Resolution number AC/II (20-21).2.RPS2

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: MSc

Program Code: RPSBCH

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

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
MSc II	III	RPSBCH301	Biochemistry of Metabolism	4
		RPSBCH302	Clinical biochemistry	4
		RPSBCH303	Molecular biology	4
		RPSBCH304	Biology of diseases & Clinical Research	4
		RPSBCHP301	Practicals based on RPSBCH301	2
		RPSBCHP302	Practicals based on RPSBCH302	2
		RPSBCHP303	Practicals based on RPSBCH303	2
		RPSBCHP304	Practicals based on RPSBCH304	2
	IV	RPSBCH401	Human Physiology & Developmental Biology	4
		RPSBCH402	Endocrinology	4
		RPSBCH403	Genetic Engineering & Biotechnology	4
		RPSBCH404	Advanced Immunology	4
		RPSBCHP401	Dissertation	4
		RPSBCHP402		
		RPSBCHP403	Practicals based on RPSBCH403	2
		RPSBCHP404	Practicals based on RPSBCH404	2

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 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 Edidin	2L

		Experiment & FRAP analysis	
	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 (4th 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	Estimation of proteins using Lowry method	
	2	Study of Ramachandran plot (Dry lab)	
	3	Study of protein denaturation – change in isoelectric pH	
	4	Colorimetric assay for cysteine	
	5	Determination of optimum pH & temperature of β-Amylase/Invertase/Urease	
	6	Determination of Km and Vmax of β-Amylase/Invertase/Urease	
	7	Assay to determine enzyme activity and specific activity	
	8	Study the effect of inhibitor on β-Amylase/Invertase/Urease	
	9	Comparative assessment of the β-Amylase/Invertase/Urease activity in free and immobilized state	
	10	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 & ANOVA using excel/ R-software	
	4	Hypothesis testing of difference between means &	
	5	Chi-square test using excel/ R-software	
	6	Correlation & Regression using excel/ R-software	
	7	Study of Gause principle using *Paramecium* species (K-strategies) as study model	
	8	Study of logistic vs exponential growth curve and problems on population ecology	
	9	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	Ammonium sulphate fractionation of proteins	
	5	Separation of protein by SDS PAGE	
	6	Separation of proteins by gel filtration chromatography	
	7	Separation of proteins using anion-exchange chromatography	
	8	Two dimensional chromatography of amino acids	
	9	Partial purification of an enzyme	
	10	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**

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	3L

		b) Isolation of induced mutants for secondary metabolites	
	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 proteins from germinating seeds	
	5	Isolation of Casein	
	6	Isolation of Lecithin & Cholesterol from egg yolk	

	7	Extraction of oils using Soxhlet apparatus and it's analysis	
	8	Bioassay of penicillin/ampicillin	
	9	Bioassay of vitamin B_{12}	
	10	Quality control experiments	
	11	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 Phylogenetic analysis, phylogenetic tree and its importance	2L
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
	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	
I	1.1.3	Epistasis & Environmental effect on phenotype	3L
	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	2L

	1.2	Pedigree analysis – Pedigree conventions and analysing pedigrees, Problems based on these concept	3L
	1.3	Structure of Nucleic acid	3L
	1.3.1	Structure and characteristic of DNA & RNA - double helical structure	
	1.3.2	A, B & Z DNA, linear and circular DNA.	
	1.4	Tm of DNA, its relation to GC content,	
	1.5	Types of RNA, structure & functions	
	1.6	Cot curves and its significance, C-value paradox	1L
II	**2**	**Genetics II**	**15L**
	2.1	Eukaryotic chromosomes, Unique and repetitive sequences of DNA	4L
	2.2	Organization of DNA in genome	
	2.3	Histones, nucleosomes, structure of chromatin, cohesion protein	
	2.4	Lampbrush & polytene chromosomes	2L
	2.5	Genetic recombinations: Holliday models	
	2.6.1	Gene mapping – Basis and Merits	4L
	2.6.2	Linear order of genes, Relative distance between linked genes, Coefficient of coincidence, Interference	
	2.7	Tetrad analysis – Ordered & Unordered tetrad	2L
	2.8	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	Models for DNA replication- Conservative, Semi-conservative & dispersive	
	3.2.3	Experimental evidences	
	3.2.4	Enzymes and proteins involved in replication	2L
	3.2.5	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	Virtual Labs – Autoradiography, Patch Clamp Techniques	
	2	Study of Electrocardiograms in healthy & diseased states	
	3	Seminar on the Principle, Working and Applications of different instruments	
	4	Instrumentation: Case studies	
	5	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**

Course Code: RPSBCH301

Course Title: Biochemistry of Metabolism

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 major catabolic and anabolic pathways in metabolism of carbohydrates, lipids, amino acids and nucleotides.
CO 2	Describe regulatory mechanisms that control the metabolic pathways.
CO 3	Realize the Influence of Diet and hormonal signalling on metabolic pathways.
CO 4	Learn Biochemical functions and integrated metabolism of in brain, digestive system, liver, red cell, muscle and adipocyte.
CO 5	Illustrate the molecular mechanisms underlying major inherited diseases of metabolism.
CO 6	Understand the relationship between the properties of macromolecules and cellular activities, cell metabolism and chemical composition.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biochemistry of Metabolism RPSBCH301	Credits/ Lectures 4 Credits
I	**1**	**Carbohydrate Metabolism**	**15L**
	1.1	Schematic representation of Glycolysis & Kreb's cycle	2L
	1.2	Gluconeogenesis: Pathway and its Regulation	1L
	1.3	Glycogen Metabolism: Synthesis, breakdown, mechanisms of control of glycogen metabolism - Direct Allosteric Control of Glycogen Phosphorylase and Glycogen Synthase, Covalent Modification of Enzymes by Cyclic Cascades, Hormonal regulation, Maintenance of Blood Glucose Levels	3L

