Syllabus for the M.Sc. Semester III and Semester IV
Program: M.Sc.
Course: Bio-Chemistry

(Credit Based Semester and Grading System with effect from the academic year 2018–2019)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>UNIT</th>
<th>TOPIC HEADINGS</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PS BCH 301</td>
<td>I</td>
<td>Overview of Classical Genetics, Nature of genetic material</td>
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<td></td>
<td>II</td>
<td>Structure and characteristic of DNA &amp; RNA, Organization of DNA in genome, Functions of gene</td>
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<td></td>
<td>III</td>
<td>Cell cycle and its regulation, Replication of DNA</td>
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<td>IV</td>
<td>Transcription of DNA, Translation (Protein Biosynthesis)</td>
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<tr>
<td>PS BCH 302</td>
<td>I</td>
<td>Introduction to Immune system, Cell and organs of Immune system</td>
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<td>II</td>
<td>Antigens and antibodies, Monoclonal antibodies, organization and expression of immunoglobulin gene and its regulation</td>
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<td>III</td>
<td>Antigen antibodies interaction, experimental animal models, cell culture system.</td>
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<td>IV</td>
<td>Molecules involved in Immunology, MHC and complement system.</td>
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<td>PS BCH 303</td>
<td>I</td>
<td>Carbohydrate metabolism and related disorders</td>
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<td>Lipid metabolism and related disorders</td>
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<td>Protein metabolism and related disorders</td>
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<td>IV</td>
<td>Nucleoprotein metabolism and related disorders</td>
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<td>PS BCH 304</td>
<td>I</td>
<td>Composition and functions of body fluids in health and disease</td>
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<td>II</td>
<td>Pharmacokinetics, Clinical research and trials and ethical issues</td>
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<td>III</td>
<td>Macronutrients of Nutritional Significance</td>
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<td>IV</td>
<td>Nutrigenomics, Current topics in nutrition, Sports nutrition.</td>
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<td>PS BCH 401</td>
<td>I</td>
<td>Regulation of gene expression, Medical genetics</td>
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<td>II</td>
<td>Chromosomal abnormalities, Mutations, DNA repair mechanism</td>
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<td>III</td>
<td>Enzymes acting on nucleic acids and techniques in Nucleic acid analysis</td>
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<td>IV</td>
<td>Recombinant DNA technology and human genome project</td>
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<td>Cytokines</td>
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<td>Immunological tolerance, Autoimmunity, Autoimmune diseases</td>
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<td>IV</td>
<td>Tumour Immunology, Immunotherapy of tumours and Immunodeficiency</td>
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<td>I</td>
<td>Water and electrolyte balance, Mineral metabolism, vitamin – mineral interaction.</td>
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<td>Haemoglobin metabolism, Hemoglobinopathies, porphyrias, Acid base balance</td>
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<td>Cancer</td>
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<td>Stem cell, Ageing,</td>
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<td>PS BCH 404</td>
<td>I</td>
<td>Organ Function Tests: Biochemical Assessments and changes in Endocrine Disorders</td>
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<td>II</td>
<td>Mechanism of drug action ,structure-function relationship, New drug investigation and application</td>
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<td>III</td>
<td>Diet in health and disease</td>
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<td>IV</td>
<td>Techniques in Nutrition</td>
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<td>PS BCH P-403</td>
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<td>Estimation of Metabolites</td>
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<td>Clinical &amp; pharma biochemistry and Nutrition</td>
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Semester III Syllabus details

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<tbody>
<tr>
<td>PS BCH 301</td>
<td>Advanced genetics</td>
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### Unit I:

**1.1 Overview of classical genetics**

1.1.1 Mendelian genetics: Mendelian laws and basis of inheritance, dominance, recessivity, genotype, phenotype

1.1.2 Problems based on Mendelian genetics

1.1.3 Chromosomal theory of heredity, sex-linked inheritance, multiple alleles, lethal genes, genetic heterozygosity

1.1.4 Gene linkage & crossing over, tetrad analysis

**1.2 Nature of genetic material**

1.2.1 Discovery of gene, action spectrum, genetic transformation, fine structure analysis of rII locus of T4 phage, overlapping genes

1.2.2 Meisch, Griffith, Hershey-Chase & Avery; RNA as genetic material

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### Unit II:

**2.1 Structure and characteristic of DNA & RNA**

2.1.1 Types of DNA

2.1.2 Tm of DNA, its relation to GC content, unique and repetitive sequences of DNA, Cot curves and its significance, C-value paradox

