**Resolution No.** AC/II(20-21).2.RPS2

# S. P. Mandali's

# Ramnarain Ruia Autonomous College

***(Affiliated to University of Mumbai)***


## Syllabus for

**Program:** MSc Part II

**Program Code:** RPSBCH

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

# PROGRAM OUTCOMES

| PO | PO Description<br><br>**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<br><br>**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 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 | Nutritional Biochemistry | 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:** RPSBCH301

**Course Title:** Biochemistry of Metabolism

**Academic year 2020-21**

**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<br>Biochemistry of Metabolism<br>RPSBCH301 | Credits/ Lectures<br>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),<br>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, | 3L |

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|---|---|---|---|
| | | methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease | |
| | 2.6 | Biosynthesis of amino acids<br>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 |

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| | 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 Folin-Wu method | |
| | 2 | Estimation of glucose by the GOD-POD method | |
| | 3 | Demonstration of glucose metabolism using handheld glucometer | |
| | 4 | Assay of serum transaminases – SGOT and SGPT. | |
| | 5 | Estimation of serum urea. | |
| | 6 | Estimation of serum creatinine. | |
| | 7 | Assay of glutamate dehydrogenase | |
| | 8 | Lipid Profile –<br>a) Estimation of total cholesterol and HDL<br>b) Estimation of Triglycerides<br>c) Estimation of LDL by calculation | |
| | 9 | Estimation of serum uric acid by phosphotungstic acid method (Caraways method) | |
| | 10 | 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 2020-21**

**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<br>Clinical Biochemistry<br>RPSBCH302 | Credits/ Lectures<br>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** | Body Fluids | **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) | |

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|---|---|---|---|
| | 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<br>Tests based on abnormalities of bile pigment metabolism - VD Bergh Reaction, Determination of Serum Bilirubin<br>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 |

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|---|---|---|---|
| | 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<br>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 | |
| | 5 | Estimation of serum phosphorus by Fiske Subbarow method | |
| | 6 | Estimation of serum Calcium | |
| | 7 | Clinical analysis of CSF – glucose, proteins, chlorides | |
| | 8 | Liver Function Tests –<br>a) Estimation of serum ALT and AST<br>b) Estimation of total and direct bilirubin<br>c) Estimation of serum alkaline phosphatase<br>d) Estimation of total proteins, albumin and determination of A/G ratio<br>e) Estimation of serum albumin by Bromocresol Green (BCG) binding method | |
| | 9 | Renal Function tests<br>a) Creatinine clearance test<br>b) Urea clearance test | |
| | 10 | Pancreatic Function Test<br>a) Estimation of serum amylase activity<br>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. Clinical Biochemistry Metabolic and Clinical Aspects by William J. Marshall, Márta Lapsley, Andrew Day, Ruth Ayling
6. 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 2020-21**

**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<br>Molecular Biology<br>RPSBCH303 | Credits/ Lectures<br>4 Credits |
|---|---|---|---|
| I | **1** | **Cell Cycle and its regulation & DNA Replication** | **15L** |
| | **1.1** | Cell cycle and its regulation | 4L |
| | **1.1.1** | Phases of cell cycle and its regulation (Cyclins & CDKs) | |
| | **1.1.2** | State of DNA in different phases of cell cycle Replication of DNA | |
| | 1.2 | Structural overview of DNA Replication | 5L |
| | 1.2.1 | Models for DNA replication- | |
| | 1.2.2 | Conservative, Semi-conservative & dispersive | |
| | 1.2.3 | Experimental evidences | |
| | 1.2.4 | Enzymes and proteins involved in replication | |
| | 1.2.5 | Mechanism of Bacterial DNA replication | |
| | 1.2.6 | Replication of DNA in yeast | |
| | 1.3 | Eukaryotic DNA polymerases | 5L |
| | 1.3.1 | Proteins and accessory molecules essential in the initiation, and elongation steps | |
| | 1.3.2 | Mechanism (Pre-RC assembly, Initiation, elongation & termination) | |
| | 1.3.3 | Concept of Okazaki fragment maturation & stalled replication fork | |
| | 1.3.4 | End replication problem and role of telomerases | |
| | 1.4 | Comparative overview of DNA replication in prokaryotes and eukaryotes | 1L |
| II | **2** | **Mutations, Chromosomal Abnormalities & DNA Repair** | **15L** |
| | **2.1** | Mutations | 3L |
| | **2.1.1** | Types of mutations<br>Physical, chemical and Biological agents causing mutations | |
| | **2.1.2** | Reverse mutations, Mutagenesis, Ames test.<br>Chromosomal aberration | |
| | 2.1.3 | Variations in chromosome structure - inversions, deletions, duplications and translocations | 2L |
| | 2.1.4 | Variations in chromosome number -<br>Euploidy and aneuploidy (Autosomal and Sex chromosomes) | |
| | 2.2 | Syndromes resulting from chromosomal | 3L |