	1.4	Futile cycle, Rapoport Luebering cycle, Cori cycle, Glucose-Alanine cycle & their significance	2L
	1.5	Shuttles-Malate-Aspartate shuttle & Glycerol phosphate shuttle	3L
	1.6	Uronic acid pathway (biosynthesis, degradation & its significance), Galactose and fructose metabolism; Sorbitol pathway	
	1.7	Biosynthesis of oligosaccharides and glycoproteins	1L
	1.8	Synthesis of carbohydrates in plants	3L
	1.8.1	Calvin cycle and its regulation, regulated synthesis of starch and sucrose, photorespiration, C4 and CAM pathways, Glyoxylate pathway, synthesis of cell wall polysaccharides	
II	**2**	**Amino acid metabolism**	**15L**
	2.1	Reactions of amino acids: Deamination, Transamination, Decarboxylation, Transmethylation, Transdeamination,	3L
	2.2	Ammonia formation, transport and detoxification in brain and liver	
	2.3	Kreb's bicycle, Urea cycle & its regulation. Inherited defects of urea cycle	2L
	2.4	Glucogenic and ketogenic amino acids.	
	2.5	Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease	3L
	2.6	Biosynthesis of amino acids Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation	2L
	2.7	Precursor functions of amino acids	1L
	2.7.1	Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA).	4L
III	**3**	**Lipid metabolism**	**15L**
	3.1	Fatty acid oxidation	4L
	3.1.1	Fatty acid transport to mitochondria, β-oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β-oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis	

	3.2	Fatty acid synthesis	2L
	3.2.1	Transport of mitochondrial Acetyl Co A to cytosol, Fatty acid synthase complex, Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.	
	3.2.2	Biosynthesis of eicosanoids, cholesterol, steroids and isoprenoids	2L
	3.2.3	Synthesis of prostagladins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of steroids and isoprenoids.	3L
	3.2.3	Biosynthesis of glycerophospholipids and sphingolipids	2L
	3.4	Lipid storage diseases	2L
IV	4	**Nucleic Acid Metabolism & Integration of Metabolism**	**15L**
	4.1	Biosynthesis of purine and pyrimidine nucleotides	3L
	4.1.1	De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Deoxyribonucleotides and synthesis of nucleotide triphosphate	
	4.1.2	Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates,	2L
	4.2	Biosynthesis of coenzyme nucleotides	1L
	4.3	Degradation of purine and pyrimidine nucleotides	2L
	4.4	Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism.	1L
	4.5	Disorders of purine and pyrimidine metabolism – Lesch-Nyhan, syndrome, Gout, SCID, adenosine deaminase deficiency	3L
	4.6	Integration of metabolism	1L
	4.6.1	Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).	2L
		Practicals – RPSBCHP301	2 Credits
	1	Estimation of glucose by the GOD-POD method	
	2	Study of glucose metabolism using handheld glucometer	
	3	Estimation of amino acids by ninhydrin	
	4	Estimation of serum urea by diacetyl monoxime method	

	5	Estimation of serum creatinine by alkaline picrate method	
	6	Assay of glutamate dehydrogenase	
	7	Estimation of serum uric acid by phosphotungstic acid method (Caraways method)	
	8	Use of softwares to understand metabolism – KEGG, Ecocyc, Metacyc, Biocyc	

References:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641- 0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freemanand Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
4. Principles of Biochemistry by G. Zubay, W. Parson, D.
5. Biochemistry - Voet, D. and Voet, J.G. - John Wiley & Sons, Inc. USA.

Course Code: RPSBCH302

Course Title: Clinical Biochemistry

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	The student will learn and understand the basics of circulatory system including haematopoiesis, homeostasis, and diseases of blood.
CO 2	Explain the fundamentals, composition and significance of Body fluids
CO 3	To get acquainted with the role of enzymes in diagnosis of various diseases.
CO 4	The student will be aware of the organ function tests available for detection of their functionality
CO 5	Illustrate Pathophysiology of certain disorders related to certain organs & Clinical tests available for detection

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Clinical Biochemistry RPSBCH302	Credits/ Lectures 4 Credits
I	**1**	**Haematopoiesis & related disorders**	**15L**
	1.1	Introduction to Haematopoiesis	1L
	1.1.1	Erythropoiesis - Stages of development of erythrocytes, Precursors of RBCs, Factors influencing erythropoiesis	2L
	1.1.2	Role of erythropoietin	
	1.2	Haemoglobin (Hb)-Features, varieties, combination of Hb with gases, Haeme-haeme interactions	4L
	1.2.1	Biosynthesis of Haemoglobin (with structures)	
	1.2.3	Biochemical pathway for Porphyrin synthesis, formation of Haeme	
	1.3	Haeme catabolism	2L
	1.4	Haemoglobinopathies	2L

	1.4.1	Genetics basis of haemoglobinopathies - Sickle cell anemia, Thalassemia – alpha (Subtypes of alpha thalassemia) & beta	
	1.5	Blood gas analysis	1L
	1.5.1	Leucopoiesis, Leucocytosis and factors responsible, Leukopenia, Thrombopoiesis, Thrombocytopenia	2L
	1.6	Molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems, haemophilia and thrombosis	1L
II	**2**	**Biochemistry of body Fluids & related disroders**	**15L**
	2.1	Plasma	3L
	2.1.1	Composition, Separation of plasma proteins – Salting out, Cohn's fractionation, Electrophoresis	
	2.1.3	Characteristics, functions and clinical significance of plasma proteins	
	2.2	Proteinuria – types & causes	1L
	2.3	Bile	4L
	2.3.1	Bile pigments- Biliverdin and Bilirubin	
	2.3.2	(formation, transport, conjugation in liver cells, secretion in bile, excretion)	
	2.3.3	Clinical importance of bile formation (concept - index of rate of haeme catabolism, shunt hyperbilirubinaemia, bilirubin encephalopathy)	
	2.4	Lymph- Formation, composition and circulation	1L
	2.5	CSF- Composition, Appearance, Pressure of CSF and Biochemical Changes in CSF and its clinical significance	2L
	2.6	Synovial fluid- Composition, Classification and Clinical significance – synovial fluid viscosity, pathology	1L
	2.6.1	Analysis – mucin clot test, microscopic analysis	1L
	2.7	Pericardial fluid- Composition, Function & Pericardiocentesis, Pericardial effusion, Ischemic heart disease	2L
III	**3**	**Enzymes & isoenzymes of clinical importance**	**15L**
	3.1	Introduction, Possible mechanisms responsible for abnormal enzyme levels	4L
	3.2	Value of serum enzyme assay in clinical practice Enzyme assays of clinical significance	

