Resolution No. AC/II(21-22).2.RPS2

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: MSc I

Program Code: RPSBCH

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

PROGRAM OUTCOMES

PO	PO Description **A student completing Master's Degree in SCIENCE program will be able to:**
PO 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate, and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
PO 2	Critically evaluate, analyse, and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
PO 3	Access, evaluate, understand, and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
PO 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
PO 5	Demonstrate initiative, competence, and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
PO 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
PO 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills, and lead a team for planning and execution of a task.
PO 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Master's Degree in SCIENCE program in the subject of BIOCHEMISTRY will be able to:**
PSO 1	Acquire necessary knowledge and skills to undertake a career in research, either in industry or in an academic set up.
PSO 2	Compare and contrast the breadth and depth of scientific knowledge in the broad range of fields including Protein biochemistry, Bioenergetics, Diagnostic Biochemistry, Hormonal Biochemistry, Molecular Biology, Nutritional Biochemistry, and Nanotechnology.
PSO 3	Extrapolate and comprehend the regulatory role of metabolic processes and understand the underlying cause of metabolic disorders
PSO 4	Acquire thorough knowledge of Biochemical Techniques, Advanced Immunology, Physiology, Genetic Engineering, and Biotechnology
PSO 5	Describe and express the biochemical basis of human diseases, protein structure and conformation, non-invasive diagnostics, clinical research, and its importance in drug development. Usage of this knowledge further for multitude of laboratory applications.
PSO 6	Integrate and apply the techniques in Biophysics, Analytical Biochemistry, Clinical biochemistry, Microbiology, Molecular Biology and Basics in Bioinformatics
PSO 7	Gain proficiency in laboratory techniques in both Biochemistry and Molecular Biology, and be able to apply the scientific method to the processes of experimentation and Hypothesis testing
PSO 8	Develop and enhance skills & improve employability through academic, research and internship opportunities
PSO 9	Gain exposure to basic research through the provision of PG research based project.
PSO 10	Learn to work as a team as well as independently to compile and interpret Biological data, carry out Research investigations and draw conclusions

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	RPSBCH101	Membrane Biochemistry & Bioenergetics	4
		RPSBCH102	Protein Biochemistry & Enzymology	4
		RPSBCH103	Biostatistics and Ecology	4
		RPSBCH104	Instrumentation and Analytical Techniques I	4
		RPSBCHP101	Practicals based on RPSBCH101	2
		RPSBCHP102	Practicals based on RPSBCH102	2
		RPSBCHP103	Practicals based on RPSBCH103	2
		RPSBCHP104	Practicals based on RPSBCH104	2
	II	RPSBCH201	Industrial Biotechnology	4
		RPSBCH202	Research Methodology, IPR, Bioinformatics & Nanotechnology	4
		RPSBCH203	Fundamentals of Genetics	4
		RPSBCH204	Instrumentation and Analytical Techniques II	4
		RPSBCHP201	Practicals based on RPSBCH201	2
		RPSBCHP202	Practicals based on RPSBCH202	2
		RPSBCHP203	Practicals based on RPSBCH203	2
		RPSBCHP204	Practicals based on RPSBCH204	2

Semester I

Course Code: RPSBCH101

Course Title: Membrane Biochemistry & Bioenergetics

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand composition and structure of bio-membranes
CO 2	Recognize the importance of transport mechanisms and cellular trafficking across biological membranes
CO 3	Describe different types of transporters and explain their mechanisms
CO 4	Comprehend the different modes of communication between cells including signal reception, transduction, amplification, and response.
CO 5	Know about Bioenergetics, mechanisms of oxidative phosphorylation
CO 6	Learn the concept and mechanism of ATP synthesis

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Membrane Biochemistry & Bioenergetics RPSBCH101	Credits/ Lectures 4 Credits
I	**1**	**Membrane Fluidics & Dynamics**	**15L**
	1.1	Overview of membrane biochemistry	2L
	1.2	Membrane fluidity	2L
	1.2.1	Importance of membrane fluidity	
	1.2.2	Maintenance of membrane fluidity- Concept of transition temperature & general characteristics	
	1.3.1	Lipid rafts- Composition significance & its role role of lipid rafts in maintaining membrane & membrane signalling	4L
	1.3.2	Specialized lipid rafts- Caveolae (Formation of Cavolins, Cavins and its significance in endocytosis & other mechanisms	
	1.4	Membrane dynamics Membrane bilayer mobility- Frye Edinin Experiment & FRAP analysis	2L
	1.5	Membrane asymmetry- Lateral membrane asymmetry- Lipids & proteins Transverse membrane asymmetry Role of Flippase, Floppase and Scramblase in maintaining asymmetry	2L
	1.6	Membrane domain and cell polarity-	2L
	1.7	Study of RBC cell- model for cell membrane	1L
II	**2**	**Membrane Transport & cellular trafficking**	**15L**
	2.1	Passive transport – Passive diffusion (Polar & Non polar), diffusion and osmosis, facilitated diffusion of ions and molecules	3L
	2.2.1	Ion channels- Ligand gated, mechanical gated, Voltage gated, Anion transporter (band 3)	
	2.2.2	Molecule channels- (Glucose transporters)	
	2.3	Primary Active transport Atpases pump- Na^+-K^+ Pump, Ca^{2+}-K^+ Pump, ABC transporter (CFTR) Light driven – Bacteriorhodopsin	4L
	2.4	Secondary active transports- Symport (Mechanism of Absorption of peptides by enterocytes), Mechanism of Cytosolic pH maintenance	3L