| | | | |
|---|---|---|---|
| | | abnormalities | |
| | 2.2.1 | Monosomies (Turner syndrome) | |
| | 2.2.2 | Disomies and trisomies (Down Syndrome, Klinefelter's syndrome)<br>Cri-du-chat syndrome, Philadelphia chromosome | |
| | 2.2.3 | Chromosomal Microdeletions – Prader-Willi Syndrome & Angelman Syndrome | 2L |
| | 2.3 | Recognition of DNA lesions and molecular mechanism of the following DNA Repairs -<br>Direct repair (Photoreactivation, O6 methyl guanine DNA methyl transferase) | 2L |
| | 2.3.1 | Single strand repairs - Base & Nucleotide Excision Repairs, Mismatch repair (Hemimethylation of DNA) | 3L |
| | 2.3.2 | Translesion synthesis and SOS repair | |
| | 2.3.3 | Recombinational repair | |
| **III** | **3** | **Prokaryotic and eukaryotic Transcription & Post-transcriptional Modifications** | **15L** |
| | 3.1 | Overview of Transcription | 1L |
| | 3.2.1 | Role of Prokaryotic RNA polymerase and promoter; Upstream regulatory sequences | 4L |
| | 3.2.2 | Stages of transcription: Initiation, elongation and termination (Rho dependent & Rho independent) | |
| | 3.2.3 | Significance of Sigma factor, Concept of Abortive initiation | |
| | 3.3 | Transcription in eukaryotes | 3L |
| | 3.3.1 | Role of promoter & regulatory elements | |
| | 3.3.2 | Eukaryotic RNA polymerases and Cis acting & Trans acting elements | |
| | 3.3.3 | Mechanism of RNA transcription in eukaryotes - Formation of pre-initiation complex, initiation, elongation and termination | |
| | 3.4 | RNA Modification | 1L |
| | r3.4.1 | Mechanism of addition of 5'-cap & formation of poly A tail | |
| | 3.4.2 | Molecular mechanism of mRNA Splicing | 1L |
| | 3.4.3 | RNA Processing of rRNA & tRNA | 1L |
| | 3.4.4 | RNA editing - Base modifications | 1L |
| | 3.5 | Role of Inhibitor -Rifampicin, Actinomycin D | 1L |
| | 3.6 | Reverse transcription (Mechanism, significance & application) | 2L |
| **IV** | **4** | **Prokaryotic and eukaryotic Translation & Post-translational Modifications** | **15L** |

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|---|---|---|---|
| | 4.1 | Genetic basis of protein biosynthesis – Concept of structural gene & Protein ,Characteristics of Genetic code | 4L |
| | 4.2 | Ribosome assembly & structure (Comparison between prokaryotic & eukaryotic ribosome) | |
| | 4.3 | tRNA – structural features and tRNA synthetase, initiator tRNA, activation of amino acids | 2L |
| | 4.4.1 | Mechanism of translation in prokaryotes: Initiation, elongation & termination | 3L |
| | 4.4.2 | Concept of Polyribosome | |
| | 4.5 | Mechanism of eukaryotic translation: Initiation, elongation & termination | 2L |
| | 4.6 | Inhibitors of translation (prokaryotes & eukaryotes) | 1L |
| | 4.7 | Post translational modifications of proteins | 1L |
| | 4.8.1 | Signal hypothesis | 2L |
| | 4.8.2 | Role of signal peptide & its role in Protein sorting | |
| | 4.9 | Protein localization in Nucleus | |
| | | **Practicals – RPSBCHP303** | 2 Credits |
| | 1 | Estimation of UV absorption of nucleic acids & proteins | |
| | 2 | Qualitative test for nucleic acids | |
| | 3 | Extraction of total nucleic acids from plant tissue | |
| | 4 | Study of viscosity of DNA solution | |
| | 5 | To hydrolyze DNA and separate nucleotide bases by paper chromatography | |
| | 6 | Estimation of DNA by the Diphenylamine method | |
| | 7 | Isolation of chromosomal DNA from E coli cells | |
| | 8 | Cytochemical staining of RNA by Methyl Green Pyronin | |
| | 9 | Isolation of RNA from Yeast/ Liver | |
| | 10 | Estimation of RNA by Orcinol Method | |