	3.3	Myocardial infarction – Creatine phosphokinase, S-GOT, LDH. Important cardiac markers useful in diagnosis of acute myocardial infarctions	4L
	3.4	GI tract diseases - Serum amylase, serum lipase	2L
	3.5	Liver diseases – Serum transaminases	
	3.6	Muscle diseases – Serum aldolase, serum CPK	2L
	3.7	Bone diseases – Serum alkaline phosphatases	
	3.8	Malignancies – Acid phosphatase, β-glucuronidase	1L
	3.9	Value & clinical significance of isoenzymes of – LDH, CPK, Alkaline phosphatase	2L
IV	**4**	**Organ Function Tests**	**15L**
	4.1	Renal Function test Preliminary investigations Classification of renal function tests – Tests based on glomerular filtration, Tests to measure Renal Plasma Flow, Tests based on tubular function	2L
	4.2	Liver Function test Tests based on abnormalities of bile pigment metabolism - VD Bergh Reaction, Determination of Serum Bilirubin Tests based on liver's part in carbohydrate metabolism – Glucose tolerance test, Galactose tolerance test, Fructose tolerance test	2L
	4.3	Tests based on changes in plasma proteins – Determination of Total Plasma Proteins and Albumin and Globulin and A:G Ratio, Estimation of Plasma Fibrinogen, Flocculation Tests, Amino acids in urine	3L
	4.4	Tests based on abnormalities of lipids - Determination of serum cholesterol and ester cholesterol and their ratio, Determination of faecal fats	2L
	4.5	Tests based on detoxicating function of liver - Hippuric acid synthesis test	2L
	4.6	Gastric Function test – Fractional gastric analysis, stimulation tests	2L
	4.7	Thyroid Function test Tests based on primary function of thyroid, Tests measuring blood levels of thyroid hormones	2L

		Practicals – RPSBCHP302	2 Credits
	1	Enumeration of Blood cells: RBC and WBC counting	
	2	Qualitative analysis of bile	
	3	Estimation of serum electrolytes	
	4	Estimation of blood glucose by ortho-toluidine mono step method	
	5	Estimation of serum phosphorus by Fiske Subbarow method	
	6	Estimation of serum Calcium by Trinder's method	
	7	Estimation of serum iron by dipyridyl method	
	8	Clinical analysis of CSF – glucose, proteins, chlorides	
	9	Liver Function Tests – a) Estimation of serum ALT and AST b) Estimation of total and direct bilirubin c) Estimation of serum alkaline phosphatase d) Estimation of total proteins, albumin and determination of A/G ratio e) Estimation of serum albumin by Bromocresol Green (BCG) binding method	
	10	Renal Function tests a) Creatinine clearance test b) Urea clearance test	
	11	Pancreatic Function Test a) Estimation of serum amylase activity b) Glucose Tolerance Test	
	12	Estimation of serum total cholesterol and HDL cholesterol	
	13	Estimation of triglycerides	

References:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
3. The World of the cell, 7th edition (2009)
4. Genetics (2012) Snustad and Simmons
5. Urinalysis and Body Fluids by Susan King Strasinger & Marjorie Schaub Di Lorenzo, 6th Edition
6. Graff's Textbook of Urinalysis and Body Fluids – Lillian A. Mundt & Kristy Shanahan, 2nd Edition
7. Fundamentals of the study of urine and body fluids – Nancy A. Brunzel, 3rd Edition,

Elsevier
8. A Textbook of Medical Biochemistry – MN Chatterjea & Rana Shinde, 8th Edition, Jaypee Publication
9. Clinical Biochemistry Metabolic and Clinical Aspects by William J. Marshall, Márta Lapsley, Andrew Day, Ruth Ayling
10. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA Principles of Biochemistry by G. Zubay, W. Parson, D.

Course Code: RPSBCH303

Course Title: Molecular biology

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 mechanism of cell cycle, relationship of cell cycle and programmed cell death via intracellular and extracellular control mechanisms
CO 2	The students will learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication.
CO 3	The student will be able to illustrate the mechanism of prokaryotic and eukaryotic replications
CO 4	The student will learn & understand different types of mutations, agents causing mutations and disorders resulting from mutations.
CO 5	Comprehend the mechanism and regulation of transcription in prokaryotes along with Reverse transcription.
CO 6	The student will be able to describe synthesis of protein from gene with the help of regulatory protein
CO 7	The student will be able to explain the Post transcriptional & translational modifications & their significance in stability

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Molecular Biology RPSBCH303	Credits/ Lectures 4 Credits
I	**1**	**Prokaryotic and eukaryotic Transcription & Post-transcriptional Modifications**	**15L**
	1.1	Overview of Transcription	1L
	1.2.1	Role of Prokaryotic RNA polymerase and promoter; Upstream regulatory sequences	4L
	1.2.2	Stages of transcription: Initiation, elongation and termination (Rho dependent & Rho independent)	

