Resolution No. AC/II(20-21).2.RUS2

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: SYBSc

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
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

Semester III

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	3L

		Effects of pH 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

Semester IV

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 manifestations	1L
	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
	1 2 3 4	**Practicals – RUSBCHP403** Estimation of Vitamin A by Carr Price method Estimation of tocopherol by Mary & Quaife method Estimation of vitamin C iodometrically Estimation of Thiamine by Thiochrome method	1 Credit

	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
