, Centrifugation, salting out dialysis & size exclusion chromatography)	

References:

1. Principles & Techniques of Practical Biochemistry – Wilson, Walker- Cambridge Univ. Press.
2. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay and Nath – Himalaya Publ. House.
3. Analytical Biochemistry - David Holme & Hazel Peck - Pearson Education Ltd, England
4. Principles of Instrumental Analysis - Douglas A. Skoog, F. James Holler, Stanley R. Crouch – Thomson Brooks/Cole
5. Cell Biology: Essential techniques – David Rickwood – Wiley
6. Cell Separation A practical Approach – D. Fisher, G E Francis and D Rickwood – Oxford University Press
7. A.L., Lehninger, Principles of Biochemistry (1982), Worth Publishers, Inc. New York.
8. Protein Purification: Principles, High Resolution Methods, and Applications (Methods of Biochemical Analysis), Jan-Christer Janson, 2011.
9. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
10. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International
11. An Introduction To Practical Biochemistry - Plummer David

Course Code: RUSBCH302

Course Title: Enzymology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Have a deeper insight in to the fundamentals enzyme properties, nomenclatures, characteristics and mechanisms
CO 2	Describe structure, functions and the mechanism of action of enzymes. Learning kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity
CO 3	Apply biochemical calculation for enzyme kinetics.
CO 4	Discuss the factors affecting enzymatic reactions.
CO 5	Describe the concepts of co-operative behaviour, enzyme inhibition and allosteric regulation
CO 6	Compare methods for production, purification, characterization and immobilization of enzymes.
CO 7	Describe the major applications of enzymes in industry, understand the principles of enzyme immobilisation techniques and enzyme extraction procedures
CO 8	Develop new ideas for the development of enzyme-based diagnostic kits
CO 9	Discuss various application of enzymes that can benefit human life
CO 10	Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Enzymology RUSBCH302	Credits/ Lectures 2 credits
I	**1**	**Introduction to enzymes**	**15L**
	1.1	Introduction to enzymology	4L
	1.1.1	Understanding the basic terminology in enzymology Enzyme, Apoenzyme, Holoenzyme, Prosthetic group, Active site, Turnover number, Specific activity, Katal, IU, Coenzyme and Cofactor	
	1.1.2	Proteolytic cleavage of zymogens and enzyme denaturation	
	1.2	Classification of enzyme- IUB system	
	1.3	Principle types of reactions catalysed by enzymes	4L
	1.3.1	Group transfer reactions – Acyl group transfer, Phosphoryl group transfer, Glycosyl group transfer	
	1.3.2	Oxido-reduction reactions	
	1.3.3	Elimination, isomerization and rearrangement reactions	
	1.4	Enzyme specificity	4L
	1.4.1	Theories of specificity of enzyme : Fischer's, lock & key and Koshland's, induced fit theories	
	1.4.2	Characteristics of enzymes and enzyme substrate complex	
	1.4.3	Concept of active center, binding sites, Stereo specificity and ES complex formation	
	1.5	Enzyme activity	3L
	1.5.1	Factors affecting enzyme activity	
	1.5.2	Concept of activation energy and transition state theory	
II	**2**	**Enzyme – kinetics, regulation, inhibition**	**15L**
	2.1	Enzyme kinetics	4L
	2.1.1	Derivation of Michaelis - Menten equation and Lineweaver Burke equation and Graphical procedures for monosubstrate reactions	
	2.1.2	Significance of Vmax & Km	
	2.2	Enzyme regulation	4L
	2.2.1	Introduction & its importance	
	2.2.2	Types of regulatory mechanisms- Product inhibition, Feedback	
	2.3	Enzyme inhibition	4L

	2.3.1	Types of inhibitors- Competitive, Non-competitive and Uncompetitive, and their mode of action and experimental determination considering suitable example.	
	2.3.2	Graphical understanding of effect of different inhibitors on enzyme kinetics (Use of LB Plot)	
	2.3.3	Numericals based on the above concepts	3L
III	**3**	**Immobilized enzymes and Application of enzymes**	**15L**
	3.1	Immobilized enzymes	7L
	3.1.1	Introduction	
	3.1.2	Importance of immobilization	
	3.1.3	Methods of immobilization- Ionic bonding, Adsorption, Covalent bonding (based on R group of amino acids), Microencapsulation and Gel entrapment	
	3.1.4	Enzyme extraction and optimum conditions, kinetics of immobilized enzyme	3L
	3.1.5	Industrial examples related to the technique	
	3.1.6	Problems associated with enzyme immobilization	
	3.2	Application of enzymes	3L
	3.2.1	Isoenzymes. Applications of enzymes in research.	
	3.2.2	Application of enzymes in diagnostics	
	3.2.3	(SGPT, SGOT, creatine kinase, alkaline and acid phosphatases),	2L
	3.2.4	Enzyme immunoassay (HRP),	
		Practicals – RUSBCHP302	1 Credit
	1	Extraction of β-Amylase, Urease & Invertase from suitable sources	
	2	Determination of optimum pH of β-Amylase	
	3	Determination of optimum temperature of β-Amylase	
	4	Determination of Km and Vmax of β-Amylase	
	5	Assay to determine enzyme activity and specific activity	
	6	Study the effect of inhibitor on β-Amylase	
	7	Comparative assessment of the β-Amylase activity in free and immobilized state	
	8	Immobilization of Yeast and its use in determination of Invertase activity	
	9	Demonstration of separation of isoenzymes of LDH by electrophoresis	

References:

1. A.L., Lehninger, Principles of Biochemistry (1982), Worth Publishers, Inc. New York.
2. Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc.
3. Textbook of medical physiology - A. C. Gyton, and J. E Hall - Saunders Elsevier Publications
4. Advances in Enzymology and Related Areas of Molecular Biology, Mechanism of Enzyme Action - Daniel Purich
5. Medical Biochemistry - Ramakrishnan (2012)
6. Molecular and cellular enzymology - Jeannine Yon-Kahn, G. Hervé
7. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
8. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International

Course Code: RUSBCH303

Course Title: Metabolism I

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the overall concept of cellular metabolism – anabolic and catabolic pathways, energy storage and release, production of building blocks for macromolecule synthesis.
CO 2	Understand the relationship between the properties of macromolecules and cellular activities, cell metabolism and chemical composition.
CO 3	Illustrate the reactions involved in the metabolic pathways of biomolecules
CO 4	Explain glucose homeostasis (pathways and hormonal regulation). Discuss Krebs cycle, electron transport, and the pentose phosphate pathway
CO 5	Describe common pathways of amino acid catabolism to release ammonia (handled by the urea cycle) and carbon skeletons.
CO 6	Differentiate between ketogenic and glucogenic amino acids, and diseases resulting from defective catabolism (phenylketonuria, maple syrup urine disease) and biosynthesis of non-essential amino acids.
CO 7	Describe the structure, biosynthesis, oxidation and storage of fatty acids.
CO 8	Deeply understand the metabolic pathways of cholesterol

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Metabolism I RUSBCH303	Credits/ Lectures 2 Credits
I	**1**	**Carbohydrate Metabolism**	**15L**
	1.1	Overview of glucose metabolism	4L
	1.1.1	Glycolysis- Salient features, reactions,	
	1.1.2	Conversion of pyruvate to lactate & its significance	
	1.1.3	Irreversible reactions of glycolysis	
	1.1.4	Regulation of glycolysis	
	1.2	Conversion of pyruvate to Acetyl CoA- Role of Pyruvate dehydrogenase complex & its regulation	1L
	1.3	Citric acid cycle- Pathway with reactions & its regulation	3L
	1.4	Glycogenolysis – [schematic – no structures, but with enzymes and coenzymes]	1L
	1.5	HMP shunt (Cellular location, sequence of reactions, multifunctional nature)	2L
	1.6	Gluconeogenesis, Glycogenesis – [schematic – no structures, but with enzymes and coenzymes]	3L
	1.7	Glyoxylate pathway	1L
II	**2**	**Amino acid metabolism**	**15L**
	2.1.1	Chemical nature, functional groups and reactivity of amino acids	4L
	2.1.2	Reactions of amino acids: Deamination, Transamination , Decarboxylation , Transmethylation, Transdeamination, Ammonia formation, transport and detoxification in brain and liver.	
	2.2	Urea cycle & its regulation	3L
	2.3	Metabolism of significant amino acids– Glycine, Phenylalanine, Tyrosine, Tryptophan	4L
	2.4	Formation of specialized products from amino acids and their functions-glutathione, creatine, creatinine, biogenic amines (dopamine, norepinephrine, GABA, Histamine)	4L
III	**3**	**Lipid metabolism**	**15L**
	3.1	Introduction to lipid metabolism	5L
	3.1.1	Lipid Digestion, Absorption, and Transport	
	3.1.2	Fatty Acid Oxidation-Fatty Acid Activation, Transport Across the Mitochondrial Membrane,	