**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 2020-21

**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<br>Biology of diseases & Clinical Research<br>RPSBCH304 | Credits/ Lectures<br>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 | 1L |
| | 4.1.2 | Pharmacological Principal of Clinical Research Drug Development And Launch | 2L |
| | 4.1.3 | Clinical Trial Design and Project Managements | 2L |
| | 4.2 | Clinical Trial Design | 4L |
| | 4.2.1 | Vendor Selection and Managements | |
| | 4.2.2 | Project Planning | |
| | 4.2.3 | Project Managements | |
| | 4.2.4 | Essential documents in Clinical Research and | 4L |
| | 4.3 | Regulatory Requirements | |
| | 4.3.1 | Essential Documents | |
| | 4.3.2 | IND Application | |
| | 4.3.3 | Clinical Study Report | |
| | 4.3.4 | NDA Application | 1L |
| | 4.3.5 | Informed Consent process and Documentation | |
| | | **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 | |
| | 5 | electrophoresis. | |
| | 6 | Visualization of cells by methylene blue | |
| | 7 | Study of viability of cells using Neutral red Assay | |
| | 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. Textbook of Designing Clinical Research by Stephen B. Hulley

# Modality of Assessment (SEMESTER III)

**Theory Examination Pattern:**

**A) Internal Assessment- 40%- 40 Marks**

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

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

1. Duration - These examinations shall be of **02 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 |

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**Course Code:** RPSBCH401

**Course Title:** Nutritional Biochemistry

**Academic year 2020-21**

**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<br>Nutritional Biochemistry<br>RPSBCH401 | Credits/ Lectures<br>4 Credits |
|---|---|---|---|
| I | **1** | **Introduction to Nutrition** | **15L** |
| | 1.1.1 | Introduction to Human nutrition & energy supply | 2L |
| | 1.1.2 | Measurement of energy content of food- | |
| | 1.2 | Calorific value of different biomolecules & mixed diet, Determination of calorific value using bomb Calorimeter (Principle & Working) | |
| | 1.3 | Respiratory quotient of food | 2L |
| | 1.4 | Measurement of energy expenditure | |
| | 1.5 | Basal metabolic rate- Definition, Measurement, factors affecting BMR & its significance | |
| | 1.5.1 | Specific dynamic action of food- Definition, Mechanism & its significance | 1L |
| | 1.5.2 | Sources, Daily requirement & Nutritional importance of biomolecules | 2L |
| | 1.5.3 | Carbohydrates- Concept of Glycemic Index of food (Graph), Importance of fiber (Complex carbohydrate) in nutrition | |
| | 1.5.4 | Lipids-Role of essential fatty acids | |
| | 1.6 | Proteins- Essential amino acids, Nitrogen Balance (Positive, Negative Nitrogen balance & factors affecting) | 4L |
| | 1.6.1 | Assessment of nutritive value of protein | |
| | 1.6.2 | Protein efficiency ratio | |
| | 1.6.3 | Biological value of protein | |
| | 1.6.4 | Net protein utilization | |
| | 1.6.5 | Chemical score | |
| | 1.6.6 | Mutual supplementation of protein | |
| | 1.7 | Recommended Dietary allowances (RDA)- Definition, Factors affecting RDA, RDA for adult | 2L |
| | 1.8 | Balance diet – Concept & significance, Designing diet for different subjects (infants, toddlers, adolescents, adults, geriatric, diseased state) | 1L |
| | 1.9 | Numericals based on above concepts | 1L |
| II | **2** | **Macroelements** | **15L** |
| | 2.1 | Biochemistry of macroelements | 4L |
| | 2.2 | Sources, Recommended daily allowances, Absorption, transport, excretion, Biochemical significance & Disorders related to: | |