2.1.3 Genome of prokaryotes, viruses, mitochondria, chloroplasts and eukaryotic organisms; movable genes, transposons & retroposons, invert repeats

2.1.4 Types of RNA, structure & functions, genetic code & their characteristics

2.2 Organization of DNA in genome

2.2.1 Histones, nucleosomes, structure of chromatin

2.2.2 Eukaryotic chromosomes, lamp brush & polytene chromosomes

2.3 Functions of gene

2.3.1 Genetic recombination: Holliday & Messelson-Radding models; enzymes and
| Unit: III |  
|---|---|
| **3.1 Cell cycle and its regulation** | 7 |
| 3.1.1 Mitosis and meiosis |  |
| 3.1.2 Phases of cell cycle; state of DNA in different phases of cell cycle |  |
| **3.2 Replication of DNA** | 8 |
| 3.2.1 Modes of replication; Meselson and Stahl’s experiment Semi-conservative replication, Okazaki fragments, enzymes and proteins in DNA replication prokaryotic & eukaryotic DNA polymerases; types and their functions |  |
| 3.2.2 Genomic and subcellular organelle replicons, viral and plasmids replicons, replication origin, initiation and replication, multiple initiation sites, |  |
| 3.2.3 Bidirectional replication, replication bubble and fidelity of replication. Inhibitors of Replication |  |

<p>| Unit: IV |<br />
|---|---|
| <strong>4.1 Transcription of DNA</strong> | 7 |
| 4.1.1 DNA dependant RNA polymerases in prokaryotes and eukaryotes, in vitro assay, properties of the enzymes, subunit structure. Reverse Transcription. |  |
| 4.1.2 Mechanism of transcription: template directed synthesis, sigma cycle, promoter recognition. Properties of promoter in prokaryotes and eukaryotes |  |
| 4.1.3 Post-transcriptional processing; maturation of rRNA &amp; tRNA, RNA splicing mechanism, poly A tail and 5ꞌ capping, non coding sequences. Inhibitors of Transcription |  |
| <strong>4.2 Translation</strong> | 8 |
| 4.2.1 Mechanism of translation: activation, initiation (importance of Shine-Dalgarno sequence), elongation and termination: Rho-dependent and Rho-independent, nonsense codons, role of RF1 and RF2 and GTP |  |
| 4.2.2 Post translational processing and modification, signal hypothesis, zymogen activation. |  |
| 4.2.3 Specific Inhibition of protein biosynthesis |  |</p>
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<tr>
<th>Course Code</th>
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<tr>
<td>PS BCH 302</td>
<td>Advanced Immunology</td>
<td>4</td>
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**Unit I:**

1.0 Introduction of Immune System-Adaptive and innate immunity

1.1 Cells and organs of Immune systems

1.1.1 Lymphoid cells, mononuclear, phagocytes, antigen presenting cell, polymorphs, mass cells and platelets.

1.1.2 Primary and secondary Lymphoid Organs, Lymphocyte Traffic.

1.1.3 B cell maturation, activation and differentiation.


1.1.5 Development of Immune System in short- Myeloid Cells, Memory B cells

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**Unit II:**

2.0 Antigens, Antigenic determinants, antigenicity and immunogenicity

2.1 Immunoglobulins –Basic structure, classes, subclasses, function

2.2 Antibody receptors

2.3 Organization and expression of immunoglobulin genes

2.3.1 Theories of antibody formation. Immunoglobulin variability

2.3.2 Genetic basis of antibody diversity

2.3.3 Regulation of Immunoglobulin production

2.4 Monoclonal antibodies

2.4.1 Production and clinical uses

2.4.2 Engineered monoclonal antibodies, Chimeric and hybrid monoclonal antibodies

2.4.3 Monoclonal antibodies constructed from immunoglobulin gene library.

2.5 Regulation of Immune response

2.5.1 Antigenic competition. Suppression of response to Antigen by presence of Antibody.
### Unit: III

#### 3.0 Antigen-Antibody Interaction (Ag-Ab Interaction)

#### 3.1 Primary and Secondary Ag-Ab Interaction

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<tr>
<th>Subsection</th>
<th>Description</th>
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<tbody>
<tr>
<td>3.1.1</td>
<td>Principles and practical aspects and Application of Primary Ag-Ab Interaction-Equilibrium Dialysis, RIA, ELISA, Immunofluorescence, Biotin-Avidin Ab Technique, Western Blotting, Flow Cytometry</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Principle &amp; practical Aspects and Application of Secondary Antigen Antibody Interaction-Precipitation, Agglutination, Complement Fixation Reactions</td>
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#### 3.2 Experimental Animal Models.