	2.5	Specialized ion channels - Aquaporins, Ionophores: gramicidin, & valinomycin	
	2.6	Antiport - Absorption of peptides by enterocytes, Antiporter in cardiac muscle cell with effect of Ouabain & digoxin	2L
	2.7	Cellular trafficking	2L
	2.7.1	The Molecular Mechanisms of Membrane Transport and the Maintenance of Compartmental Diversity	
	2.7.2	Gated, vesicular and transmembrane transport	1L
III	**3**	**Cell-cell communication**	**15L**
	3.1	Introduction to Cell-cell communication & its Biological Significance	1L
	3.2	Cell Adhesion and Cell adhesion molecules	4L
	3.2.1	Importance of cell adhesion and cell adhesion molecules	
	3.2.2	Cadherins, Lectins and selectins (Their role and importance in cell adhesion with one significant example)	
	3.3	Cell-cell junction	3L
	3.3.1	Classification	
	3.3.2	Adherence junction- Focal adhesion, Hemidesmosome, desmosome and their role in Wnt pathway, tissue integrity	
	3.3.4	Tight junction- Role of JAM (claudins and occludins) its role in glucose transport across intestine	2L
	3.3.5	Gap junction- connexon & its role in electrical synapse	1L
	3.4	Extracellular matrix in plants and animals	4L
	3.4.1	Structure and Biological significance of Collagen, Elastin, fibronectin, Laminins and integrins	
IV	**4**	**Oxidative Phosphorylation & its regulation**	**15L**
	4.1	Oxidative phosphorylation	2L
	4.2	Electron transfer reactions in mitochondrion	
	4.2.1	Universal electron acceptors – Role in biological oxidation-reduction reactions	
	4.2.2	Membrane-bound carriers (Ubiquinone, Cytochromes, Fe-S proteins, Rieske Fe-S proteins) – Structure and mechanism of electron transfer	2L

	4.3.1	Methods for determining the sequence of electron carriers	4L
	4.3.2	Structure and function of each complex of mitochondrial respiratory chain	
	4.3.3	Separation of functional complexes of respiratory chain	
	4.3.4	Flow of electrons and protons through the complexes of respiratory chain	
	4.4	Proton motive force	1L
	4.5	Alternative mechanism in plant mitochondria	
	4.6.1	Phosphoryl group transfers and ATP	1L
	4.6.2	ATP synthesis by binding-change model for ATP synthase	3L
	4.6.3	Role of luciferin in firefly flashes	
	4.6.4	Chemical uncouplers of oxidation and phosphorylation	
	4.7	Alternative respiratory pathway in plant	
	4.8	Regulation of oxidative phosphorylation	2L
	4.8.1	Regulation based on energy demands, in oxidative stress, In brown fat and integrated regulation in metabolism	
		Practicals RPSBCH101	2 Credits
	1	Separation of RBC membrane proteins by SDS-PAGE	
	2	Effect of temperature and molecular weight on diffusion	
	3	Effect of tonicity on cell membrane	
	4	Mitochondrial respiration and effect of different Inhibitors for ETC (Dry lab)	
	5	In-vitro study of RBC membrane stabilization	
	6	Isolation of lipids from plant and animal source and their utilization in the formation of artificial membrane vesicle	
	7	Graphical study of hydropathy plot and FRAP analysis (Dry lab)	

References:

1. Molecular Cell Biology (2016) 8th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M.,Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York).
2. Biochemistry (2016) 6th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston).
3. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
4. Molecular Biology of the Cell (Sixth Edition) by by Bruce Alberts
5. Essential Cell Biology – Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts, Walter (4^{th} Edition)
6. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
7. Biochemical methods, S Sadashivam and A Manickam, new age international publishers
8. Laboratory Manual in Biochemistry, 2003, J. Jayaraman, New Age International

Course Code: RPSBCH102

Course Title: Protein Biochemistry & Enzymology

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand details of protein structure such as protein organization, end group analysis and stabilizing bonds
CO 2	Know Various techniques used in the study of protein biochemistry
CO 3	Learn Protein folding & Protein Engineering and their research - oriented applications
CO 4	Analyse Ramachandran plot and other plots with respect to kinetics of different enzymes
CO 5	Determine optimum temperature, pH for the activity of an enzyme.
CO 6	Determine Km and Vmax of enzymes and to analyse enzyme kinetics.
CO 7	Understand enzyme inhibition with more complexity.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Protein Biochemistry & Enzymology RPSBCH102	Credits/ Lectures 4 Credits
I	**1**	**Introduction to Proteins & Protein Structure**	**15L**
	1.1	Organization of protein structure into primary, Secondary, Tertiary and Quaternary structures	2L
	1.2.1	Primary structure determination of protein	2L
		End group analysis-N & C terminal amino acid analysis – By dansyl chloride, Sanger's Reagent, Edman's degradation, Exopeptidase	
	1.2.2	Cleavage of disulphide bond	
	1.3	Mass spectrometry for protein analysis, Tandem MS, Solid phase peptide synthesis	3L
	1.4	Nature of stabilizing bond – covalent and non-covalent.	
	1.5	The peptide bond length & configuration-Dihydral angle psi and phi, Helices, sheets and turns – Ramachandran plot	2L
	1.6	Techniques used to study 3D Structures- X-ray diffraction, NMR	2L
	1.7	Supersecondary structures: Motifs and domains	2L
	1.8	Tertiary and quaternary structures- Structure of haemoglobin and myoglobin	2L
II	**2**	**Protein folding & Protein Engineering**	**15L**
	2.1	Protein denaturation and folding (Ribonuclease A)	2L
	2.1.1	Importance of primary structure in folding	
	2.2	Molecular mechanism of protein folding	2L
	2.3	Role of chaperons, chaperonins & PDI in protein folding	2L
	2.4	Disorders related to protein folding- Alzheimer's and prion disease	2L
	2.5	Protein Engineering	3L
	2.5.1	Basic principles, Types and Methods	
	2.5.2	Strategies in protein engineering (Directed evolution, Comparative design, Rational design)	4L
	2.5.3	Applications and case studies.	
III	**3**	**Enzyme kinetics and inhibition**	**15L**
	3.1	Introduction to enzymes, mechanism of enzyme action	3L