		Beta-Oxidation	
	3.1.3	Oxidation of Unsaturated Fatty Acids	
	3.1.4	Oxidation of Odd-Chain Fatty Acids	
	3.2	Ketone Bodies	2L
	3.3	Fatty Acid Biosynthesis- Pathway Overview, Acetyl CoA Carboxylase, Fatty Acid Synthase, Transport of Mitochondrial Acetyl-CoA Into the Cytosol, Elongases and Desaturases,	3L
	3.4	Synthesis of Triacylglycerols	1L
	3.5	Regulation of Fatty Acid Metabolism	1L
	3.6	Cholesterol Metabolism- Cholesterol Biosynthesis, Control of Cholesterol Biosynthesis and Transport, Cholesterol Utilization	3L
		Practicals – RUSBCHP303	1 Credit
	1	Estimation of glucose by the Folin-Wu method	
	2	Estimation of glucose by the GOD-POD method	
	3	Demonstration of glucose metabolism using handheld glucometer	
	4	Assay of serum transaminases – SGOT and SGPT	
	5	Estimation of serum urea.	
	6	Estimation of serum creatinine.	
	7	Assay of glutamate dehydrogenase	
	8	Lipid Profile –	
	a	Estimation of total cholesterol and HDL	
	b	Estimation of Triglycerides	
	c	Estimation of LDL by calculation	
	9	Field trip to pathology lab/super-speciality hospitals	

References:

1. Biochemistry - U. Sathyanarayana - Books and Allied (P) Ltd. Kolkata.
2. Biochemistry - Voet, D. and Voet, J.G. - John Wiley & Sons, Inc. USA.
3. Biochemistry by L. Stryer W.H. Freeman Press, San Francisco, USA.
4. Outlines of Biochemistry - E.E. Conn and P.K. Stumpf – Wiley Eastern, New Delhi.
5. Text book of Biochemistry - J.L Jain
6. Text Book of Biochemistry - D.M. Vasudevan
7. Text Book of Biochemistry - A.C. Deb, 9th revised edition (2017)
8. Biochemistry - Garret, R.H. and Grisham, C.M. (2005) Thomson Learning INC.
9. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
10. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International
11. An Introduction to Practical Biochemistry - Plummer David

Modality of Assessment (SEMESTER III)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Model making/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 2 out of 3	04	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 2 out of 3	04	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 2 out of 3	04	UNIT III
Q3. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I, II & III
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I, II & III
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester III

Course	301			302			303			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150

Course Code: RUSBCH401

Course Title: Microbiology & Industrial Biotechnology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Demonstrate practical skills in microscopy and handling techniques related to it and staining procedures
CO 2	Apprehend the basic microbial structure and function and study the structural similarities and differences among various physiological groups of microorganisms
CO 3	Know various Culture media and their applications in order to apply them for the industrial production
CO 4	Acquire information about large scale production and purification of various industrially important produces.
CO 5	Appreciate how microbiology is applied in manufacture of industrial products
CO 6	Appreciate the different types of fermentation processes
CO 7	Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively
CO 8	Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer and Understand the rationale in medium formulation & design for microbial fermentation
CO 9	Procure information about types and applications of biosensors in the field of biology
CO 10	Appreciate the technological advances in the field of Biosensors and get fascinated with the advances in the research field and try to pursue them.
CO 11	Quantitative estimation of biomolecules like vitamins & antibiotics will help in understanding their efficacy

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Microbiology & Industrial Biotechnology RUSBCH401	Credits/ Lectures 2 Credits
I	**1**	**Introduction to Microbiology**	**15L**
	1.1	Historical background (contributions or Leeuwenhoek. Pasteur, etc) and General characteristics (size, shape, and structure) of Bacteria	2L
	1.2	Microbial Taxonomy: Microbial species and strains. Classification of bacteria based on morphology (shape and flagella). staining reaction, nutrition and extreme environment (extremophiles: Thermophiles, Psychrophiles, Halophiles, Magnetotactic, Radiation resistant organisms: examples with their application)	4L
	1.3	Bacterial cell wall: Structure and function, components of peptidoglycan framework	2L
	1.4	Staining methods (principles of staining & types or stains) and microscopic identification of bacteria	3L
	1.5	Microbial Growth - Growth Curve, Mathematical expression, Synchronous growth, Generation time	2L
	1.6	Culture media (N, C, Special requirements), Natural and Synthetic media	2L
II	**2**	**Fermentation Technology**	**15L**
	2.1	Basics of fermentation	1L
	2.2	Types of fermentation processes based on the products formed (biomass, enzymes, metabolites, recombinant products, transformation process to modify a product)	5L
	2.3	Stages of a typical fermentation process	2L
	2.4	Media preparation and optimization based on biochemical parameters	2L
	2.5	Sterilization and disinfection techniques	3L
	2.6	Basic design of fermenter	2L
III	**3**	**Industrial Biotechnology**	**15L**
	3.1	Introduction	3L
	3.2	Recovery and purification of fermented products	
	3.3	Industrial synthesis of different products obtained from Bioprocess technology	6L
	3.3.1	Penicillin, Vit B_{12}, Cheese, Amylase, Protease,	

		Ethanol, Acetic Acid	
	3.3.2	Biosensors, Features of biosensors Types of Biosensors based on: Enzymes (environmental monitoring) Antibodies (detection of pathogens) Nucleic acids & Aptamers (clinical diagnosis)	6L
		Practicals – RUSBCHP401	1 Credit
	1	Testing of Air micro-flora by plate exposure technique	
	2	Demonstration of Micrometry	
	3	Permanent slides of Nostoc & Rhizopus	
	4	Staining Techniques – Gram staining, Capsule staining, endospore staining, lipid staining	
	5	Study of microbial growth curve	
	6	Cell count in a culture medium using optical density (We use serial dilution method and analyse using colorimeter)	
	7	A study of culture inoculation methods – Pour plate, Spread plate & Streak plate	
	8	Determination of minimum inhibitory concentration of any one disinfectant	
	9	Antibacterial activity testing using disc diffusion and agar well method	
	10	Determination of percentage purity of acetic acid in vinegar solution	
	11	Estimation of vitamin C by dichlorophenol dye method	
	12	Bioassay of penicillin by agar diffusion method	
	13	Bioassay of Vitamin B12 by agar diffusion method	

References:

1. Microbiology - M. Pelczar, E.C.S. Chan and M.R. Krieg - McGraw Hill Inc., Singapore (1997).
2. General Microbiology, Vol. I & II – Powar, Daginawala – Himalaya Publishing House. (2015).
3. General Microbiology – Stanier, Adelberg, Ingraham – The Macmillan Press, London (1987)
4. Industrial microbiology - A.H. Patel - Macmillan India Ltd.
5. Industrial microbiology - L. E. Casida - New age international publishers
6. Microbial Biochemistry - G. N. Cohen
7. Industrial Fermentation - Paul Allen
8. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
9. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International

Course Code: RUSBCH402

Course Title: Plant Biochemistry

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Study the structural details of the plant cell
CO 2	Illustrate the chemistry of different plant pigments in order to explore their isolation, characterization and applications in various fields
CO 3	Explain and understand the biochemistry of photosynthetic process and its relation to man and its environment.
CO 4	Understand the mechanism of Nitrogen fixation and its importance in agricultural production and environment
CO 5	Acquire knowledge about the importance of secondary metabolites and its industrial applications.
CO 6	Identify the class and functions of secondary metabolites and appreciate their role in physiology of plants
CO 7	Know the significance of plant growth regulators in the development of plants
CO8	Understand the basics of plant tissue culture as it is an important tool for both basic and applied aspects of plant based research
CO9	Become competent to explain relation between Photosynthesis, growth hormones and Plant growth
CO10	Develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Plant Biochemistry RUSBCH402	Credits/ Lectures 2 Credits
I	**1**	**Plant cell structure, plant pigments & nitrogen metabolism**	**15L**
	1.1	Introduction to Plant cell	8L
	1.1.1	Plant cell wall (structure), Vacuole (tonoplast membrane), plasmodesmata, plastids and other cell organelles	
	1.1.2	Overview of Leaf structure – Upper epidermis, palisade mesophyll, spongy mesophyll, lower epidermis, Guard cells and stomata	
	1.1.3	Specialized plant cells (in brief) – Parenchyma, Sclerenchyma, Collenchyma, Xylem and phloem	
	1.1.4	Concept of apoplast, apoplastic and symplastic pathways	
	1.2	Plant pigments –	4L
	1.2.1	Primary pigment - Chlorophyll (Types and function)	
	1.2.1	Role of accessory pigments and their biological significance Carotenoids, Xanthophylls, Betalains, Anthocyanins and other flavonoids	
	1.3	Nitrogen metabolism	3L
	1.3.1	Sources of Nitrogen, different forms of nitrogen in plants	
	1.3.2	Conversion of nitrate to nitrite & finally to ammonia, biological nitrogen fixation in plants	
II	**2**	**Plant Biochemistry**	**15L**
	2.1	Photosynthesis	4L
	2.1.1	Light reactions: Light harvesting complexes, Absorption of light, Photophoshorylation: Cyclic and Non-cyclic (Z scheme)	
	2.1.2	Dark reactions: Calvin cycle, regulation of Clavin cycle	3L
	2.2	C4 cycle and CAM pathway	
	2.3	Photorespiration	2L
	2.4	Photoperiodism and photoinhibition	
	2.5	HMP shunt – Oxidative phase & Non-oxidative	1L
	2.6	Synthesis of glucose, starch, sucrose	1L
	2.7	Physiology of plant movements	4L