	1.2.3	Significance of Sigma factor, Concept of Abortive initiation	
	1.3	Transcription in eukaryotes	3L
	1.3.1	Role of promoter & regulatory elements	
	1.3.2	Eukaryotic RNA polymerases and Cis acting & Trans acting elements	
	1.3.3	Mechanism of RNA transcription in eukaryotes - Formation of pre-initiation complex, initiation, elongation and termination	
	1.4	RNA Modification	1L
	1.4.1	Mechanism of addition of 5'-cap & formation of poly A tail	
	1.4.2	Molecular mechanism of mRNA Splicing	1L
	1.4.3	RNA Processing of rRNA & tRNA	1L
	1.4.4	RNA editing - Base modifications	1L
	1.5	Role of Inhibitor -Rifampicin, Actinomycin D	1L
	1.6	Reverse transcription (Mechanism, significance & application)	2L
II	**2**	**Prokaryotic and eukaryotic Translation & Post-translational Modifications**	**15L**
	2.1	Genetic basis of protein biosynthesis – Concept of structural gene & Protein, Characteristics of Genetic code	4L
	2.2	Ribosome assembly & structure (Comparison between prokaryotic & eukaryotic ribosome)	
	2.3	tRNA – structural features and tRNA synthetase, initiator tRNA, activation of amino acids	2L
	2.4.1	Mechanism of translation in prokaryotes: Initiation, elongation & termination	3L
	2.4.2	Concept of Polyribosome	
	2.5	Mechanism of eukaryotic translation: Initiation, elongation & termination	2L
	2.6	Inhibitors of translation (prokaryotes & eukaryotes)	1L
	2.7	Post translational modifications of proteins	1L
	2.8.1	Signal hypothesis	2L
	2.8.2	Role of signal peptide & its role in Protein sorting	
	2.9	Protein localization in Nucleus	
III	**3**	**Gene regulation in prokaryotes**	**15L**
	3.1.1	Principles of gene regulation, Constitutive & inducible genes, one cistron-one subunit concept	3L
	3.1.2	Negative and positive regulation	
	3.2	Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, allosteric site	2L

	3.3	Lac operon – Structure, inducers (allolactose, IPTG), Negative control & Positive control of lac operon	3L
	3.4	Tryptophan operon – structure & regulation	2L
	3.5	Arabinose operon – structure, function & regulation	2L
	3.6	Regulatory RNAs in bacteria, small RNA and riboswitches	3L
IV	**4**	**Gene regulation in eukaryotes**	**15L**
	4.1.1	Role of regulatory transcription factors in eukaryotic gene regulation-general TF and Regulatory TF, TFIID and Mediator	2L
	4.1.2	Modulation of the function of regulatory transcription factors Ligand modification Protein protein interaction Covalent modification	2L
	4.2.1	Gene regulation by chromatin remodelling – removal of histone octamer nucleosome structure, shifting of the nucleosome and changing the canonical subunits of histone octamer for the non-canonical subunits	4L
	4.2.2	Histone acetylation and deacetylation, Gene silencing – DNA methylation	
	4.2.3	Regulation of galactose metabolism in yeast	2L
	4.2.4	Regulation by phosphorylation of nuclear transcription factors	2L
	4.3	Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA	3L
		Practicals – RPSBCHP303	2 Credits
	1	To hydrolyze DNA and separate nucleotide bases by paper chromatography	
	2	Isolation of chromosomal DNA from E coli cells	
	3	Qualitative Analysis of DNA by AGE	
	4	Designing of Oligonucleotide primers for PCR	
	5	Amplification of a DNA fragment by PCR	
	6	Cytochemical staining of RNA by Methyl Green Pyronin	
	7	Total RNA isolation from Bacterial Cells	

References:

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

2. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley & Sons. Inc.
4. Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell.
5. Genetics: Analysis & principles by Robert brooker 5th edition, McGraw-Hill Education, 201
6. Molecular Cell Biology by Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky, Darnell

Course Code: RPSBCH304

Course Title: Biology of diseases & Clinical Research

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	The student will able to understand the cooperative relationship between Biochemistry and Medicine
CO 2	Learn the factors in the spread of infectious diseases & Explain biology and pathogenesis of infectious agents
CO 3	Describe the Immune responses of body against various pathogenic organisms
CO 4	Recognize the Biochemical aspect of cancer, Assays for diagnosis & treatment
CO 5	Understand the Physiology of cardiovascular diseases
CO 6	Realize the importance of drug development through clinical research

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biology of diseases & Clinical Research RPSBCH304	Credits/ Lectures 4 Credits
I	**1**	**Infectious diseases**	**15L**
	1.1	Bacterial infections: Tetanus, Diphtheria, Tuberculosis, Typhoid, Cholera	3L
	1.2	Viral infection: Measles, Mumps, influenza, HIV	
	1.3	Protozoan: Malaria and Trypanosomiasis	3L
	1.4	Parasitic infection: Leishmaniasis	
	1.5	Treatment of infectious agents	
	1.5.1	Characteristics of an ideal chemotherapeutic agent	2L
	1.6	Mode of action of antibiotics on	
	1.6.1	Cell wall (Penicillin and Cephalosporins)	1L
	1.6.2	Cell Membrane (Polymyxin and Imidazole)	1L
	1.6.3	Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol)	1L
	1.6.4	Nucleic acid (Quinolones, Nalidixic acid, Rifamycin)	1L

	1.6.5	Enzyme inhibitors (Trimethoprim)	1L
	1.7	Mechanisms of drug resistance- evolution, pathways and origin	2L
II	**2**	**Cancer**	**15L**
	2.1	Genetic basis of cancer	1L
	2.2	Experimental evidenced for transformation of cell	
	2.3	Oncogenes	3L
	2.3.1	Identification of chromosomal oncogene	
	2.3.2	Gain of function mutation	
	2.3.3	Conversion of proto-oncogene to oncogene	2L
	2.3.4	Missense mutation, Gene amplification , chromosomal translocation , viral integration	
	2.5	Tumor suppressor gene- Role of p53 and RB gene	2L
	2.6	Assays – Trypan blue exclusion method, MTT assay, Soft Agar Colony Formation Assay	3L
	2.7	Molecular profiling for classification of cancer,	
	2.8	DNA microarray	
	2.9	Cancer therapy- Antimetabolites, Chemotherapy (purine & pyrimidine analog), Demethylating agents	4L
	2.9.1	Cancer immunotherapy	
III	**3**	**Cardiovascular diseases**	**15L**
	3.1	Definition; The origin of cardiovascular diseases (electrical, structural and circulatory) and types of CVDs	2L
	3.2	Defining the broad spectrum of Ailments	3L
	3.3	Stages of CVDs	
	3.4	Molecular basis of CVDs - hypertension, coronary heart (artery) disease, cerebrovascular disease, cardiomyopathy, cardiac hypertrophy, atherosclerosis, myocardial infarction.	5L
	3.5	Diagnosis and Treatment strategies: screening methods; Current treatment modalities and their advantages and disadvantages, major side effects; Challenges of treatment. biomarkers for CVDs	5L
IV	**4**	**Clinical research**	**15L**
	4.1	Introduction of Clinical Research	1L
	4.1.1	Clinical Trial Phases & Evaluation Role of Placebo Interpretation of clinical data, Meta-analysis	2L
	4.1.2	Pharmacological Principal of Clinical Research Drug Development And Launch	2L
	4.1.3	Clinical Trial Design and Project Managements	1L