	3.2	Types of enzyme catalysis – Acid base, Covalent & metal ion	
	3.3	Enzyme kinetics	4L
	3.3.1	The Relationship between Substrate Concentration and Reaction Rate- Michaelis-Menten Kinetics of monosubstrate enzyme reaction, LB Plot, Einsethal Cornish Bowden Plots & Eadie- Hofstee plot	
	3.4	Enzyme inhibition	4L
		Types of inhibitors- Competitive, Non-competitive and Uncompetitive, Mixed, Suicidal inhibition and their mode of action and experimental determination considering suitable example	
	3.5	Allosteric enzymes	4L
		Mechanism of action, deviation from MM equation and allosteric regulation	
		Allosteric interactions- protein ligand binding, co-operativity, Hill & Scatchard plot	
IV	**4**	**Enzyme regulation and modifications**	**15L**
	4.1	Enzyme regulation- Product inhibition, Feedback control, Enzyme induction and repression	3L
	4.2.1	Enzyme modification reactions (Phosphorylation, Adenylation, Uridylylation, ADP-ribosylation, Methylation)	3L
	4.2.2	Regulation of enzymes by proteolytic cleavage	
	4.3	Enzymatic action and biological role of following – Hexokinase, Chymotrypsin, Carboxypeptidase A	2L
	4.4	Immobilized enzymes	2L
	4.4.1	Relative practical and economic advantage for industrial use	
	4.4.2	Methods of immobilization- Ionic bonding, Adsorption, Covalent bonding (based on R group of amino acids), Microencapsulation and Gel entrapment.	4L
	4.4.3	Immobilization of multienzyme system	1L

		Practicals – RPSBCHP102	2 Credits
	1	Plotting graphs using computer tools	
	2	Estimation of proteins using Lowry method	
	3	Study of Ramachandran plot (Dry lab)	
	4	Study of protein denaturation – change in isoelectric pH	
	5	Colorimetric assay for cysteine	
	6	Determination of optimum pH & temperature of β-Amylase/Invertase/Urease	
	7	Determination of Km and Vmax of β-Amylase/Invertase/Urease	
	8	Assay to determine enzyme activity and specific activity	
	9	Study the effect of inhibitor on β-Amylase/Invertase/Urease	
	10	Comparative assessment of the β-Amylase/Invertase/Urease activity in free and immobilized state	
	11	Reusability & Storage stability of immobilized Amylase/Invertase/Urease	

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 HallSaunders Elsevier Publications, A division of Reed Elsevier India Pvt .Ltd.New Delhi ISBN 81-8147-084-2
4. Advances in Enzymology and Related Areas of Molecular Biology, Mechanism of Enzyme Action, Daniel Purich
5. Medical Biochemistry by Ramakrishnan (2012)
6. ENZYMES: Catalysis, Kinetics and Mechanisms by N.S. Punekar
7. Molecular and cellular enzymology by Jeannine Yon-Kahn, G. Hervé.
8. Biochemical methods, S Sadashivam and A Manickam, new age international publishers
9. J. Jayaraman , Laboratory Manual in Biochemistry, 2003, New Age International

Course Code: RPSBCH103

Course Title: Biostatistics and Ecology

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Acquire hands-on practical training to plan biological experiments with requisite sample size. After completion of experiments based on different sample sizes students will be able to perform proper statistical analysis of the data using mean, median, mode, Range, percentiles, variance, SD, Mean deviation and Coefficient of variation
CO 2	Apply the principles of biological data management in real life situations.
CO 3	Learn R software and this training will improve computational, mathematical and computer skills of the students.
CO 4	Make the use of Hypothesis testing, Chi-square, Correlation & Regression, Normal distribution, ANOVA, Probability in their research work.
CO 5	Know statistical methods and it will help them in improving their analytical and interpretation skills
CO 6	Understand different concepts in population studies and ecology

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biostatistics and Ecology RPSBCH103	Credits/ Lectures 4 Credits
I	**1**	**Descriptive statistics and Probability**	**15L**
	1.1	Descriptive statistics:	5L
	1.1.1	Measures of central tendency - Mean, Median and mode	
	1.1.2	Measures of dispersion- Range, percentiles, variance, SD, Mean deviation, Coefficient of variation	5L
	3.1	Probability	5L
	3.1.1	Operations on events and probability	
	3.1.2	Conditional probability	
	3.1.3	Addition & Multiplication laws	
	3.1.4	Concept of odds in favour and odds against	
II	**2**	**Normal distribution, Hypothesis testing and ANOVA**	**15L**
	2.1.1	Normal distribution and skewness	3L
	2.1.2	Normal variate & its significance	
	2.2	Hypothesis testing –	4L
		z-test – one sample, two samples	
		One sample t-test	
		Independent and Paired t-test	5L
	2.3	Standard error	
	2.4	ANOVA – characteristics and types One way ANOVA testing	3L
III	**3**	**Chi-square, Correlation & Regression and Introduction to R-software**	**15L**
	3.2	Chi-square	2L
	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	
	1.2	Correlation	4L
	1.2.1	Introduction to Correlation, Bivariate & multivariate distributions,	
	1.2.2	Types of correlation	
	1.2.3	Measure of correlation – Karl Pearson, Spearman rank order and scatter plot	
	1.3	Regression	3L
	1.3.1	Concept of regression, Types of regression	