		Physical movements – Xerochasy, Hydrochasy Vital movements – Protoplasmic streaming, paratonic movements Tactic movements – Chemotaxis, Phototaxis, Thermotaxis Tropic movements – Chemo / geo / hydro / photo / thigmo tropism Nastic movements – Seismonasty, Nyctynasty, Photonasty, Chemonasty, Thermonasty	
III	**3**	**Regulation of plant growth, secondary metabolites & PTC**	**15L**
	3.1	Plant Growth Substances Structure and Function of - Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic Acid	3L
	3.2	Secondary metabolites of plants Nitrogen containing compounds (Alkaloids), Terpenes & Phenolic compounds – An introduction to Shikimic acid pathway, Mevalonic acid pathway, MEP Pathway	5L
	3.3	Plant Tissue-culture	7L
	3.3.1	Introduction; Plant breeding; Techniques for maintenance	
	3.3.2	Genetic culture techniques: Callus regeneration, mutant selection from culture; Protoplast fusion, Transformation	
	3.3.3	Applications of PTC	
		Practicals – RUSBCHP402	1 Credit
	1	Study the photosynthetic O2 evolution in hydrilla plant	
	2	Isolation of chloroplast from spinach leaves and estimation of chlorophyll content	
	3	Separation of photosynthetic pigments by TLC	
	4	Isolation of starch from potato	
	5	Estimation of carotene in fruits and vegetables	
	6	Estimation of anthocyanin content in vegetable	
	7	Separation of plant pigments by Adsorption	
	8	Column Chromatography/TLC	
	9	Phytochemical Screening Using Suitable Source	
	10	Estimation of Total Phenolic Content	
	11	Estimation of Flavonoids Content	
	12	Study of Plant Tissue Culture techniques	

References:

1. Biochemistry & Molecular Biology of Plants - Bob B. Buchanan - Wilhelm Gruissem and Russel L. Jones
2. Plant Biochemistry - Heldt H.-W., Piechulla B.
3. Methods in plant biochemistry and molecular biology - Dashek, William V
4. Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet - Alan Crozier
5. Plant Physiology - Taiz and Zeiger - Sinauer Associates Inc.
6. Plant Biochemistry - Caroline Bowsher, Martin steer, Alyson Tobin - Garland science
7. Plant Biochemistry - P.M Dey and J.B. Harborne - Academic Press
8. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers

Course Code: RUSBCH403

Course Title: Metabolism II

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand simple concepts related to metabolism, metabolic roles played by vitamins and minerals, appreciate the correlation between energy molecules, reducing equivalents and their role in metabolic pathways.
CO 2	Comprehend the pathways and cycles of nucleic acid metabolism.
CO 3	Describe the interrelationship between metabolic pathways of different biomolecules and their interdependence
CO 4	Appreciate the importance of enzymes and coenzymes in pathophysiology of diseases.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Metabolism II RUSBCH403	Credits/ Lectures 2 credits
I	**1**	**Metabolism of Vitamins and Co-enzymes**	**15L**
	1.1	Water soluble vitamins	7L
	1.1.1	Vitamin B complex(Chemistry of the vitamin & its coenzyme form, Biochemical role and disorders) – Thiamin, Riboflavin, Niacin, Pyridoxine, Biotin, Lipoic acid:- Chemistry of the Vitamin and its coenzyme form [structure not to be done, only group involved in its activity]	
	1.1.2	Vitamin C	
	1.2	Fat soluble vitamins A,D,E,K (Chemistry of the vitamin & its coenzyme form, Biochemical role and disorders) –	
	1.2.1	Vitamin A – Chemistry, Wald's Visual cycle and role of Rhodopsin (with structure), Transducin, cGMP in vision; Deficiency disorders (Night Blindness, Xerosis Conjunctiva, Xerosis Cornea, Bitot's Spots, Keratomalacia, Follicullar Hyperkeratosis)	4L
	1.2.2	Vitamin D – role in Ca absorption and mobilization, Deficiency disorders (Rickets, Osteomalacia);	2L
	1.2.3	Vit E and Vit K– physiological role (Vitamins D, E, K no structures)	2L
II	**2**	**Nucleic Acid Metabolism & Integration of Metabolism**	**15L**
	2.1	Metabolism of Purine and pyrimidine	6L
	2.1.1	Biosynthesis and degradation	
	2.1.2	Salvage pathway	
	2.1.3	Inhibitors	1L
	2.2	Integration of metabolism	
	2.2.1	Integration of major metabolic pathways of energy metabolism	1L
	2.2.2	Organ specialization and metabolic integration – Liver, Adipose tissues, Skeletal muscle, Brain, Kidney	4L
	2.2.3	Metabolism of starvation - Liver, Adipose tissues, Skeletal muscle, Brain	3L
III	**3**	**Metabolic disorders**	**15L**
	3.1	Inborn error: With respect to Etiology and Clinical	1L

		manifestations	
	3.2	Disorders related to Carbohydrate Metabolism: Glycogen storage diseases and its types, Glucose-6-phosphate dehydrogenase deficiency disease, Wernicke-Korsakoff syndrome, Fabry's disease Classical galactosemia, essential fructosuria	4L
	3.3	Disorders related to Amino acid Metabolism: Hyperammonemia, Glycinuria, Phenyl ketonuria, Tyrosinemia & its types, Alkaptonuria, Albinism, Metabolic disorders of urea cycle, Hartnup's disease, Cystinuria, Cystinosis, Homocystinuria &its types, Maple syrup disease	4L
	3.4	Disorders related to Lipid Metabolism: Wolman disease Disorders of Fatty acid oxidation – Genetic deficiencies in carnitine transport and Acyl CoA dehydrogenase (Jamaican vomiting sickness, SIDS), Refsum's disease Disorders of Sphingolipids – Neimann-Pick, Farber's disease, Tay-Sach's and Sphingolipidoses Disorders of lipoprotein metabolism – Hypo and hyper lipoproteinemias, Deficicency of LDL receptors Disorders of glycolipids – Gaucher & Krabbe's disease	4L
	3.5	Disorders related to Nucleic acid Metabolism: Purine metabolism disorders (Gout and its types, Lesch-Nyhan syndrome), Pyrimidine metabolism disorders (Orotic aciduria, Reye's syndrome)	2L
		Practicals – RUSBCHP403	1 Credit
	1	Estimation of Vitamin A by Carr Price method	
	2	Estimation of tocopherol by Mary & Quaife method	
	3	Estimation of vitamin C iodometrically	
	4	Estimation of Thiamine by Thiochrome method	
	5	Estimation of Riboflavin by Slater method	
	6	Estimation of serum uric acid by phosphotungstic acid method (Caraways method)	
	7	Use of softwares to understand metabolism – KEGG, Ecocyc, Metacyc, Biocyc	
	8	Case study and questionnaire designing for survey on metabolic disorders	

References:

1. Biochemistry - U. Sathyanarayana - Books and Allied (P) Ltd. Kolkata.
2. Biochemistry - Voet, D. and Voet, J.G. - John Wiley & Sons, Inc. USA.
3. Biochemistry by L. Stryer W.H. Freeman Press, San Francisco, USA.
4. Outlines of Biochemistry - E.E. Conn and P.K. Stumpf – Wiley Eastern, New Delhi.
5. Text book of Biochemistry - J.L Jain
6. Text Book of Biochemistry - D.M. Vasudevan
7. Text Book of Biochemistry - A.C. Deb, 9th revised edition (2017)
8. Biochemistry - Garret, R.H. and Grisham, C.M. (2005) Thomson Learning INC.
9. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
10. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International
11. An Introduction To Practical Biochemistry - Plummer David

Modality of Assessment (SEMESTER IV)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Model making/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 2 out of 3	04	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 2 out of 3	04	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 2 out of 3	04	UNIT III
Q3. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I, II & III
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I, II & III
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester IV

Course	401			402			403			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150