	4.2	Drug Invention; New Drug Development and Drug Assay	2L
	4.2.1	Animal Toxicity studies: Systemic toxicity studies, Local toxicity studies & Specialised toxicity studies Interpretation of animal data, Subjective responses	
	4.2.2	Drug Assay: 1. Chemical 2. Biological – Indication, Principle, Types & Biostandardisation Immunological	2L
	4.3	Radio-receptor assays & ELISA	1L
	4.4	Essential documents in Clinical Research and Regulatory Requirements	4L
	4.4.1	IND Application	
	4.4.2	NDA Application	
	4.4.3	Informed Consent process and Documentation	
	4.4.4	Clinical Study Report	
		Practicals – RPSBCHP304	2 Credits
	1	WIDAL test – Qualitative & Quantitative	
	2	Antibiotic testing by agar well method	
	3	Determination of MIC of antibiotic	
	4	Separation of isoenzymes of LDH by electrophoresis.	
	5	Visualization of cells by methylene blue	
	6	Study of viability of cells using Neutral red Assay	
	7	Case studies on clinical research	

References:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
5. Genetics Analysis and Principles by Robert J. Brooker
6. Concepts of Genetics by William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian
7. Textbook of Pharmacology – F.S.K Barar

8. Molecular Biology of Cancer Mechanisms, Targets, and Therapeutics by Lauren Pecorino
9. Clinical Trials, Second Edition_ Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines – Tom Brody
10. Early Drug Development Strategies and Routes to First-in-Human Trials by Mitchell N. Cayen
11. Pharmacology and Pharmacotherapeutics by R.S. Satoskar, Nirmala N. Rege, S.D. Bhandarkar – 24th Edition
12. Textbook of Designing Clinical Research by Stephen B. Hulley

Modality of Assessment (SEMESTER III)

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 III

Course	301			302			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	303			304			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: RPSBCH401

Course Title: Human Physiology & Developmental Biology

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	The student will learn and understand the basic concepts of nutrition, and nutritional values of foods, and Basal metabolic rate and measurement of energy requirements.
CO 2	Deduce the dietary requirement of carbohydrates, lipids and proteins and their biological significance
CO 3	The course will also aid to learn the nutritional requirement and significance of dietary minerals like macroelements and microelements
CO 5	Understand the condition of malnutrition, its prevention, and recommended dietary allowances.
CO 6	Students will be learning topics like Introduction to nutrition, Macroelements, Microelements and Nutrigenomics, Nutritional disorders and Antinutritional Factors

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Human Physiology & Developmental Biology RPSBCH401	Credits/ Lectures 4 Credits
	1	**Musculoskeletal system and its related disorders**	**15L**
	1.1	Bones- Composition, formulation, Structure and functions	3L
	1.2	Bone's role in calcium homeostasis, factors affecting bone metabolism, bone remodeling	
	1.3	Diseases related to bone - Osteogenesis imperfecta, osteoporosis, osteomalacia, Fibrous dysplasia, Osteomyelitis	3L

I	1.4	Physiology of muscle contraction in striated and non-striated muscle	3L
	1.4.1	Types of muscles: ultrastructure of smooth, skeletal and cardiac muscle fibers	
	1.4.2	Muscle proteins, organization of contractile protein and definition of sarcomeres	
	1.4.3	Mechanism of muscle contraction, excitation of striated muscles	4L
	1.4.4	Energetics of muscle contraction, regulation of skeletal muscle contraction	
	1.4.5	Calmodulin and its regulatory role	
	1.4.6	Diseases related to muscle - muscular dystrophies, myositis	2L
II	**2**	**Cardiovascular Physiology**	**15L**
	2.1	Pericardium – Structure, function and clinical significance	2L
	2.2	Cardiac muscle tissue, difference in atrial and ventricular cardiac muscle, clinical significance	2L
	2.3.1	Action potentials in cardiac muscle – Causes, Phases	4L
	2.3.2	Velocity of signal conduction, Refractory period of cardiac muscle	
	2.5	Function of Ca2+ ions and transverse tubules in excitation-contraction coupling	
	2.6.1	Physical characteristics of the circulation	4L
	2.6.2	Basic principles of circulatory function	
	2.6.3	Interrelationships of pressure, flow and resistance	
	2.7	Vascular distensibility	3L
	2.8	Microcirculation – Structure and capillary system	
III	**3**	**Neurophysiology and its related disorders**	**15L**
	3.1	Nervous system and its classification	3L
	3.2	Neuron - Structure and maintenance of neurons, Functional classes of neurons	
	3.3	Non-neuronal cells and nerve tissue	
	3.4	Membrane potentials: Resting Membrane Potential, Graded potentials, Action potential	5L
	3.5	Transmission of nerve impulse, role of Ca+2 in release of neurotransmitter from pre-synaptic membrane, function of receptor proteins and secondary messengers on the postsynaptic neuron	
	3.6	Chemical & electrical synapse, Post-synaptic potentials: excitatory and inhibitory	2L

	3.7	Characteristics of some important neurotransmitters (Acetylcholine, Glycine, GABA, Aspartate, Glutamate, Catecholamines)	3L
	3.8	Disorders related to defects in neurotransmission– Parkinson's disease, stroke, Alzheimer's disease	2L
IV		**Developmental Biology**	**15L**
		Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation	2L
		Morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants	2L
		Gametogenesis, fertilization (in humans & sea urchin)	3L
		Early development, cell surface molecules in sperm-egg recognition in animals	3L
		Embryonic cleavage	2L
		Formation of germ layers in animals	
		Sexual reproduction in plants - Gametogenesis, double fertilization in plants	3L

References:

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
3. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321-53910-6.