	1.3.2	Regression coefficient and equation	
	1.3.3	Simple & multiple regression	
	3.3	Introduction & application of R-software	3L
IV	**4**	**Ecology**	**15L**
	4.1	Introduction to ecology	1L
	4.2	Habitat and Niche	3L
		Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement	
	4.3	Population Ecology	4L
		Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations	
	4.4	Species Interactions	3L
		Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis	
	4.5	Community Ecology	4L
		Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones	
		Practicals – RPSBCHP103	2 Credits
	1	Introduction & application of R-software	
	2	Descriptive statistics using Microsoft excel/ R-software	
	3	Hypothesis testing of means & Hypothesis testing of difference between means using excel/ R-software	
	4	ANOVA & Chi-square test using excel/ R-software	
	5	Correlation & Regression using excel/ R-software	
	6	Study of Gause principle using *Paramecium* species (K-strategies) as study model	
	7	Study of logistic vs exponential growth curve and problems on population ecology	
	8	Graphical study of Lotka Voltera competition equation	

References:

1. Biostatistics by Arora
2. B.K. Mahajan. Jaypee brothers, Methods in biostatistics for medical & research workers. 6thedition, Medical Publishers (P) ltd.
3. Wayne Daniel, Biostatistics: A Foundation for Analysis in Health Sciences, 10th edition, 2013, Wiley.
4. Analysis of Biological Data, M. Whitlock and D. Schluter (2009); Roberts and company publishers
5. Statistical Modeling: A Fresh Approach by Daniel Kaplan
6. Research methodology Methods and Techniques by C.R. Kothari
7. OdumE.P. Fundamentals of Ecology, sauders publication; Indian edition, Nataraj Publications Dehradun, 1998.
8. Verma, P.S. and Agarwal, V.K. Concept of ecology (Environmental Biology), S.Chand & Co. Ltd., New Delhi 2004.

Course Code: RPSBCH104

Course Title: Instrumentation and Analytical Techniques I

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Gain expertise in the isolation of various biomolecules and organelles.
CO 2	Obtain hands-on training in basic separation techniques in biochemistry and gain expertise in the isolation of various biomolecules and organelles
CO 3	Acquire a sound background of latest methods used in biochemistry for purification of enzymes, isolation and characterization of proteins, nucleic acids, etc.
CO 4	Develop practical skills related to applications of spectroscopy, chromatography, electrophoresis
CO 5	Get equipped with the latest techniques used in analysis of biomolecules and this will help them in undertaking further research in the area of biochemistry in any research/industrial institution.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Instrumentation and Analytical Techniques I RPSBCH104	Credits/ Lectures 4 Credits
I	**1**	**Spectrophotometric techniques based on photometry**	**15L**
	1.1	Introduction to spectrophotometric techniques	1L
	1.2.	Principle, Instrumentation, Working & Biochemical applications of:	
	1.2.1	Ultraviolet and visible light spectroscopy	3L
	1.2.2	Fluorescence spectroscopy	2L
	1.2.3	Luminometry	2L
	1.2.4	Circular dichroism spectroscopy	2L
	1.2.5	Light scattering	2L
	1.2.6	Atomic spectroscopy	3L
II	**2**	**Introduction to Chromatography**	**15L**
	2.1	Principle of chromatography – distribution coefficient, retention time, retention factor, eddy diffusion, Theoretical plates	2L
	2.2	Types of Chromatography	
	2.2.1	Planar Chromatography	4L
		Paper Chromatography, TLC and HPTLC (Principle, working and applications)	
	2.2.2	Column Chromatography	3L
		Partition chromatography	
		Normal phase Vs reverse phase chromatography	
		Chiral chromatography	
		Ion-exchange chromatography	3L
		Hydrophobic interaction chromatography /Size exclusion	
		Affinity chromatography-	3L
		Immunoaffinity chromatography	
		Metal chelate ligand chromatography	
III	**3**	**Introduction to Electrophoresis and advanced electrophoresis techniques**	**15L**
	3.1	General principle of electrophoresis, and concept of electroendo-osmotic flow and Frictional coefficient	2L
	3.2	Types of Electrophoresis based on apparatus and supporting matrix	
	3.3	Electrophoresis of proteins	5L

		Polyacrylamide gel (cross-linking reaction for the formation of polyacrylamide gel)	
		Continuous and Discontinuous buffer system SDS PAGE, Native PAGE, Gradient gel, Isoelectric focusing gel, 2D Gel	
		Detection, estimation and recovery of Proteins in gels- Staining techniques (CBB, Silver staining, Zinc staining), protein blotting	
	3.4	Electrophoresis of nucleic acid –	3L
		Electrophoresis of DNA –AGE, PFGE	
		Electrophoresis of RNA	
		Detection of Nucleic acid in gel- Ethidium bromide, syber green	
	3.5	Advanced electrophoresis- Capillary electrophoresis, Immunoelectrophoresis, Microchip electrophoresis,	4L
	3.6	Gel documentation system- Principle and its application	1L
IV	**4**	**Radioisotopic Techniques**	**15L**
	4.1	Radioisotopes - Radioisotope Decay, Production of Isotopes, Synthesis of labelled compounds, Interaction of Radioactivity with matter, Measurement of Radioactivity with matter	5L
	4.2	Radio-activity counters	5L
	4.2.1	Methods based upon Gas Ionization (Ionization Chambers, Proportional Counters, Fundamentals of Geiger Counters)	
	4.2.2	Photographic methods	
	4.2.3	Methods based upon excitation - Liquid Scintillation counting	4L
	4.3.1	Uses of Stable Isotopes in Biology & Clinical Diagnostics	
	4.3.2	Commonly used Isotopes	
	4.4	Safety Aspects and Precautions	1L
		Practicals – RPSBCHP104	2 Credits
	1	Estimation of glucose by Folin-Wu method	
	2	Estimation of Na and K using flame photometer	
	3	Separation of amino acids/ sugars/ bases by thin layer chromatography/paper	
	4	Separation of protein by SDS PAGE	
	5	Separation of proteins by gel filtration chromatography	

	6	Separation of proteins using anion-exchange chromatography	
	7	Two dimensional chromatography of amino acids	
	8	Partial purification of an enzyme	
	9	Determination of pKa of glycine	

References:

1. Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th ed., Wilson, K., and Walker, J. (eds), Cambridge University Press (New Delhi)
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D.,Wiley Blackwell (West Sussex)
3. Analytical Biochemistry by David Holme and Hazel Peck
4. Introduction to Instrumentation in Life Sciences (2012) Bisen, P.S. and Sharma, A., CRC Press/Taylor and Francis Group (California), ISBN:978-1-4665-1240-
5. Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education
6. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay and Nath –Himalaya Publ. House.
7. Chromatography – G. Abbott
8. Chromatography Concepts, Methods and Applications – By Judah Carter
9. Biochemical methods, S Sadashivam and A Manickam, new age international publishers
10. J. Jayaraman , Laboratory Manual in Biochemistry, 2003, New Age International

Modality of Assessment (SEMESTER I)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

B) External Examination- 60%- 60 Marks
Semester End Theory Examination: (Deviation from the usual modality)
Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

1. Duration - These examinations shall be of **02 ½ 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 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	103			104			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Semester II

Course Code: RPSBCH201

Course Title: Industrial Biotechnology

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the fermentation process, inoculum development and fermentation media.
CO 2	Acquire information about large scale production and purification of various industrially important produces.
CO 3	Procure information about types and applications of biosensors in the field of biology.
CO 4	Obtain knowledge about production of different types of vaccines
CO 5	Realize the importance and identify the requirements for the compliance of QC, QA, GMP and GLP

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Industrial Biotechnology RPSBCH201	Credits/ Lectures 4 Credits
I	**1**	**Industrial Importance of Carbohydrates, Proteins & Lipids**	**15L**
	1.1	Carbohydrates of industrial importance	2L
	1.1.1	Manufacturing and refining of cane sugar, pectin & cellulose	
	1.1.2	Manufacturing of polysaccharides-Plant polysaccharide (Gum Arabic), microbial polysaccharides– modified starches & celluloses	3L
	1.2	Lipids of industrial importance	3L
	1.2.1	Extraction and refining of vegetable oils and animal fats & essential oils	
	1.2.2	Extraction and applications of chlorophyll, carotene, lycopene Turmeric	2L
	1.3	Proteins of industrial importance	5L
	1.3.1	Hormones – conventional & engineered-Insulin, Erythropoietin, Growth hormones	
	1.3.2	Non – catalytic industrial proteins – casein, whey proteins, Egg proteins, wheat germ proteins.	
II	**2**	**Biosensors & Vaccine Technology**	**15L**
	2.1	Biosensors	2L
	2.1.1	Beneficial features of biosensors	
	2.1.2	Basic components of biosensor	
	2.2	Types: Electrochemical, Thermometric, Optical, Piezoelectric, Whole cell, Immunobiosensor (Construction and development) Types of biosensors, their construction, working and application in various industries and medicine	2L
	2.2.1	Calorimetric biosensor – Enzyme based sensors (Importance in clinical diagnosis)	3L
	2.2.2	Potentiometric biosensor- Ion selective electrode (Importance in environmental monitoring)	
	2.2.3	Amperometric biosensor- (Glucose monitoring) Optical biosensor- Chromogenic reaction	
	2.2.4	Piezo-electric biosensor –Crystal study	1L
	2.2.5	Immunosensor - ELISA	
	2.3	Production of vaccine	2L

	2.3.1	Vaccine derived from whole organism Attenuated & Inactivated vaccine	
	2.3.2	Vaccine derived from macromolecules purified from pathogenic organism – Use of Bacterial polysaccharide, Toxoid, Proteins, Synthetic peptide for vaccine development	3L
	2.3.3	Recombinant vector vaccine	
	2.3.4	Multivalent subunit vaccine- (SMAA complex & ISCOM)	2L
	2.3.5	DNA vaccine (Production & applications)	
	2.3.6	Anti-Idiotype vaccine (Use of hybridoma technology)	
III	**3**	**Bioprocess technology**	**15L**
	3.1	Upstream processing:	2L
	3.1.1	Strains and Strain Improvement of industrial microorganisms	
	3.1.2	Isolation of industrially important microorganisms	
	3.1.3	Improvement of industrial microorganisms a) Selection of induced mutants for primary metabolite b) Isolation of induced mutants for secondary metabolites	3L
	3.1.4	Sterilization i) Introduction ii) Media sterilization	
	3.1.5	Design and methods of batch sterilization	2L
	3.1.6	Design and methods of continuous sterilization	
	3.2	Downstream processing	5L
	3.2.1	Recovery & Purification of fermentation products: i. Introduction, Precipitation, Filtration - theory, filter-aids, batch filters (Plate and frame filters), continuous filters (Rotary vacuum), Centrifugation: flocculating agent, range of centrifuges - Basket, tubular bowl. ii. Cell disruption: Physico-chemical. iii. Liquid – Liquid extraction, Solvent recovery, iv. Chromatography, Ultrafiltration, reverse osmosis, liquid membranes, drying, crystallization, Whole broth processing.	
	3.3	Environmental aspects	3L
	3.3.1	Effluent treatment and regulations for fermentation industry	
	3.3.2	Modern methods of effluent treatment	
IV	**4**	**Total Quality Management (QC, QA, GLP, GMP)**	**15L**
	4.1	Importance of Laboratory Quality	2L

	4.1.1	Overview of the quality management system	
	4.2	Introduction and Concept (in labs & production processes) of -	3L
	4.2.1	QC – Types, Requirement to implement QC, Control materials	
	4.2.2	QA – SOP, Calibration, Auditing and checking compliance	3L
	4.2.3	GMP – Sanitation and Hygiene, Qualification and validation, Documentation of GMP practices	3L
	4.2.4	GLP – Protocol, Standard Operating Procedures (SOPs), Validation of methods, Audits and Inspection	4L
		Practicals – RPSBCHP201	2 Credits
	1	Estimation of Total Carbohydrates by anthrone method	
	2	Colorimetric estimation of fructose	
	3	Isolation of pectin form apples	
	4	Isolation of cellulose by acidified sodium chlorite treatment	
	5	Plant protein extraction by TCA-Acetone method	
	6	Isolation of Lecithin & Cholesterol from egg yolk	
	7	Extraction of oils using Soxhlet apparatus and it's analysis	
	8	Bioassay of vitamin B_{12}	
	9	Quality control experiments	
	10	Virtual Lab – Bioreactor modelling & Simulation Lab	