Course Code: RUSBCH501

Course Title: Membrane Biochemistry & Cancer Biology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the importance of carbohydrates, lipids and proteins as a structural component of biomembranes.
CO 2	Summarize the composition and structure of biomembranes, transport mechanisms across biological membranes.
CO 3	Illustrate the mechanism of oxidative phosphorylation, photophosphorylation and basic concept of Bioenergetics
CO 4	Learn the concept and mechanism of ATP synthesis
CO 5	Describe factors that contribute to cancer development, discuss cancer prevention and currently available therapeutic treatments.
CO 6	Develop an understanding on various genetic and molecular changes which takes place during transformation into malignant cells.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Membrane Biochemistry & Cancer Biology RUSBCH501	Credits/ Lectures 2.5 Credits
I	**1**	**Biomembranes & Cell Surface**	**15L**
	1.1	Overview of membrane functions	2L
	1.2	Fluid mosaic model	
	1.3	Chemical Composition of Membranes	3L
	1.3.1	Membrane lipids (Phospholipids, Glycolipids, sterols (Cholesterol), Lipid rafts	
	1.3.2	Membrane proteins - Classification- Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins Peripheral Proteins- Spectrin on RBC Integral Membrane Proteins- Glycophorin A on RBC Lipid-Anchored proteins- Role of GPI anchored protein in blood grouping	8L
	1.3.3	Membrane carbohydrate – Role of membrane glycoproteins	2L
II	**2**	**Membrane Transport, Vesicular Transport and Membrane Fusion**	**15L**
	2.1	Introduction to the transport mechanism across cell membrane	3L
	2.2	Passive transport – Passive diffusion (Polar & Non polar),diffusion and osmosis, facilitated diffusion of ions and molecules	
	2.3	Ion channels- Ligand gated, mechanical gated, Voltage gated	3L
	2.4.1	Primary Active transport ATPases pump- Na^+-K^+ Pump, ABC transporter	2L
	2.4.2	Secondary active transports Symport (Mechanism of Absorption of peptides by eneterocytes)	2L
	2.5	Specialized ion channels- Aquaporins	3L
	2.6	Antiport -Absorption of peptides by eneterocytes,	
	2.7	Artificial membrane vesicle-Liposomes, Micelles	2L
III	**3**	**Bioenergetics & Oxidative Phosphorylation**	**15L**
	3.1.1	Principle of Bioenergetics	2L
	3.1.2	Importance of thermodynamics, concept of Gibb's free energy, enthalpy, entropy, Standard free	3L

		energy change and equilibrium constant	
	3.2	Oxidative phosphorylation Electron transfer reactions in mitochondrion (Complexes I to IV; Q cycle in Complex III)	4L
	3.3	Structure of ATP synthase and ATP synthesis Models for ATP synthesis - chemiosmotic model & Rotational Catalysis	4L
	3.4	Inhibitors & Uncouplers of ETC and ATP synthesis	2L
IV	**4**	**Cancer Biology & Apoptosis**	**15L**
	4.1.1	Introduction to the biology of cancer	2L
	4.1.2	Difference between tumor and Cancer	
	4.2.1	Classification of tumor	2L
	4.2.2	Properties of cancer cells	
	4.3	Cell cycle regulators and cancer	1L
	4.4.1	Oncogene- Ras protein	2L
	4.4.2	Tumor suppressor gene- Role of P53, Comparison between functional & Non Functional p53	
	4.5	Assays – Trypan blue exclusion method, MTT assay, Soft Agar Colony Formation Assay	2L
	4.6	Cancer therapy -	2L
	4.6.1	Chemotherapy (purine & pyrimidine analog)	
	4.6.2	Demethlyating agents	
	4.7	Apoptosis –	2L
	4.7.1	Properties of apoptotic cells	
	4.7.2	Difference between apoptosis and Necrosis	
	4.7.3	Role of caspases in apoptosis	
	4.7.4	Mechanism (Intrinsic & Extrinsic pathway)	2L
		Practicals – RUSBCHP501	1.5 Credits
	1	Osmosis across dialysing membrane	
	2	Diffusion rate of $KMnO_4$	
	3	Study the differential permeability of a semi-permeable membrane	
	4	Effect of temperature and molecular weight on diffusion	
	5	Visualization of cells by methylene blue	
	6	Study of viability of cells using Neutral red Assay	
	7	Mitochondrial respiration and effect of different Inhibitors for ETC (Dry lab)	

References:

1. Jain MK. Introduction to Biological membranes, John Wiley and sons New York, 1988
2. Vance DE & Vance JE, Biochemistry of lipids and Biomembranes, Benzamin Cummings 1985
3. Biomembranes by RB Gennis Springer Verlag 2012 2nd edition
4. Jones MN & Chapman D. Micelles monolayers and biomembranes Wiley-Lis New York, 1995
5. Molecular Biology of Cell: Bruce Alberts, 4th Edition, Garland Science
6. Weinberg RA. The Biology of Cancer, Second Edition, NewYork: GarlandScience,2013.
7. Ruddon RW. Cancer Biology, fourth edition, Oxford University Press, USA.
8. Biochemistry by Voet & Voet, International student version
9. Lehninger's - Principles of Biochemistry by David L. Nelson
10. Introductory Practical Biochemistry by Sawhney
11. Practical Biochemistry by David Plummer
12. Biochemical methods by S Sadashivam & A Minackam, New Age International publisher.

Course Code: RUSBCH502

Course Title: Analytical Techniques & Introduction to Immunology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand isolation, culture and counting of cells and model organisms used in research.
CO 2	Describe the separation & purification techniques for proteins & techniques to quantify biomolecules.
CO 3	Develop an understanding of the characteristics and the nature of antigen – antibody reactions
CO 4	Justify the role of immune cells and their mechanism in body defence system
CO 5	Illustrate various mechanisms that regulate immunological response and how it's triggered and regulated
CO 6	Learn different tools & techniques used in diagnosis like Radioimmunoassay, ELISA, Immunofluorescence, Western Blotting, etc.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Analytical Techniques & Introduction to Immunology RUSBCH502	Credits/ Lectures 2.5 Credits
I	**1**	**Biochemical Investigation**	**15L**
	1.1	Approaches to and levels of biochemical investigations	2L
	1.2	Whole animal and plant studies – the advantages and disadvantages of model systems for biochemical investigation (*E.coli*, Yeast, *Dictyostelium*, *C. elegans*, *Drosophila*, *Arabidopsis*)	4L
	1.3	Organ & Tissue studies	3L
	1.4	Isolated and cultured tissue and cell techniques: isolation, culture and counting of cells	
	1.5	Cell Fractionation:	3L
	1.5.1	Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme, organic solvent), temperature	
	1.5.2	Choice of suspension medium (isotonic & hypotonic solution, PBS) and separation methods	3L
	1.5.3	Problems of cell fractionation	
II	**2**	**Protein Purification Techniques**	**15L**
	2.1	Protein Isolation Selection of a Protein Source Methods of Solubilization Stabilization of Proteins Assay of Proteins	3L
	2.2	General Strategy of Protein Purification Solubilities of Proteins Effects of Salt Concentrations Effects of Organic Solvents Effects of pH Crystallization	3L
	2.3	Ultracentrifugation- Preparative Ultracentrifugation	1L
	2.4	Chromatographic Separations- Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography	4L
	2.5	Electrophoresis- Gel Electrophoresis, SDS PAGE, Isoelectric Focusing	4L

III	**3**	**Introduction to Immunology**	**15L**
	3.1.1	Innate immunity – Anatomical barriers, physiological barriers, phagocytic/endocytic barriers, Inflammatory barriers	4L
	3.1.2	Adaptive immunity – Active & Passive	
	3.2	Cells of the immune system: Lymphocytes – B cells and T cells, Natural killer cells – Mononuclear phagocytes, Granulocytes, Antigen presenting cells	4L
	3.3	Organs of the immune system	4L
	3.3.1	Primary lymphoid organs: Thymus, Bone marrow	
	3.3.2	Secondary lymphoid organs: Lymphatic system, Lymph nodes, Spleen, MALT	
	3.4	Immune responses - Humoral & Cell mediated response	3L
	3.5	Overview of B-cell & T-Cell activation, maturation & differentiation	
IV	**4**	**Antigens and antibodies**	**15L**
	4.1	Antigens: Antigenecity, immunogenecity, epitope, factors determining immunogenecity, Haptens, adjuvants	3L
	4.2	Antibodies	5L
	4.2.1	Tiselius & Kabat Experiment, Porter & Edelman Experiment	
	4.2.2	Fine structure of immunoglobulin	
	4.2.3	Antibody classes and biological activities	
	4.2.4	Antigenic determinants on immunoglobulins, B-cell receptor	
	4.3	Antigen- Antibody interactions: Forces involved, antibody affinity, antibody avidity, Cross reactivity	2L
	4.3.1	Precipitation reactions – Oudins, Ouchterlony	2L
	4.3.2	Agglutination reactions: Blood typing, bacterial agglutination, passive agglutination, agglutination inhibition, Coomb's test	3L
	4.3.3	Immunoelectrophoresis : Principles of Radioimmunoassay, ELISA, Immunofluorescence, Western Blotting	
		Practicals – RUSBCHP502	1.5 Credits
	1	Separation of proteins by gel filtration chromatography	
	2	Demonstration of separation of proteins using anion-exchange chromatography	
	3	Ammonium sulphate fractionation of proteins	

	4	Virtual lab – Study of model organisms in research	
	5	Isolation & Partial purification of an enzyme (Cell lysis, Centrifugation, salting out dialysis & size exclusion chromatography)	
	6	(Note- Size exclusion chromatography- Separation based on molecular weight)	
	7	Preparation of blood smear and Differential leucocyte count	
	8	Immunoprecipitation of antigen and antibody	
	9	Ouchterlony double immunodiffusion (DID)	
		Assays based on agglutination reactions - Blood typing	
	10	Demonstration of Enzyme linked immunosorbent assay (ELISA)	
	11	WIDAL test – Qualitative & Quantitative	

References:

1. Cell Biology: Essential techniques – David Rickwood – Wiley
2. Cell Separation A practical Approach – D. Fisher, G E Francis and D Rickwood – Oxford University Press
3. A.L., Lehninger, Principles of Biochemistry (1982), Worth Publishers, Inc. New York.
4. Protein Purification: Principles, High Resolution Methods, and Applications (Methods of Biochemical Analysis), Jan-Christer Janson, 2011.
5. Immunology by Goldsby and Kuby, W.H. Freeman Co.
6. Weir D.M., Immunology: Student's Notes, ELBS- Oxford.
7. Bowry T.R., Immunology Simplified, 2nd Ed., ELBS and Oxford.
8. Ivan, Immunology Method Manual, Vol. 4 1997, Academic Press, Sani Diego.
9. Roitt Ivan and others, Immunology, 6th Ed., Mosby, Edinburg.
10. Hood Leroy E., Immunology, 2nd Ed., 1976, Benjamin Cummings Publication
11. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
12. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International
13. An Introduction to Practical Biochemistry - Plummer David

Course Code: RUSBCH503

Course Title: Molecular Biology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Learn the molecular events of DNA Replication, transcription and translation process
CO 2	Understand the principle of gene organization and the roles of promoters, coding and termination sequences
CO 3	Distinguish and compare the transcription process occurring in prokaryotes and eukaryotes
CO 4	Describe how gene expression is regulated at the post-transcriptional level
CO 5	Analyse the tools and techniques for construction of recombinant DNA, cloning vectors & genomic and cDNA library
CO 6	Gain knowledge on the applications of RDT in various field

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Molecular Biology RUSBCH503	Credits/ Lectures 2.5 Credits
I	**1**	**DNA Replication & Repair**	**15L**
	1.1.1	Replication of DNA (in prokaryotes)	3L
	1.1.2	Modes of DNA replication: Theta & rolling circle	
	1.2	Enzymes (pol I, II and III) and accessory proteins	3L
	1.3	Mechanism of semi-conservative replication (Initiation, elongation & termination)	3L
	1.4	DNA repair Mechanisms	4L
	1.4.1	Direct repair (Photoreactivation, O^6 methyl guanine DNA methyl transferase)	
	1.4.2	Excision repairs - base & nucleotide excision, Mismatch repair (Hemimethylation of DNA)	
	1.4.3	SOS repair	2L
	1.4.4	Recombinational repair	
II	**2**	**Transcription & Post-transcriptional Modifications**	**15L**
	2.1	Introduction to Transcription	1L
	2.2	Types of RNA & its function	2L
	2.3	Assembly for transcription-Template strand, RNA polymerase Holoenzyme, Transcriptional unit, Promoter	
	2.4	Mechanism of RNA transcription in prokaryotes: Initiation, elongation and termination	3L
	2.5	Significance of Sigma factor, Concept of Abortive initiation	1L
	2.6	Comparative overview of transcription in prokaryotes & eukaryotes	2L
	2.7	Inhibitors of transcription -Rifampicin, Actinomycin D	
	2.8.1	mRNA (Mechanism of formation of 5'-cap and poly A tail),	1L
	2.8.2	Post-transcriptional modifications: Concept of introns, exons, split genes and mechanism of mRNA splicing	2L
	2.8.3	Processing of tRNA, rRNA (arrangement of prokaryotic rDNA)	1L
	2.9	Reverse transcription (Mechanism, significance & application)	2L

III	**3**	**Translation & Post-translational Modifications**	**15L**
	3.1	Introduction to Translation (protein biosynthesis) in prokaryotes	1L
	3.2	Characteristics of Genetic code, tRNA synthetase	2L
	3.3	Mechanism of translation: Activation of amino acids, chain initiation, elongation & termination	4L
	3.4	Inhibitors of prokaryotic translation (Puromycin, Streptomycin, Tetracycline, Chloramphenicol, Erythromycin)	2L
	3.5	Post translational modifications of proteins (proteolytic cleavage, acylation, phosphorylation, methylation, glycosylation)	2L
	3.6	Signal hypothesis	2L
	3.7	Concept of Protein sorting in cell organelles	2L
IV	**4**	**Introduction to RDT & techniques of RDT**	**15L**
	4.1	Introduction of RDT	3L
	4.2	Tools for RDT	
	4.2.1	Enzymes- Restriction endonucleases, ligases, terminal transferases, reverse transcriptase	
	4.2.2	Cloning and Expression Vectors- Plasmid, pBR 322, PUC-19 Bacteriophage – Lambda phage Cosmid; Artificial Chromosomes(BAC and YAC) Shuttle vectors	3L
	4.2.3	Probes- DNA probes	2L
	4.3	Applications of RDT- Agriculture (Bt Cotton); Medicine (Insulin); GM food	
	4.4	Isolation of gene: Gene library and c-DNA library; Southern blot; Northern blot	2L
	4.5	Gene Transfer: Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief)	3L
	4.6	Selection and screening- Antibiotic and colony hybridization	2L
	4.7	DNA Amplification by PCR	
	1 2 3 4 5 6 7	**Practicals – RUSBCHP503** To hydrolyze DNA and separate nucleotide bases by paper chromatography Estimation of UV absorption of nucleic acids & proteins Study of viscosity of DNA solution Estimation of DNA by the Diphenylamine method Isolation of chromosomal DNA from *E coli* cells Isolation of RNA from Yeast/ Liver	1.5 Credits

	8	Estimation of RNA by Orcinol Method Extraction of total nucleic acids from plant tissue	

References:

1. Molecular Biology of Cell: Bruce Alberts, 4th Edition, Garland Science
2. Tropp, B.E. Molecular Biology. Genes to Proteins.2011 (4th Ed.) Jones and Bartlett publications.
3. Freifelder, D. Essential of Molecular Biology, 1998 (3rd Ed.)
4. Lewin, B. Gene X, Jones & Bartlett, 2009
5. Molecular Cell Biology by James Dernell, Harvey Lodish and David Baltimore, W.H. Freeman & Co., 2007 (6th Ed.).
6. From Genes to Genomes by Bale J.W. & Schantz M. V. (2003).
7. Gene Biotechnology by Jogdand
8. Biochemical methods by S Sadashivam & A Minackam, New Age International publisher.

Course Code: RUSBCH504

Course Title: Biostatistics & Bioinformatics

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Organize the fundamental concepts in the design and analysis of medicinal studies, including difference between observational and experimental studies, the outcome measure of study, comparability of the control group or control population.
CO 2	Collect data relating to variables which can be examined and descriptive statistics can be calculated from the obtained data
CO 3	Translate the knowledge gained on types of data and tools of data collection in compiling and performing statistical analysis.
CO 4	Gain knowledge about various biological databases that provide information about nucleic acid and proteins.
CO 5	Locate and extract data from key bioinformatics databases and resources.
CO 6	Understand the use of computational skills in the field of Biology

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biostatistics & Bioinformatics RUSBCH504	Credits/ Lectures 2.5 Credits
I	**1**	**Biostatistics & descriptive statistics**	**15L**
	1.1	Introduction to Biostatistics	2L
	1.2	Scope and applications of biostatistics	
	1.3	Common statistical terms: Sources, nature and presentation of data; Measurement and scales of measurement	3L
	1.4	Descriptive statistics:	4L
	1.4.1	Measures of central tendency - Mean, Median and mode	
	1.4.2	Measures of dispersion- Range, percentiles, variance, SD, Mean deviation, Coefficient of variation	6L
II	**2**	**Test of Hypothesis I**	**15L**
	2.1.1	Normal distribution and normal curve	4L
	2.1.2	Asymmetric distribution	
	2.1.3	Normal variate & its significance	
	2.1.4	Statistical problems based on the above concepts	
	2.2	Introduction to Hypothesis	3L
	2.2.1	Concept of Level of Significance, Degrees of freedom, One-tailed and two tailed tests, Type I and Type II errors	
	2.2.2	Hypothesis testing of mean - Z-test, t-test (grouped and ungrouped data)	5L
	2.2.3	Statistical problems based on the above concepts	
	2.3.1	Introduction to ANOVA, Types of ANOVA	3L
	2.3.2	Statistical problems based on the above concepts	
III	**3**	**Test of Hypothesis II**	**15L**
	3.1.1	Introduction to Hypothesis testing of difference between population means	5L
	3.1.2	Z-test, t-test (Paired and unpaired)	
	3.1.3	Statistical problems based on the above concepts	
	3.2	Tests based on Chi-square distribution	4L
	3.2.1	Test of population variance	
	3.2.2	Test of goodness of fit	3L
	3.2.3	Test of association - 2 x 2 Table, Yates' correction	3L
	3.2.4	Statistical problems based on the above concepts	
IV	**4**	**Bioinformatics**	**15L**

	4.1	Introduction to Bioinformatics	1L
	4.2	Sequence & Nomenclature	2L
	4.2.1	IUPAC Symbol	
	4.2.2	Nomenclature of DNA Sequences	
	4.2.3	Nomenclature of Protein Sequences	
	4.2.4	Directionality of sequences	
	4.3	Types of sequences used in bioinformatics- Genomic DNA, cDNA, Organelle DNA, EST's, Gene sequencing tag, STS & Biomolecules	2L
	4.4	Information sources in Bioinformatics Genome database, Mouse genome database, Genebank	1L
	4.5	Information retrieval from biological databases- Entrez, Taxonomy browser, Locus link & Sequence Retrieval Systems (SRS)	3L
	4.6	Similarity based database searching tools- BLAST & FASTA	3L
	4.7	Resources for gene level sequence- Uni-gene database, Homo-gene database & Refseq database	2L
	4.8	Applications of informatics tools in Analysis- Genomics and Proteomics	1L
		Practicals – RUSBCHP504	1.5 Credits
	1	Descriptive statistics using Microsoft excel	
	2	Hypothesis testing of means & ANOVA using excel	
	3	Hypothesis testing of difference between means & Chi-square test using excel	
	4	Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept.	
	5	BLAST suite of tools for pairwise alignment	
	6	Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB	
	7	Multiple sequence alignment (CLUSTALW/TCoffee) and construction of phylogenetic trees	

References:

1. Biostatistics by P. K. Malhan and P. N. Arora, Himalaya Publishing house
2. Methods of biostatistics for medical students and research workers by Mahajan, B.K.; Jaypee brothers publishers.