Course Code: RPSBCH402

Course Title: Endocrinology

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	Study the historical experiments that lead to the discovery of various hormones
CO 2	Deeply understand the communication between the nervous system and the endocrine system
CO 3	Learn the structure, functions and the disorders associated with the various hormones starting from the pituitary hormones to the gonadal hormones.
CO 4	Appreciate and analyze the endocrine regulation of the various metabolisms such as carbohydrate metabolism, Protein metabolism, calcium homeostasis, menstrual cycle, pregnancy and menopause.
CO 5	Apply the knowledge of hormones in assay of hormones such as T3, T4 and TSH and understand the strategy behind contraception.
CO 6	Present a case study on a hormonal and a metabolic disorder

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Endocrinology RPSBCH402	Credits/ Lectures 4 Credits
I	**1**	**Introduction to Endocrinology & cellular signalling**	**15L**
	1.1	Functions of hormones and their regulation	2L
	1.2	Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms	
	1.3	Chemical classification of hormones, transport of hormones in the circulation and their half-lives	1L
	1.4	Hormone receptors - extracellular and intracellular	3L
	1.4.1	Receptor - hormone binding, Scatchard analysis	

	1.4.2	G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca^{2+}	4L
	1.5	Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC	
	1.5.1	Protein kinases (PKA, PKB, PKC, PKG)	
	1.5.2	Receptor tyrosine kinases - EGF, insulin and Ras - MAP kinase cascade	4L
	1.5.3	Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway	
	1.6	Steroid hormone Receptor	1L
II	**2**	**Hypothalamic- hypophysial system and Hormones of the adrenals**	**15L**
	2.1	Hypothalamic - Pituitary axis: anatomy, histology, vasculature and secretions	2L
	2.2.1	Physiological and biochemical actions of hypothalamic hormones and Anterior pituitary hormones	
	2.2.2	Hormone feed- back regulatory cascade	
	2.3.1	Posterior pituitary hormones –structure, physiology	3L
	2.3.2	Biochemical actions of AVP and Oxytocin; Diabetes insipidus	
	2.4	Histology of Adrenal Gland	2L
	2.5	Physiology and action of Aldosterone; the Renin Angiotensin System	
	2.6.1	Physiology and Biochemical actions of Cortisol	2L
	2.6.2	Regulation of cortisol synthesis: POMC and CRH	
	2.7.1	Adrenal medullary Hormones: Epinephrine and Norepinephrine	2L
	2.7.2	The Fight or flight response; Dual receptor hypothesis	
	2.8	General adaptation syndrome: acute and chronic stress response	3L
	2.9	Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.	
III	**3**	**Hormones regulating Metabolism, Calcium homeostasis and Growth**	**15L**
	3.1.1	Thyroid gland- Histology	3L
	3.1.2	Biosynthesis of thyroid hormone and its regulation: Role of TRH and TSH in T4 synthesis and response	
	3.1.3	Physiological and biochemical action of Thyroxine	

	3.1.4	Pathophysiology of thyroxine secretion: Hyper and hypothyroidism, Goitre, Graves' disease, Cretinism, Myxoedema	3L
	3.2.1	Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin	3L
	3.2.2	Mechanism of Ca2+ regulation and pathways involving bone, skin, liver, gut and kidneys	
	3.2.3	Pathophysiology - rickets, osteomalacia, osteoporosis	3L
	3.3	Regulation of Growth: growth hormone and somatomedin	
	3.4	Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies	4L
	3.5	Physiology and biochemical actions of Growth factors- EGF, PDGF and EPO	
IV	**4**	**Pancreatic, GI tract and Reproductive hormones**	**15L**
	4.1	Cells involved in release of gastrointestinal hormones	3L
	4.1.1	Gastrin family of hormones	
	4.1.2	CCK: the secretin family of hormones	
	4.1.3	Incretins; Ghrelin	
	4.2	Summary of hormone metabolite control of GI function	2L
	4.3	Hormones of the Pancreas: Structure, synthesis, physiology and biochemical actions of insulin and glucagon	
	4.4	Adipocyte hormones: Adiponectin and leptin; Appetite and satiety control	3L
	4.5	Pathophysiology - . Type I and type II Diabetes mellitus, Obesity and Metabolic syndrome	
	4.6	Male and female sex hormones	4L
	4.6.1	Interplay of hormones during ovarian and uterine phases of menstrual cycle	
	4.6.2	Placental hormones; role of hormones during parturition and lactation	
	4.6.3	Hormone based contraception	3L
	4.6.4	Concept - ammenorrhea, menorrhagia, PMS, PCOS, Menopause	

	PRACTICALS	
RPSBCHP401 & RPSBCHP402	**Project Work**	4 Credits
	GUIDELINE TO CARRY OUT PROJECTWORK 1. The main purpose of introduction of Project Work at MSc II is to inculcate research culture. It will also make the students familiar with Research Methodology i.e. reference work, experimental work, data analysis of experimental data, interpretation of results obtained, writing of project work and compilation of bibliography in proper order. 2. Each student shall complete a small research project during their academic year of MSc II. However, the initial reference work for the project can be started in MSc I. 3. **Nature of Research Project:-** Experimental-based or literature survey involving laboratory analytical work will be considered as the Research Project. 4. **Duration of Project work:-** Using the infrastructure available in Ramnarain Ruia Autonomous College the duration to complete the project work will be from the commencement of the project work till the end of January of MSc II (Sem IV) academic year. The duration to complete the project work from any institute apart from Ramnarain Ruia Autonomous College will be 03 months (This needs prior approval from the Department of Biochemistry, Ramnarain Ruia Autonomous College). 5. **Schedule for Submission of project Work:-** Experimental work or literature survey must be completed and the report on the same (2 Copies) will have to be submitted by the end of February of MSc II (Sem IV) 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 & Conclusion j) Future Prospects k) Bibliography 7. The project will be assessed.	