References:

1) L.E.Casida, Industrial Microbiology, New Age International publishers
2) Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey (Smithers Rapra)
3) Handbook of Good Laboratory Practices (GLP), Second Edition – World Health Organization
4) Quality Assurance - A Practical Guide to the Design and Implementation of Assessments and Monitoring Programmes, Jamie Bartram and Gareth Rees, World Health Organization
5) M. Pelczar, E.C.S. Chan and M.R. Krieg, MICROBIOLOGY, McGraw Hill Inc., Singapore (1997).
6) L. E. Casida, Industrial microbiology, New age international publishers
7) Industrial Fermentation by Paul Allen
8) Biochemical methods, S Sadashivam and A Manickam, new age international publishers
9) J. Jayaraman, Laboratory Manual in Biochemistry, 2003, New Age International

Course Code: RPSBCH202

Course Title: Research Methodology, IPR, Bioinformatics & Nanotechnology

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the objectives of doing scientific research.
CO 2	Learn how to identify the area of research to be conducted, how to proceed for literature survey using a variety of sources and how to write research project proposal with well-placed hypothesis and objectives.
CO 3	Learn the skills of research design, nature of sample size as well as collection and analysis of data.
CO 4	Know the skills of writing research report and making oral presentations.
CO 5	Understand the significance of studying different variables in a research study and its effects on the results obtained and the importance of the statistical analysis of the results. At the end the students will also be aware of different methodologies by which research can be effectively communicated.
CO 6	Understand methods used for bioinformatics studies.
CO 7	Comprehend the synthesis of nanomaterials and their applications in the field of biology and medicines.
CO 8	Appreciate the technological advances in the field of nanobiotechnology and get fascinated with the advances in the research field and try to pursue them.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Research Methodology, IPR, Bioinformatics & Nanotechnology RPSBCH202	Credits/ Lectures 4 Credits
I	**1**	**Research, Research Design & Presentation**	**15L**
	1.1	Research	4L
	1.1.1	Meaning of research, Objectives of research, Types of Research, Research Process	
	1.1.2	Criteria for good research, Significance of research.	
	1.2	Research Problem	
	1.2.1	Formulating research problem	
	1.2.2	Problems encountered by a researcher	
	1.3	Research Design	
	1.3.1	Meaning and need for research design, Features of good research design,	
	1.3.2	Types of research designs – exploratory, descriptive, experimental, survey and case study.	6L
	1.3.3	Different research designs and their basic principle. Study Designs and Variations (only definitions): Prospective, retrospective, prospective & retrospective, observational, experimental, clinical trials, RCT, Cohort, cross sectional and case-controlled studies.	
	1.3	Presentation	5L
	1.3.1	Methodology for writing a report and oral presentation	
	1.3.2	Presentation – Oral & Written. Use of digital media.	
	1.3.3	Preparing for oral presentation, Structure of oral presentation	
	1.3.4	Giving the oral presentation - Presentations in classrooms, scientific meets & public audience. Scientific Communication	
II	**2**	**Report Writing & IPR and Patents**	**15L**
	2.1	Report Writing	8L

	2.1.1	Significance of report writing, Different s in report writing, types of report.	
	2.1.2	Mechanics and precautions of writing research reports for scientific journals, popular magazines, seminars/symposia/ conferences/workshops	
	2.1.3	Layout of research report, Layout for poster	
	2.2	Intellectual Property Right (IPR)	7L
	2.2.1	Introduction, Types, Objectives, Applications.	
	2.2.2	Patents- Definition and concept, Types, Criteria, Registration of Patents	
III	**3**	**Bioinformatics**	**15L**
	3.1	Introduction to In silico biology - Aim, Scope, Application & limitations	2L
	3.2	Introduction to Biological Databases	5L
	3.2.1	Types of Biological Databases – primary & Secondary & Specialized databases	
	3.2.2	Information Retrieval from Biological Databases Biological Databases and retrieval techniques Nucleotide Databases- Genbank, EMBL, DDBJ Unigene, Literature Database- Pubmed, Medline Protein Sequence Databases- Swissprot, PIR, TrEMBL Protein Structural Databases- PDB, RasMol SCOP, CATH Metabolic pathway database- KEGG, Metacyc, Ecocyc, Biocyc Other databases- OMIM, Taxonomy Sequence Alignment Pairwise Sequence Alignment	
	3.3	Evolutionary Basis Sequence Homology versus Sequence Similarity Sequence Similarity versus Sequence Identity Statistical Significance of Sequence Alignment	2L
	3.4	Protein Motifs and Domain Prediction, Identification of Motifs and Domains in Multiple Sequence Alignment	2L
	3.5	Motif and Domain Databases Using Regular Expressions Motif and Domain Databases Using Statistical Models	2L
	3.6	Molecular phylogenetics	2L