3. Bioinformatics- Concepts, Skill and applications by Rastogi, S.C.; Mendiratta, Namita and Rastogi, Parag; C.B.S. Publishers & Distributors
4. Principles of biostatistics, M. Pagano and K. Gauvreau (2000); Duxbury Thomas learnings
5. Essential Bioinformatics (2006), JinXiong, Cambridge University Press
6. Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York)
7. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons,Inc. (New Jersey)
8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed.,Baxevanis, A.D. & Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey)
9. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B.,Oxford University Press (India)

Modality of Assessment (SEMESTER V)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Model making/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 1 out of 2	03	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 1 out of 2	03	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 1 out of 2	03	UNIT III
Q3. B	Any 2 out of 3	06	
Q4. A	Any 1 out of 2	03	UNIT IV
Q4. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I, II, III & IV
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I, II, III & IV
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester V

Course	501			502			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course	503			504			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course Code: RUSBCH601

Course Title: Human Physiology & Pharmacology

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the functions of physiological systems such as cardiac and reproductive and its related disorders.
CO 2	Elucidate the structure, layer, chamber and valves of the human cardiac system
CO 3	Describe the structure of the organs of the reproductive system in males and females.
CO 4	Recognize the speed of onset of drug action, intensity of the drug's effect and duration of action controlled by fundamental pathways of drug movement and modification in the body - Absorption, Distribution, Metabolism and Elimination.
CO 5	Impart fundamental knowledge on the mode of action of different therapeutic drugs its mechanism and adverse effects.
CO 6	Apply knowledge of research culture at under graduate level, to know the concept of research its objectives, tools and importance and techniques of documentation.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Human Physiology & Pharmacology RUSBCH601	Credits/ Lectures 2.5 Credits
I	**1**	**Cardiac Physiology and related disorders**	**15L**
	1.1.1	Structure of the heart	3L
	1.1.2	Layers of the heart wall	
	1.1.3	Chambers and valves of the heart	
	1.2	Physiology of the cardiac muscle	2L
	1.3	Conducting system of heart, comparative rates of conduction system of heart	3L
	1.4	Heart sound, heart rate and factors influencing heart rate	2L
	1.5	Cardiac cycle and effect of heart rate on cardiac cycle	2L
	1.6	Cardiac output	1L
	1.7	Hypertension, congestive heart disease, myocardial infarction, cardiac arrhythmias	2L
II	**2**	**Reproductive system**	**15L**
	2.1	Male reproductive system: scrotum, testes, reproductive system ducts of in males, accessory sex glands	3L
	2.2	Female reproductive system: Ovaries, uterine tubes, uterus, vagina, vulva, perineum, mammary glands	3L
	2.3	The female reproductive cycle: Hormonal regulation of the female reproductive cycle, phases of the female reproductive cycle	2L
	2.4	Birth control measures; abortion: Surgical sterilization, hormonal methods, abortion	2L
	2.5	Development of the reproductive systems Aging; reproductive systems	2L
	2.6	Clinical connection: Cryptorchidism, vasectomy, circumcision, premature ejaculation, ovarian cysts	3L
III	**3**	**Pharmacokinetics & Bioassay**	**15L**
	3.1	Physicochemical properties of drugs	2L
	3.2	Routes of drug administration	3L
	3.2.1	Drug absorption: through-GIT, pulmonary, renal, placental and blood-brain barrier	2L
	3.2.2	Bioavailability and Bioequivalence	1L
	3.3	Drug Distribution	1L

	3.4	Drug Metabolism and Excretion	2L
	3.5	Factors affecting drug dosage and drug delivery	2L
	3.6	Bioassays: Preclinical and clinical evaluation, Therapeutic drug monitoring	2L
IV	**4**	**Therapeutic drugs & Drugs acting on Haemopoietic System**	**15L**
	4.1	Therapeutic drugs: (Mechanism of action and adverse effects)	1L
	4.1.1	Anti-inflammatory – Non steroid anti-inflammatory NSAID [Ibuprofen], Salicylates – [Aspirins]	1L
	4.1.2	Cardiovascular drugs- CVS [Ca channel blocker- Amlodipine, and Beta blocker – Proprenolol]	1L
	4.1.3	Antibiotic – Penicillin and Sulphonamide	2L
	4.1.4	Antacid- Proton pump blocker –Omeprazole	
	4.2	Drugs acting on Haemopoietic System	
	4.2.1	Metabolism of iron	1L
	4.2.2	Iron therapy: Oral Iron preparations, Parental Iron preparations, Toxicity of Iron: Desferrioxamine Mesylate	2L
	4.2.3	Folic Acid (Pteroylglutamic acid) : Mode of Action, Therapeutic Uses	1L
	4.2.4	Vitamin B12 (Cyanocobalamin): Mode of Action, Therapeutic Uses	1L
	4.2.5	Hydroxycobalamin	1L
	4.2.6	Erythropoietin	
	4.2.7	Colony Stimulating Factors: Filigrastim, Lenograstim, Molgramostim	1L
	4.2.8	Anti-coagulants – Mechanism of Haemostasis Intravenous anticoagulants – Heparin Oral anticoagulants – Coumarin derivatives & Indanedione derivatives	3L
		Practicals – RUSBCHP601: PROJECT WORK **Guideline to Carry Out Project work** 1. The main purpose of introduction of Project Work at TYBSc is to inculcate research culture at under-graduation level. It will also make the students familiar with Research Methodology i.e. reference work, experimental work, analysis of experimental data, interpretation of results obtained, writing of project work and compilation of bibliography in proper order. 2. Each student individually or in a group shall complete a small research project during their	1.5 Credits

		academic year of TYBSc. However, the initial reference work for the project can be started after the conclusion of SYBSc Semester IV examination and summer vacation to TYBSc. 3. Nature of Research Project:-Experimental-based involving laboratory analytical work will be considered as the Research Project. 4. Duration of Project work:-Using the infrastructure available in the Biochemistry Department, Ramnarain Ruia Autonomous College, the duration to complete the project work will be from the commencement of the project work till the mid of January of TYBSc (Sem V) academic year. 5. Schedule for Submission of project Work:- Experimental work must be completed and the report on the same (2 Copies) will have to be submitted by the end of January of TYBSc (Sem V) academic year. 6. The project should be divided into the following parts:- a) Certification of completion of Project Work b) Acknowledgement c)Introduction d) Review of Related Literature e) Aims and Objectives f) Plan of work g) Material and Methods h) Results i) Discussion j) Bibliography 7. The project will be assessed **GUIDELINE FOR THE ASSESMENT OF PROJECT WORK** 1. The practical 601 of Sem VI (Course Code No. RUSBCHP601) shall be exclusively devoted for the project. 2. Each student will complete the project (2 copies) and get both the copies certified by the guiding teacher and the Head of Dept. (HOD) by January of TYBSc (Sem V) academic year. 3. One copy of the certified project will be	

submitted to the Department; while the other copy will be retained by the students for his/ her personal record.

4. The candidate is required to present the Research Project to the examiner followed by Viva- Voce examination based on the project work by the examiner.
5. The following Marking Scheme shall be considered while assessing the project work

Particular		Marks
a)	Project Work (Contents Submitted in the bound form)	30
b)	Presentation of Project Work to examiner	10
c)	Viva- voce Exam based on Project Work	10
	TOTAL	**50**

References:

1. Principles of Anatomy and Physiology: Gerard J, 12th edition, John Wiley & Sons.
2. Human Physiology –Chatterjee.C.C, Medical Allied Agency
3. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York),
4. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi).
5. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco),
6. Essentials of Pharmacotherapeutics by FSK Barar