GUIDELINE FOR THE ASSESMENT OF PROJECT WORK

1. The practical 401 & 402 of Sem IV (Course Code No. RPSBCHP401 & RPSBCHP402) 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 February of MSc II (Sem IV) 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. 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)	50
b)	Presentation of Project Work to Examiner	30
c)	Viva- voce Exam based in Project Work	20
	TOTAL	**100**

References:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962- 1.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. Guyton and Hall Textbook of Medical Physiology 13th Edition by John E. Hall, Elsevier
5. Harrison's Endocrinology, Second Edition by J. Larry Jameson
6. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

Course Code: RPSBCH403

Course Title: Genetic Engineering & 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	Acquire wide knowledge about Recombinant DNA technology by studying about various Vectors and Restriction Enzymes involved.
CO 2	Study of Various Expression Systems and Molecular Markers
CO 3	Apply the fundamental knowledge to understand Application of R-DNA technology and use of Restriction enzymes in construction of various vectors and libraries such as c-DNA & Genomic libraries
CO 4	Recognize the importance of Screening of the libraries with the help of " Reporter Genes" and Molecular Markers such as RFLP,RAPD, AFLP.
CO 5	Analyse and Interpret the knowledge about Genetic engineering and prospects of improving crop productivity, resistance, resistance to disease and environmental stresses, methods for production of transgenic animals.
CO 6	Develop innovative methods & Apply learned knowledge to their future research

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Genetic Engineering & Biotechnology RPSBCH403	Credits/ Lectures 4 Credits
I	**1**	**Introduction to RDT & cloning vectors**	**15L**
	1.1	Overview of RDT, Extraction and purification of plasmid and bacteriophage DNA	3L
		Restriction and modification systems, restriction endonucleases, Concept of sticky ends, blunt ends	
	1.2	Other enzymes used in manipulating DNA molecules:	4L
		Terminal transferases, linkers and adapters, homopolymer tailing	
	1.3	Reverse transcriptase	

	1.3.1	DNA ligase, Ligation of DNA molecules	
	1.3.2	Synthetic oligonucleotides - synthesis and use	2L
	1.3.3	Plasmids and bacteriophages as vectors for gene cloning	4L
	1.4	Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z	
	1.5	Cloning vectors based on M13 and λ bacteriophage, and in vitro packaging Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectors	
	1.5.1	BAC and YAC	2L
II	**2**	**Gene transfer processes, selection for recombinants & clone identification**	**15L**
	2.1	Transformation	3L
	2.1.1	Preparation of competent cells using transformation and selection for transformed cells	
	2.1.2	Identification for recombinants - insertional inactivation, blue-white selection Conjugation (F^+& F^- cells)	
	2.2.1	Mechanism of conjugation in Hfr strains	3L
	2.2.2	Interrupted mating experiment technique	
	2.2.3	Problems based on above concept	
	2.2.4	Transduction (Generalized & Specialized)	
	2.3	Introduction of phage DNA into bacterial cells	2L
	2.3.1	Identification of recombinant phages	
	2.3.2	Transfection	
	2.4	Transient and stable transfection	5L
	2.4.1	Chemical and physical methods of transfection	
	2.4.2	The problem of selection, direct selection, marker rescue.	
	2.4.3	cDNA and Genomic libraries, identification of a clone from gene library, colony and plaque hybridization probing, Southern and Northern hybridization	
	2.5	Methods based on detection of the translation product of the cloned gene	2L
III	**3**	**Expression of cloned genes, PCR & DNA sequencing**	**15L**
	3.1.1	Vectors for expression of foreign genes in E. coli, cassettes and gene fusions	3L
	3.1.2	Challenges in producing recombinant protein in E. coli	
	3.2	Production of recombinant protein by eukaryotic cells	4L

	3.2.1	Fusion tags such as, poly-histidine, glutathione, maltose binding protein and their role in purification of recombinant proteins	
	3.3.1	Fundamentals of polymerase chain reaction	5L
	3.3.2	Types of PCR – hot start, multiplex, reverse transcriptase PCR and Nested PCR, quantitative PCR,Primer, designing for PCR, Cloning PCR products	
	3.4	DNA sequencing by Sanger's method, Automated Sanger's DNA sequencing, Pyrosequencing	3L
IV	**4**	**Application of genetic engineering in Biotechnology**	**15L**
	4.1	Site–directed mutagenesis (original method, Kunkel's method, cassette mutagenesis, PCR oligonucleotide mutagenesis), Protein engineering (T4-lysozyme), yeast two hybrid systems	4L
	4.2	Production of recombinant pharmaceuticals such as insulin, human growth hormone (original, receptor fragment-hormone coupled, albutropin), factor VIII.	2L
	4.3	Recombinant vaccines	1L
	4.4	Gene therapy & its application	1L
	4.5	Applications in agriculture – Bt cotton, problems with genetically modified plants, glyphosate herbicide resistant crops, ethical & safety concerns	3L
	4.6	RDT in diagnosis and treatment of diseases	2L
	4.7	Model organisms: *Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio* and *Arabidopsis thaliana*	2L
		Practicals – RPSBCHP403	2 Credits
	1	Isolation of plasmid DNA from E. coli cells	
	2	Separation of chromosomal & plasmid DNA using agarose gel electrophoresis	
	3	Digestion of plasmid DNA with restriction enzymes	
	4	Preparation of competent cells ($CaCl_2$ treatment)	
	5	Transformation of E. coli cells with plasmid DNA	
	6	Demonstration of complementation of β−galactosidase for Blue and White selection	
	7	β-galactosidase Activity Assay in Permeabilized Yeast	