		Phylogenetic analysis, phylogenetic tree and its importance	
IV	**4**	**Nanotechnology**	**15L**
	4.1	Nanomaterials-its synthesis and applications	2L
	4.1.1	Synthesis of Nanoparticles – Solvent Extraction, Emulsification, Salting out, Solvent Displacement, Spray Drying	
	4.1.2	Synthesis of Nanocapsules – Nanoprecipitation, Emulsion, – Diffusion, Double emulsification, Emulsion coacervation, Layer by layer	2L
	4.1.3	Synthesis Nanotubes – Arc-vaporization, Laser ablation, Chemical Vapour Deposition	2L
	4.2	Gold Nanoparticles – Types and its applications in biology	4L
	4.3	Lab-on-a-chip (LOC) – Principle & role in clinical diagnosis	
	4.4	Nanotherapeutics	3L
	4.5	Nanotoxicity	
	4.5.1	Absorption and distribution of Nanoparticles	2L
	4.5.2	Toxicological effects of nanoparticles in various target organs	
		Practicals – RPSBCHP202	2 Credits
	1	Collection of Biochemical data and its presentation	
	2	Review of research work carried out of any 5 national or international research centers or institutes	
	3	Presentation of review of research using powerpoint	
	4	Preparation of research proposal for minor/ major research projects to be submitted to the funding agencies	
	5	Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept	
	6	BLAST suite of tools for pairwise alignment	
	7	Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB	
	8	Multiple sequence alignment (CLUSTALW/ TCoffee) and Construction of phylogenetic trees	
	9	Preparation of nanoparticles and analysis	

References:

1) Research Methodology methods and techniques, Second Revised Edition, C.R.Kothari (New Age International Publishers)
2) Bhattacharya, D. K. (2003): Research Methodology, Excel Books, New Delhi
3) Research Methods Lippinott Company, U.K
4) Bioinformatics methods and applications, Genomics, Proteomics and drug discovery, Fourth Edition, S.C.Rastogi
5) Introduction to Bioinformatics in Microbiology. Henrik Christensen, Springer International Publishing (2018)
6) Introduction to Bioinformatics. Arthur Lesk, Oxford University Press (2013)
7) Nanobiotechnology, David Andrew Phoenix & Waqar Ahmed (One central press ltd)

Course Code: RPSBCH203

Course Title: Fundamentals of Genetics

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Strengthen the fundamentals of Mendelian and neo-Mendelian genetics.
CO 2	Understand the structure of DNA & RNA
CO 3	Learn and apply concepts like epistasis, gene mapping, tetrad and Pedigree analysis which will be helpful in competitive examinations
CO 4	Acquire knowledge about Organization of DNA in genome
CO 5	Gain a thorough understanding of the mechanism of cell cycle, relationship of cell cycle and programmed cell death via intracellular and extracellular control mechanisms
CO 6	Know about mechanism of DNA replication which would lay a foundation for studying next processes of central dogma.
CO7	Enlist different types of mutations, agents causing mutations and disorders resulting from mutations.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Fundamentals of Genetics RPSBCH203	Credits/ Lectures 4 Credits
I	**1**	**Genetics I**	**15L**
	1.1	Non –Mendelian inheritance	3L
	1.1.1	Molecular mechanism of Incomplete dominance, co-dominance & Overdominance	
	1.1.2	Incomplete penetrance	
	1.1.3	Epistasis & Environmental effect on phenotype	4L
	1.1.4	Sex linked inheritance; Sex influenced inheritance & Sex limited inheritance	
	1.1.5	Allelic effects- Pleiotropy, Polygenic inheritance	
	1.1.6	Maternal gene effect, Maternal inheritance & cytoplasmic inheritance	3L
	1.2	Pedigree analysis – Pedigree conventions and analysing pedigrees (genetic basis, probability)	5L
	1.3	Problems based on these concept	
II	**2**	**Genetics II**	**15L**
	2.1.1	Eukaryotic chromosomes, Unique and repetitive sequences of DNA	3L
	2.1.2	Tm of DNA, its relation to GC content, Cot curves and its significance, C-value paradox	
	2.1.3	Histones, nucleosomes, structure of chromatin, cohesion protein	3L
	2.2	Lampbrush & polytene chromosomes	
	2.3	Genetic recombinations: Holliday models	
	2.4	Genetic mapping in Eukaryotes - Linear order of genes, Relative distance between linked genes, Coefficient of coincidence, Interference	3L
	2.5	Tetrad analysis – Ordered & Unordered tetrad	3L
	2.6	Genetic mapping in bacteria	
	2.7	Problems based on above concept	3L
III	**3**	**Cell Cycle and its regulation & DNA Replication**	**15L**
	3.1	Cell cycle and its regulation	3L
	3.1.1	Phases of cell cycle and its regulation (Cyclins & CDKs)	
	3.1.2	State of DNA in different phases of cell cycle	
	3.2	Replication of DNA	2L
	3.2.1	Structural overview of DNA Replication	

	3.2.2	Enzymes and proteins involved in replication	2L
	3.2.3	Mechanism of Bacterial DNA replication	
	3.3	Replication of DNA in yeast	2L
	3.3.1	Eukaryotic DNA polymerases	
	3.3.2	Proteins and accessory molecules essential in the initiation, and elongation steps	
	3.3.3	Mechanism (Pre-RC assembly, Initiation, elongation & termination)	2L
	3.3.4	Concept of Okazaki fragment maturation & stalled replication fork	3L
	3.3.5	End replication problem and role of telomerases	
	3.4	Comparative overview of DNA replication in prokaryotes and eukaryotes	1L
IV	4	**Mutations, Chromosomal Abnormalities & DNA Repair**	**15L**
	4.1	Mutations	3L
	4.1.1	Types of mutations	
	4.1.2	Physical, chemical and Biological agents causing mutations	
	4.1.3	Reverse mutations, Mutagenesis, Ames test.	
	4.2	Chromosomal aberration	3L
	4.2.1	Variations in chromosome structure - inversions, deletions, duplications and translocations	
	4.2.2	Variations in chromosome number - Euploidy and aneuploidy (Autosomal and Sex chromosomes)	
	4.3	Syndromes resulting from chromosomal abnormalities	4L
	4.3.1	Monosomies (Turner syndrome)	
	4.3.2	Disomies and trisomies (Down Syndrome, Klinefelter's syndrome)	
	4.3.3	Cri-du-chat syndrome, Philadelphia chromosome	
	4.3.4	Chromosomal Microdeletions – Prader-Willi Syndrome & Angelman Syndrome	
	4.4	Recognition of DNA lesions and molecular mechanism of the following DNA Repairs	5L
	4.4.1	Direct repair (Photoreactivation, O6 methyl guanine DNA methyl transferase)	
	4.4.2	Single strand repairs - Base & Nucleotide Excision Repairs, Mismatch repair (Hemimethylation of DNA)	
	4.4.3	Translesion synthesis and SOS repair	