Course Code: RUSBCH602

Course Title: Food Biochemistry & Environmental Science

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand physical & chemical reactions in food, the role of enzymes in food processing and how they aid in carrying out changes in food
CO 2	Identify the chemistry and applications of enzymes in food industries and flavour.
CO 3	Acquire thorough knowledge about the changes in reactions in food and how enzymes could be of great importance in food processing
CO 4	Know the properties of different food components and to understand the principle underlying the biochemical techniques used in food analysis.
CO 5	Describe the interdisciplinary nature of environmental studies and also create awareness for the same.
CO 6	Impart knowledge of various methodologies that are adapted for effective monitoring of environmental parameters.
CO 7	Introduce the concept of water and waste water treatment techniques and the aspects involved in solid waste minimization and complete environmentally safe method of their disposal.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Food Biochemistry & Environmental Science RUSBCH602	Credits/ Lectures 2.5 Credits
I	**1**	**Physicochemical Principles of food**	**15L**
	1.1	Introduction & Importance	2L
	1.1.1	Physical & chemical characteristics of food	
	1.2	Factors affecting physicochemical properties	4L
	1.2.1	Enzymatic reactions- softening, Oxidation (Ascorbic acid & Phenolic oxidation) Glycolytic reaction, Hydrolytic reactions, pigmentation (Cholorophylase) browning, Maillard reaction & Caramelization reaction	
	1.2.2	Chemical reactions- 1. Lipid oxidation, non-enzymatic browning 2. Colour changes - Chlorophylls - Anthocyanins - Carotenoids (lipid soluble compounds) 3. Flavour changes 4. Phenophytinisation -photo- oxidation. – Oxidation – 5. Enzyme-induced oxidative breakdown of unsaturated fatty acids	4L
	1.3	Physicochemical changes in following food Changes in fruit ripening Comparison between Raw vs Ripe Fruit	1L
	1.3.1	Changes in meat- Post Mortem Changes in Meat (Pre-rigor stage, Rigor Mortis, Post Rigor Stage Lipid oxidation	3L
	1.3.2	Non enzymatic hydrolysis by Haeme protein Autolytic enzyme spoilage	1L
II	**2**	**Enzymes in Food Processing**	**15L**
	2.1	Enzymes in carbohydrates, proteins and lipid modifications	3L
	2.1.1	Enzymes for starch modification- maltodextrins and corn syrup solids: liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup, fructose and fructo-oligosaccharides	
	2.1.2	Enzymes for protein modification - hydrolysates and bioactive peptides	3L

	2.1.3	Enzymes for Lipid modification- Lipase catalyzed synthesis of structured triglycerides, fats, and margarine	3L
	2.2 2.2.1 2.2.2 2.2.3 2.2.4	Enzymes as processing aids Role of enzymes in Dairy processing - cheese making and whey processing Role of enzymes in meat processing- tenderization and flavour development Role of enzymes in fish processing- De-skinning, collagen extraction Role of enzymes in Egg processing- catalase, glucose oxidase, hydrolase	3L
	2.3	Role of enzymes in the production of flavours	3L
	2.3.1	Enzyme-aided extraction of plant materials for production of flavours	
	2.3.2	Production of flavour enhancers such as nucleotides, MSG; flavours from hydrolyzed vegetable/animal protein	
III	**3**	**Fundamentals of Environmental Chemistry**	**15L**
	3.1	Air and Atmosphere	3L
	3.1.1	Particles, ions and radicals in the atmosphere	
	3.1.2	Chemical processes for formation of inorganic and organic particulate matter	
	3.1.3	Thermochemical and photochemical reactions in the atmosphere	2L
	3.1.4	Oxygen and ozone chemistry – Formation of ozone layer, sources and effects of ozone depletion on environment	
	3.1.5	Chemistry of air pollutants	2L
	3.1.6	Photochemical smog, Carcinogens in the air	
	3.1.7	Effects of air pollution on health	
	3.2	Water and aquatic system	2L
	3.2.1	Organic pollutants [pesticides, insecticides, detergents, oil spills, toxic organic chemicals]	
	3.2.2	Inorganic pollutants [heavy metals – Hg, Pb, As, Cd]	
	3.2.3	Thermal pollution of water	3L
	3.2.4	Concept of DO, BOD, COD, Acidity, Alkalinity, Hardness	
	3.2.5	Effects of water pollution on health	

	3.3	Soil Soil properties, Types of soil pollution – acidification, agrochemical pollution, salinization, and contamination by metalliferous wastes	3L
IV	**4**	**Environmental pollution management and environmental monitoring**	**15L**
	4.1	Air Pollution Management	3L
	4.1.1	Control methods for particulates - Gravitational Settling Chambers, Centrifugal collectors, Wet collectors, Fabric Filters, Electro Static Precipitators	
	4.1.2	Control methods for gaseous pollutants - Adsorption, Absorption, Condensation, Combustion	
	4.2	Water analysis & Waste water management	5L
	4.2.1	Physico – chemical and Bacteriological sampling and analysis of water quality	
	4.2.2	Primary treatment methods – screening, grit removal, primary sedimentation	
	4.2.3	Secondary treatment methods - Activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons	
	4.2.4	Tertiary treatment methods - Chlorination, Ion Exchange	
	4.3	Solid Waste Management Sanitary Landfill, Recycling, Composting, Incineration, Energy recovery options from organic wastes	2L
	4.4	Environmental monitoring and remote sensing	4L
	4.4.1	Introduction & Objective	
	4.4.2	Types of Monitoring- Source Monitoring & Ambient environment monitoring	
	4.4.3	Importance of remote sensing in environmental monitoring	
	4.4.4	Approaches used to monitor the environment-air, water and soil (Principles and Significance)	1L
	 1 2 3 4	**Practicals – RUSBCHP602** Determination of salinity / chlorides in water by Silver nitrate method Determination of the Chemical Oxygen Demand of water/ Effluent by the Potassium Dichromate method Determination of potability of water by conducting a coliform count	1.5 Credits

	5	Determination of the Dissolved Oxygen content of water/ Effluent by the Winkler's Iodometric method	
	6	Determination of the Biological Oxygen Demand of water/ Effluent	
	7	Determination of the Alkalinity of water/ Effluent	
	8	Determination of the Acidity of water/ Effluent	
	9	Estimation of lead by the EDTA method	
	10	Estimation of Organic content of soil by Diphenylamine method	
	11	Estimation of $CaCO_3$ of soil by Bromothymol Blue Method	
		Visit to a Food processing industry and report writing	

References:

1. Total Quality Assurance for the Food Industries – WA Gould & RW Gould. CTI Publications Inc., USA 1988
2. Current Good Manufacturing Practices for Food Plan Sanitation – WA Gould, CTI Publications Inc. USA 1980
3. Fundamental Concepts of Environmental Chemistry – Sodhi, Narosa Publishing House, 2002
4. Principles of Environmental Chemistry – Kothandaram & Swaminathan, B I Publishers, Chennai
5. Environmental Chemistry – AK De, New Age International Publishers
6. Biochemical methods by S Sadashivam & A Minackam, New Age International publisher.

Course Code: RUSBCH603

Course Title: Biochemistry of Metabolism

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Comprehend the reactions of catabolism and anabolism of biomolecules -carbohydrates, amino acids and lipids.
CO 2	Illustrate the pathways and cycles of nucleic acid metabolism
CO 3	Recognize the involvement of biomolecules in energy metabolism and storage of energy through anabolic pathways
CO 4	Recognize the involvement of biomolecules in energy metabolism and outflow of energy through catabolic pathways.
CO 5	Learn various experiments carried out by scientists to enable understanding of the pathways and cycles of metabolism.
CO 6	Understand simple concepts related to metabolism and to be familiar with the various metabolic pathways.
CO 7	Describe the interrelationship between metabolic pathways of different biomolecules and their interdependence.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biochemistry of Metabolism RUSBCH603	Credits/ Lectures 2.5 Credits
I	**1**	**Carbohydrate Metabolism**	**15L**
	1.1	Overview of glucose metabolism	4L
	1.1.1	Glycolysis- Salient features, reactions,	
	1.1.2	Conversion of pyruvate to lactate & its significance	
	1.1.3	Irreversible reactions of glycolysis	
	1.1.4	Regulation of glycolysis	
	1.2	Conversion of pyruvate to Acetyl CoA- Role of Pyruvate dehydrogenase complex & its regulation	1L
	1.3	Citric acid cycle- Pathway with reactions & its regulation	3L
	1.4	Glycogenolysis – [schematic – no structures, but with enzymes and coenzymes]	1L
	1.5	HMP shunt (Cellular location, sequence of reactions, multifunctional nature)	2L
	1.6	Gluconeogenesis, Glycogenesis – [schematic – no structures, but with enzymes and coenzymes]	3L
	1.7	Glyoxylate pathway	1L
II	**2**	**Amino acid metabolism**	**15L**
	2.1.1	Chemical nature, functional groups and reactivity of amino acids	4L
	2.1.2	Reactions of amino acids: Deamination, Transamination, Decarboxylation, Transmethylation, Transdeamination	
	2.2	Ammonia formation, transport and detoxification in brain and liver.	3L
	2.3	Urea cycle & its regulation	2L
	2.4	Metabolism of significant amino acids– Glycine, Phenylalanine, Tyrosine, Tryptophan	2L
	2.5	Formation of specialized products from amino acids and their functions-glutathione, creatine, creatinine, biogenic amines (dopamine, norepinephrine, GABA, Histamine)	4L
III	**3**	**Lipid metabolism**	**15L**
	3.1	Introduction to lipid metabolism	5L
	3.1.1	Lipid Digestion, Absorption, and Transport	
	3.1.2	Fatty Acid Oxidation-Fatty Acid Activation,	