References:

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
4. Genetic engineering and its applications, P. Joshi, Botania Publishers and Distributors
5. Recombinant DNA: A short course, Watson etal, Scientific Americal Books
6. Biotechnology Fundamentals and Applications, S.S.Purohitt, Agrobios Publishers, 2001.
7. Molecular Biology of the Gene: Watson, Baker, Bell, Gann, Levine, Losick; Pearson Benjamin Cummings & CSHL Press
8. Gene cloning & DNA analysis: an introduction; seventh edition; T A Brown; Wiley Blackwell publications

Course Code: RPSBCH404

Course Title: Advanced immunology

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	Learn the fundamental principles of immune response including molecular, biochemical and cellular basis of immune homeostasis
CO 2	Develop various aspects of immunological response and how its triggered and regulated
CO 3	Explain the specific interactions of Antigens and antibodies and the diversity of antibodies developed at the germ line DNA
CO 4	Complete knowledge of the molecular mechanisms and kinetics of the immune responses, both humoral and cell mediated immunity
CO 5	Enhance the knowledge of various immune-techniques ranging from precipitation and agglutination reactions to ELISA, Radio immunoassay and flow cytometry.
CO 6	The course will aid in understanding the principles of Graft rejection, Auto immunity and Antibody based therapy.

DETAILED SYLLABUS

Course Code/ Unit	**Unit**	**Course/ Unit Title** Advanced immunology RPSBCH404	**Credits/ Lectures** 4 Credits
I	**1**	**Antigen-Antibody Interactions and Complement System**	**15L**
	1.1.1	Overview of Antigens and Antibodies	1L
	1.1.2	Antigen- Antibody interactions: Forces involved, antibody affinity, antibody avidity, Cross reactivity	2L
	1.1.3	Precipitation reactions – Oudins, Ouchterlony	2L
	1.1.4	Agglutination reactions: Blood typing, bacterial agglutination, passive agglutination, agglutination inhibition,	

	1.1.5	Immunoelectrophoresis: Principles of Radioimmunoassay, ELISA, Immunofluorescence, Western Blotting	3L
	1.2	Complement system	
	1.2.1	Function and components	2L
	1.2.2	Complement activation - Classical, Alternate & Lectin pathways.	3L
	1.2.3	Biological consequence of complement activation – formation of MAC	3L
II	**2**	**MHC, Antigen processing and presentation & TCR**	**15L**
	2.1	Major histocompatibility complex	2L
	2.1.1	MHC polymorphism & organization of MHC genes-class I & class II	
	2.1.2	Cellular distribution & structure of class I & II molecules	
	2.1.3	MHC and immune responsiveness – Determinant-selection model and Holes-in-the-repertoire model	2L
	2.1.4	MHC and disease susceptibility (Hereditary haemochromatosis)	2L
	2.2	Antigen processing and presentation	4L
	2.2.1	Self MHC restriction of T cells	
	2.2.2	Cytosolic and endocytic pathway	
	2.2.3	Presentation of non-peptide antigens	
	2.3	T-cell Receptor	2L
	2.3.1	Structure, organization & rearrangement of TCR genes	
	2.3.2	TCR receptor complex TCR – CD3	1L
	2.3.3	TCR accessory membrane molecules	1L
	2.3.4	Ternary TCR-peptide-MHC complex	1L
III	**3**	**B- and T-lymphocytes**	**15L**
	3.1	T-cell Maturation	2L
	3.2	Thymic selection of T-cell repertoire – Positive and negative selection, central issues in thymic selection	3L
	3.3	TH-cell activation	
	3.4	T-cell differentiation	1L
	3.5	Peripheral γδ T-cell	2L
	3.6	Cytotoxic T-cells	2L
	3.7	B-cell maturation	4L
	3.8	B-cell activation and proliferation – Thymus dependent and Thymus independent	
	3.9	Formation of T-B conjugates	1L

IV	**4**	**Cytokines & Immune response in health & diseases**	**15L**
	4.1	Humoral and cell mediated immune response	2L
	4.1.1	Cytokines - Introduction, Properties	
	4.1.2	Cytokine receptors	3L
	4.1.3	Biological functions of cytokines	
	4.1.4	Therapies based on Cytokines	
	4.2	Hypersensitivity reactions	3L
	4.2.1	Gel & Coomb's classification - types of hypersensitivity reactions	
	4.3	Transplantation immunology	3L
	4.3.1	Types of transplant; immunological basis of allograft rejection.	
	4.4	Autoimmunity	4L
	4.4.1	Organ specific –Myasthenia gravis; Hashimotos thyroiditis; Graves' Disease; Systemic – Rheumatoid arthritis, Systemic lupus erythematosus	
		Practicals – RPSBCHP404	2 Credits
	1	Preparation of blood smear and Differential leucocyte count.	
	2	Separation of lymphocytes by Ficoll Hypaque method	
	3	Lymphocyte viability testing by trypan blue	
	4	Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID).	
	5	Assays based on agglutination reactions - Blood typing (active) & passive agglutination (C reactive protein kit & virtual lab).	
	6	Demonstration of Enzyme linked immunosorbent assay (ELISA) & DOT ELISA	
	7	Separation of serum proteins by PAGE	
	8	Virtual Lab to study immunological Techniques	

References:

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617- 8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

4. Willey, J. Sherwood L, Woolverton C, (2016), Prescott Microbiology. 10th Edition, McGraw-Hill Publisher, Columbus, OH
5. Pelczar Mi J., Chan, E.C.S., Krieg, NR, (2009). Microbiology, McGraw-Hill publisher
6. Immunology – C. V. Rao, Narosa Publishing House

Modality of Assessment (SEMESTER IV)

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 IV

Course	401			402			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	403			404			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100