| | | | |
|---|---|---|---|
| | 2.2.1 | Calcium | 4L |
| | 2.2.2 | Phosphorous | |
| | 2.2.3 | Magnesium | 3L |
| | 2.2.4 | Sodium | |
| | 2.2.5 | Potassium | |
| | 2.2.6 | Chlorine | 4L |
| | 2.2.7 | Sulphur | |
| | 2.2.8 | Phosphorous | |
| III | **3** | **Microelements** | **15L** |
| | 3.1 | Biochemistry of microelements | 4L |
| | 3.2 | Sources, Recommended daily allowances, Biochemical significance & Disorders related to : | |
| | 3.2.1 | Copper | 2L |
| | 3.2.2 | Iodine | 2L |
| | 3.2.3 | Manganese | 1L |
| | 3.2.4 | Zinc | 2L |
| | 3.2.5 | Molybdenum | 1L |
| | 3.2.6 | Cobalt | 1L |
| | 3.2.7 | Fluorine | 1L |
| | 3.2.8 | Selenium | 1L |
| IV | **4** | **Nutrigenomics, Nutritional disorders and Antinutritional Factors** | **15L** |
| | 4.1 | Nutrient-Gene Interaction | 2L |
| | 4.2 | Drug-Nutrient Interaction | |
| | 4.3 | Obesity, Brown and White Adipose Tissue, Specific dynamic action factors affecting thermic effect of food. | 1L |
| | 4.4 | Role of Leptin, Ghrenin, Adiponectin in food intake. | 1L |
| | 4.5 | Pathophysiology of Nutritional disorders | 1L |
| | 4.5.1 | Nutritional disorders of carbohydrate- Obesity, Non-Insulin dependent diabetes mellitus, Lactose intolerance, Celiac disease, Dental carries | 2L |
| | 4.5.2 | Nutritional disorders of proteins- Protein energy Malnutrition (Kwashiorker, Marasmus & Marasmic kwashiorkor) | 2L |
| | 4.5.3 | Nutritional disorders related to lipids – Essential fatty acid deficiency, cholesterol (Good vs Bad), Atherosclerosis & Arteriosclerosis | 2L |
| | 4.5.4 | Eating disorders – Bulimia nervosa, Anorexia nervosa | 2L |
| | 4.6 | Antinutritional factors – Phytin, oxalates, tannins, trypsin inhibitors, soluble and non-soluble NSPs | 2L |

**References:**

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

**Course Code:** RPSBCH402

**Course Title:** Endocrinology

**Academic year 2020-21**

**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<br>Endocrinology<br>RPSBCH402 | Credits/ Lectures<br>4 Credits |
|---|---|---|---|
| I | **1** | **Introduction to Endocrinology & cellular signalling** | **15L** |
| | 1.1 | Functions of hormones and their regulation | 2L |
| | 1.2 | Chemical signalling - 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 | |

| | | | |
|---|---|---|---|
| | 2.6.2 | Regulation of cortisol synthesis: POMC and CRH | 2L |
| | 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**<br>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.<br>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.<br>3. **Nature of Research Project:-**Experimental-based or literature survey involving laboratory analytical work will be considered as the Research Project.<br>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.<br>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).<br>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. 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 2020-21**

**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<br>Genetic Engineering & Biotechnology<br>RPSBCH403 | Credits/ Lectures<br>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, Protein engineering (T4-lysozyme), yeast two hybrid systems | 2L |
| | 4.2 | Production of recombinant pharmaceuticals such as insulin, human growth hormone, 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* | 4L |

| | | | |
|---|---|---|---|
| | | **Practicals – RPSBCHP403** | 2 Credits |
| | 1 | Transformation of E. coli cells with plasmid DNA. | |
| | 2 | Isolation of plasmid DNA from E. coli cells. | |
| | 3 | Digestion of plasmid DNA with restriction enzymes. | |
| | 4 | Amplification of a DNA fragment by PCR. | |
| | 5 | Complementation of β−galactosidase for Blue and White selection. | |
| | 6 | Separation of chromosomal & plasmid DNA using agarose gel electrophoresis | |

**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
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**Course Code:** RPSBCH404

**Course Title:** Advanced immunology

**Academic year 2020-21**

**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<br>Advanced immunology<br>RPSBCH404 | Credits/ Lectures<br>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

# Modality of Assessment (SEMESTER IV)

**Theory Examination Pattern:**

**A) Internal Assessment- 40%- 40 Marks**

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

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

3. Duration - These examinations shall be of **02 ½ HOURS** duration.
4. 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 |

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