		Transport Across the Mitochondrial Membrane, Beta-Oxidation	
	3.1.3	Oxidation of Unsaturated Fatty Acids	
	3.1.4	Oxidation of Odd-Chain Fatty Acids	
	3.2	Ketone Bodies	2L
	3.3	Fatty Acid Biosynthesis- Pathway Overview, Acetyl CoA Carboxylase, Fatty Acid Synthase, Transport of Mitochondrial Acetyl-CoA Into the Cytosol, Elongases and Desaturases	3L
	3.4	Synthesis of Triacylglycerols	1L
	3.5	Regulation of Fatty Acid Metabolism	1L
	3.6	Cholesterol Metabolism- Cholesterol Biosynthesis, Control of Cholesterol Biosynthesis and Transport, Cholesterol Utilization	3L
IV	**4**	**Nucleic Acid Metabolism & Integration of Metabolism**	**15L**
	4.1	Metabolism of Purine and pyrimidine	6L
	4.1.1	Biosynthesis and degradation	
	4.1.2	Salvage pathway	
	4.1.3	Inhibitors	
	4.2	Integration of metabolism	1L
	4.2.1	Integration of major metabolic pathways of energy metabolism	1L
	4.2.2	Organ specialization and metabolic integration – Liver, Adipose tissues, Skeletal muscle, Brain, Kidney	4L
	4.2.3	Metabolism of starvation - Liver, Adipose tissues, Skeletal muscle, Brain	3L
		Practicals – RUSBCHP603	1.5 Credits
	1	Estimation of glucose by the Folin-Wu method	
	2	Estimation of glucose by the GOD-POD method	
	3	Demonstration of glucose metabolism using handheld glucometer	
	4	Assay of serum transaminases – SGOT and SGPT	
	5	Estimation of serum urea.	
	6	Estimation of serum creatinine.	
	7	Estimation of serum uric acid by phosphotungstic acid method (Caraways method)	
	8	Assay of glutamate dehydrogenase	
	9	Lipid Profile –	
	a	Estimation of total cholesterol and HDL	
	b	Estimation of Triglycerides	
	c	Estimation of LDL by calculation	

	10	Use of softwares to understand metabolism – KEGG, Ecocyc, Metacyc, Biocyc	

References:

1. Biochemistry - U. Sathyanarayana - Books and Allied (P) Ltd. Kolkata.
2. Biochemistry - Voet, D. and Voet, J.G. - John Wiley & Sons, Inc. USA.
3. Biochemistry by L. Stryer W.H. Freeman Press, San Francisco, USA.
4. Outlines of Biochemistry - E.E. Conn and P.K. Stumpf – Wiley Eastern, New Delhi.
5. Text book of Biochemistry - J.L Jain
6. Text Book of Biochemistry - D.M. Vasudevan
7. Text Book of Biochemistry - A.C. Deb, 9th revised edition (2017)
8. Biochemistry - Garret, R.H. and Grisham, C.M. (2005) Thomson Learning INC.
9. Biochemical methods - S Sadashivam and A Manickam - New Age International publishers
10. Laboratory Manual in Biochemistry - J. Jayaraman - New Age International
11. An Introduction to Practical Biochemistry - Plummer David

Course Code: RUSBCH604

Course Title: Nutritional Biochemistry

Academic year 2020-21

COURSE OUTCOMES:

After successful completion of this course, the students would be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Realize the importance of balanced diet and other parameters in maintaining it.
CO 2	Explore the functions of macronutrients & micronutrients and to examine the clinical and biochemical effects of its depletion.
CO 3	Examine the biochemical, physiological and clinical impact of inadequate intakes of specific nutrients.
CO 4	Develop a keen insight into interrelationship between genes and nutrients.
CO 5	Acquaint the importance of nutrition in health and study the main features of carbohydrates, proteins, lipids and minerals.
CO 6	Familiarize newer concepts of dietary management of various disorders and disease.
CO 7	Select biochemical techniques relevant in nutritional biochemical research
CO 8	Provide an understanding of biochemistry and explore the biochemical activity in the human body of nutrients and food constituents.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Nutritional Biochemistry RUSBCH604	Credits/ Lectures 2.5 Credits
I	**1**	**Introduction to Nutrition**	**15L**
	1.1.1	Introduction to Human nutrition & energy supply	2L
	1.1.2	Measurement of energy content of food- Calorific value of different biomolecules & mixed diet, Determination of calorific value using bomb Calorimeter (Principle & Working)	
	1.2	Respiratory quotient of food	2L
	1.3	Measurement of energy expenditure Basal metabolic rate- Definition, Measurement, factors affecting BMR & its significance	
	1.4	Specific dynamic action of food- Definition, Mechanism & its significance	1L
	1.5	Sources, Daily requirement & Nutritional importance of biomolecules	4L
	1.5.1	Carbohydrates- Concept of Glycemic Index of food (Graph), Importance of fiber (Complex carbohydrate) in nutrition	
	1.5.2	Lipids-Role of essential fatty acids	
	1.5.3	Proteins- Essential amino acids, Nitrogen Balance (Positive, Negative Nitrogen balance & factors affecting)	
	1.6	Assessment of nutritive value of protein	3L
	1.6.1	Protein efficiency ratio	
	1.6.2	Biological value of protein	
	1.6.3	Net protein utilization	
	1.6.4	Chemical score	
	1.6.5	Mutual supplementation of protein	
	1.7	Recommended Dietary allowances (RDA)- Definition, Factors affecting RDA, RDA for adult	1L
	1.8	Balance diet – Concept & significance, Designing diet for different subjects (infants, toddlers, adolescents, adults, geriatric, diseased state)	2L
	1.9	Numericals based on above concepts	
II	**2**	**Macroelements**	**15L**
	2.1	Biochemistry of macroelements	3L
	2.2	Sources, Recommended daily allowances,	3L

		Absorption, transport, excretion, Biochemical significance & Disorders related to:	
	2.2.1	Calcium	3L
	2.2.2	Phosphorous	
	2.2.3	Magnesium	3L
	2.2.4	Sodium	
	2.2.5	Potassium	3L
	2.2.6	Chlorine	
	2.2.7	Sulphur	
III	**3**	**Microelements**	**15L**
	3.1	Biochemistry of microelements	2L
	3.2	Sources, Recommended daily allowances, Biochemical significance & Disorders related to:	3L
	3.2.1	Copper	3L
	3.2.2	Iodine	
	3.2.3	Manganese	3L
	3.2.4	Zinc	
	3.2.5	Molybdenum	3L
	3.2.6	Cobalt	
	3.2.7	Fluorine	
	3.2.8	Selenium	1L
IV	**4**	**Nutrigenomics, Nutritional disorders and Antinutritional Factors**	**15L**
	4.1	Nutrient-Gene Interaction	2L
	4.2	Drug-Nutrient Interaction	
	4.3	Obesity, Brown and White Adipose Tissue, Specific dynamic action factors affecting thermic effect of food.	2L
	4.4	Role of Leptin, Ghrenin, Adiponectin in food intake.	2L
	4.5	Pathophysiology of Nutritional disorders	2L
	4.5.1	Nutritional disorders of carbohydrate- Obesity, Non-Insulin dependent diabetes mellitus, Lactose intolerance, Celiac disease, Dental carries	
	4.5.2	Nutritional disorders of proteins- Protein energy Malnutrition (Kwashiorker, Marasmus & Marasmic kwashiorkor)	2L
	4.5.3	Nutritional disorders related to lipids – Essential fatty acid deficiency, cholesterol (Good vs Bad), Atherosclerosis & Arteriosclerosis	2L
	4.5.4	Eating disorders – Bulimia nervosa, Anorexia nervosa	2L
	4.6	Antinutritional factors – Phytin, oxalates, tannins, trypsin inhibitors, soluble and non-soluble NSPs	1L

		Practicals – RUSBCHP604	1.5 Credits
	1	Anthropometric measurements	
	2	Isolation of casein from milk	
	3	Extraction of albumins and globulins from egg white	
	4	Isolation of lipids from egg yolk and separation by TLC.	
	5	Estimation of Cholesterol	
	6	Estimation of Calcium by EDTA method	
	7	Estimation of phosphorus by Fiske Subarrow method	
	8	Estimation of copper by the Isoamyl alcohol method	
	9	Survey on nutritional disorders and its statistical analysis	

References:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York)
2. Human nutrition and dietetics by Davidson, S. etal.; Churchill Livingstone Publishers.
3. Nutrition and dietetics by Joshi, Shubhangini A.; Tata McGraw and Hill publishers
4. Nutrition Science by Srilakshmi, B.; New Age International publishers
5. Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings, S.E, Raymond, J. Elsevier's Publications.
6. The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications..
7. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.
8. Nutritional Biochemistry: Tom Brody.
9. Textbook of medical laboratory technology: Dr. Praful Godkar, Bhalani Publishing House
10. Biochemical methods by S Sadashivam & A Minackam, New Age International publisher.

Modality of Assessment (SEMESTER VI)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/poster presentation/Model making/Quiz	20
2	One class Test (multiple choice questions / subjective)	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **02 HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1. A	Any 1 out of 2	03	UNIT I
Q1. B	Any 2 out of 3	06	
Q2. A	Any 1 out of 2	03	UNIT II
Q2. B	Any 2 out of 3	06	
Q3. A	Any 1 out of 2	03	UNIT III
Q3. B	Any 2 out of 3	06	
Q4. A	Any 1 out of 2	03	UNIT IV
Q4. B	Any 2 out of 3	06	
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Practical I, II, III & IV
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Practical I, II, III & IV
Laboratory work	25
Viva	5
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester VI

Course	601			602			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course	603			604			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100