	4.4.4	Recombinational repair	
		Practicals – RPSBCHP203	2 Credits
	1	Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes	
	2	Induction of polyploidy in onion roots	
	3	Smear technique to demonstrate sex chromatin in buccal epithelial cells.	
	4	Study of abnormal human karyotype and pedigrees (dry lab)	
	5	Problems based on gene mapping	
	6	Extraction of total nucleic acids from plant tissue	
	7	Estimation of UV absorption of nucleic acids & proteins	
	8	Effect of UV Radiation on Bacterial Growth	

References:

1) E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, Ney York.
2) Watson, Baker, Bell, Gann, Levine, Losick, "Molecular Biology of the Gene", Fifth Edition, Pearson Education (LPE)
3) Russell, P.J., "iGenetics- A Molecular Approach", Third Edition, Pearson International Edition
4) Snustad & Simmons, "Principles of Genetics", Third Edition, John Wiley & Sons Inc
5) Watson, Gilman, Witkowski, Zoller, "Recombinant DNA", Second Edition, Scientific American Books
6) Pierce, B.A, "Genetics- A Conceptual Approach", Second Edition, W.H. Freeman &Co

Course Code: RPSBCH204

Course Title: Instrumentation and Analytical Techniques II

Academic year 2021-22

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Gain Knowledge about advanced instruments used in biochemical analysis.
CO 2	Comprehend the diagnosis of various diseases better by studying Instruments used in medicine.
CO 3	Acquire a sound background of latest methods used in biochemistry for purification of enzymes, isolation and characterization of proteins, nucleic acids, etc.
CO 4	Develop interest in analysis of biomolecules and this will help them in undertaking further research in the area of biochemistry in any research/industrial institution.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Instrumentation and Analytical Techniques II RPSBCH204	Credits/ Lectures 4 Credits
I	**1**	**Spectrophotometric techniques based on molecular structure and interactions**	**15L**
	1.1	Introduction to spectroscopic techniques for Structural analysis	1L
	1.2	Principle, Instrumentation, Working & Biochemical applications of	3L
	1.2.1	Infrared and Raman spectroscopy	
	1.2.2	Surface plasmon resonance	2L
	1.2.3	Electron paramagnetic resonance	2L
	1.2.4	Nuclear magnetic resonance	3L
	1.2.5	X-ray diffraction	2L
	1.2.6	Small-angle scattering	2L
II	**2**	**Advanced Chromatography**	**15L**
	2.1	Gas chromatography, Principle, Working, Detectors (ECD, TCD, FID, NP)	3L
	2.2	High performance liquid Chromatography- Principle, Working Detectors (UV, PDA, RI, conductivity, fluorescence)	3L
	2.3	Introduction to Hyphenation GC-MS and LC-MS	3L
	2.4	MALDI & MALDI-TOF	3L
	2.5	Sample Preparation and Biochemical Applications of above mentioned Techniques	3L
III	**3**	**Special Instrumental Methods of Analysis**	**15L**
	3.1	Basic Principles, Instrumentation, working and applications of -	
	3.1.1	FRAP, FRET, FLIM	3L
	3.1.2	Conductometry	1L
	3.1.3	Potentiometry	2L
	3.1.4	Selective Ion Meters	2L
	3.1.5	High Frequency Titrations	2L
	3.1.6	Polarography	2L
	3.1.7	Anode Stripping Voltammetry	2L
	3.1.8	Neutron Activation Analysis	1L
IV	**4**	**Instruments used in medicine**	**15L**
		Principle and working of	

	4.1	Dialyser, Nebulizer, Otoscope, Bone Densitometry Single neuron recording, patch-clamp recording	4L
	4.2	ECG, Defibrillator	1L
	4.3	Brain activity recording, lesion & stimulation of brain - PET, MRI, fMRI, CAT	3L
	4.4	Medical imaging –	2L
	4.4.1	Radiography (Projection radiographs & Fluoroscopy)	
	4.4.2	Ultrasound (medical ultrasonography), Elastography, Tactile imaging	3L
	4.4.3	Tomography, Echocardiography (Heart Ultrasound)	2L
		Practicals – RPSBCHP204	2 Credits
	1	Effect of ion concentration on the conductance of solutions	
	2	Virtual Labs – Autoradiography, Patch Clamp Techniques	
	3	Study of Electrocardiograms in healthy & diseased states	
	4	Seminar on the Principle, Working and Applications of different instruments	
	5	Instrumentation: Case studies	
	6	Field visit & report writing	

References:

1. Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th ed., Wilson, K., and Walker, J. (eds), Cambridge University Press (New Delhi)
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D.,Wiley Blackwell (West Sussex)
3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
4. Introduction to Instrumentation in Life Sciences (2012) Bisen, P.S. and Sharma, A., CRC Press/Taylor and Francis Group (California), ISBN:978-1-4665-1240-
5. Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education
6. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay and Nath –Himalaya Publ. House.
7. Medical Biochemistry by Ramakrishnan (2012)
8. TextBook of Medical Physiology – Guyton – Prism Books Pvt. Ltd. – Bangalore

Modality of Assessment (SEMESTER II)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

B) External Examination- 60%- 60 Marks
Semester End Theory Examination: (Deviation from the usual modality)
Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

1. Duration - These examinations shall be of **02 ½ 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 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	203			204			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100
