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

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for

Program: MSc II

Program Code: RPSBCH

(Credit Based Semester and Grading System for academic year 2022–2023)

GRADUATE ATTRIBUTES

GA	GA Description **A student completing Master's Degree in SCIENCE program will be able to:**
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

PO	Description **A student completing Master's Degree in SCIENCE program in the subject of BIOCHEMISTRY will be able to:**
PO 1	Acquire necessary knowledge and skills to undertake a career in research, either in industry or in an academic set up.
PO 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.
PO 3	Extrapolate and comprehend the regulatory role of metabolic processes and understand the underlying cause of metabolic disorders
PO 4	Acquire thorough knowledge of Biochemical Techniques, Advanced Immunology, Physiology, Genetic Engineering, and Biotechnology
PO 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.
PO 6	Integrate and apply the techniques in Biophysics, Analytical Biochemistry, Clinical biochemistry, Microbiology, Molecular Biology and Basics in Bioinformatics
PO 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
PO 8	Develop and enhance skills & improve employability through academic, research and internship opportunities
PO 9	Gain exposure to basic research through the provision of PG research based project.
PO 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 II	III	Core 1	Biochemistry of Metabolism	4
		Core 2	Human Physiology	4
		SEC	Medical Biochemistry	4
		Research	--	8
			Practicals based on Core 1	2
			Practicals based on SEC	2
	IV	Core 1	Advanced immunology	4
		Core 2	Biology of diseases and Clinical research	4
		SEC	Molecular biology	4
		Internship	--	8
			Practicals based on Core 1	2
			Practicals based on SEC	2

Semester III

Course Code: RPSBCH301

Course Title: Biochemistry of Metabolism

Academic year 2022-23

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	torage 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
	1	**Practicals – RPSBCHP301** Estimation of glucose by the GOD-POD method	2 Credits

	2 3 4 5 6 7 8	Study of glucose metabolism using handheld glucometer Estimation of amino acids by ninhydrin Estimation of serum urea by diacetyl monoxime method Estimation of serum creatinine by alkaline picrate method Assay of glutamate dehydrogenase Estimation of serum uric acid by phosphotungstic acid method (Caraways method) 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: Medical Biochemistry

Academic year 2022-23

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 Medical 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	2L

		Tests based on primary function of thyroid, Tests measuring blood levels of thyroid hormones	
		Practicals – RPSBCHP302	2 Credits
	1	Enumeration of Blood cells: RBC and WBC counting Qualitative analysis of bile	
	2	Estimation of serum electrolytes	
	3	Estimation of blood glucose by ortho-toluidine mono step method	
	4	Estimation of serum phosphorus by Fiske Subbarow method	
	5	Estimation of serum Calcium by Trinder's method	
	6	Estimation of serum iron by dipyridyl method	
	7	Clinical analysis of CSF – glucose, proteins, chlorides	
	8	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	
	9	Renal Function tests a) Creatinine clearance test b) Urea clearance test	
	10	Pancreatic Function Test a) Estimation of serum amylase activity b) Glucose Tolerance Test	
	11	Estimation of serum total cholesterol and HDL cholesterol	
	12	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 2022-23

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	
	1.3.3	Mechanism of RNA transcription in eukaryotes - Formation of pre-initiation complex, initiation, elongation and termination, Phosphorylation of RNAPII	
	1.4	RNA Modification	1L
	1.4.1	Mechanism of addition of 5'-cap & formation of poly A tail, 5'-cap of snRNA	
	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, role of snoRNA	1L
	1.5	Role of Inhibitor -Rifampicin, Actinomycin D, α-Amanitin	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 7	Cytochemical staining of RNA by Methyl Green Pyronin 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 2022-23

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	Bioassay of penicillin/ampicillin	
	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	Spectroscopic estimation of aspirin hydrolysate	

	8	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

Semester IV

Course Code: RPSBCH401

Course Title: Human Physiology & Developmental Biology

Academic year 2022-23

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
I	**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
	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	**4**	**Developmental Biology**	**15L**
	4.1	Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation	2L
	4.2	Morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants	2L
	4.3	Gametogenesis, fertilization (in humans & sea urchin)	3L
	4.4	Early development, cell surface molecules in sperm-egg recognition in animals	3L
	4.5	Embryonic cleavage	2L
	4.6	Formation of germ layers in animals	
	4.7	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 2022-23

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	

	2.5	Physiology and action of Aldosterone; the Renin Angiotensin System	2L
	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	3L
	3.1.4	Pathophysiology of thyroxine secretion: Hyper and hypothyroidism, Goitre, Graves' disease, Cretinism, Myxoedema	
	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 2022-23

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; CRISPR-Cas 9 system	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 2022-23

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