In Breed Strength, Adoptive Transfer Systems, SCID Mice and SCID Human Mice.

#### 3.3 Cell Culture System

Primary Lymphoid Cell Culture, Clone Lymphoid Cell Line, Hybrid Lymphoid Cell Line

### Unit: IV

#### 4.0 Molecules involved in Immunology

#### 4.1 Major Histocompatibility Complex (MHC)

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<tr>
<th>Subsection</th>
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<tbody>
<tr>
<td>4.1.1</td>
<td>General organization and inheritance of MHC.</td>
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<tr>
<td>4.1.2</td>
<td>Structure of Class I and Class II HLA Molecules and organization of Class I and Class II HLA Genes. Cellular distribution of MHC Molecules.</td>
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<tr>
<td>4.1.3</td>
<td>Regulation of MHC Expression- Determinant Selection Model, Holes in the Repertoire Model.</td>
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<td>4.1.4</td>
<td>MHC and susceptibility to disease</td>
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<td>4.2</td>
<td>Antigen processing and presentation</td>
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<td>4.3</td>
<td>Self MHC Restriction of T Cell</td>
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<td>4.4</td>
<td>Role of Antigen presenting cells.</td>
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<td>4.5</td>
<td>Pathways for Antigen Processing, Cytosolic and Endocytic pathway, clinical application</td>
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<td>4.6</td>
<td>Complement System</td>
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<tr>
<td>4.6.1</td>
<td>Definition, components and function. Complement activation, Classical and alternative pathways of membrane attack complex.</td>
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<td>4.6.2</td>
<td>Complement receptor and biological consequences of Complement activation, cell lysis, inflammatory response, opsonisation of antigen, viral neutralization, Solubilisation of immune complexes</td>
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<td>4.6.3</td>
<td>Complement deficiency</td>
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# Semester III Syllabus details

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<tbody>
<tr>
<td>PS BCH 303</td>
<td>Advanced Metabolism</td>
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## Unit I

### 1.1 Carbohydrate Metabolism & related disorders:

1.1.1 Glycogen Metabolism: Synthesis, breakdown, regulation, Glycogen storage disorder.

1.1.2 Gluconeogenesis: Cori cycle, Glucose-Alanine cycle, Regulation of Gluconeogenesis, Rapaport Luebering cycle & its significance.

1.1.3 Uronic acid pathway (biosynthesis, degradation & its significance), Galactose and fructose metabolism; lactose intolerance, essential fructosuria, fructose intolerance, Sorbitol pathway,

1.1.4 Regulation of Blood glucose level by liver, renal regulation & hormonal regulation. Diabetes mellitus and its diagnosis – GTC, Hba1C, Sugar interconversion and nucleotide sugar formation. Biosynthesis of oligosaccharides and glycoproteins

1.1.5 Mucopolysaccharides ;Structure, function and disorders.

## Unit II

### 2.1 Lipid and related disorders & Free radical Metabolism

2.1.1 Peroxisomal minor pathways of fatty acids oxidation) Disorder related to fatty acid oxidation, (Genetic deficiencies in carnitine transport and Acyl CoA dehydrogenase, Refsum’s disease, Zellweger syndrome)

2.1.2 Cholesterol: Biosynthesis, control, transport, utilization and atherosclerosis, cholesterol lowering drugs (statins etc.)

2.1.3 Arachidonate metabolism: Prostaglandins, Prostacyclins, thromboxanes and leukotrienes, the cyclic pathway of prostaglandins, Prostacyclins, thromboxanes’ the linear pathway of leucotrienes.

2.1.4 Phospholipid, glycolipid and lipoprotein: metabolism of glycerophospholipids, sphingolipids, sphingophospholipids, sphingoglycolipids.

2.1.5 Lipoprotein Metabolism: Metabolism of chylomicrons, VLDL, LDL, HDL, disorders of lipoprotein metabolism ( Hypo and hyper lipoproteinemias) transport lipoproteins and membrane lipoproteins

2.1.6 Adipose tissue Metabolism, starvation metabolism, fatty liver, ketone bodies-formation, utilization, ketosis, metabolism of alcohol (ethanol), disorders of lipid metabolism( Sphingolipidosis) – Neimann-Pick and Tay-Sach’s disease, Gaucher’s disease, Fabry’s disease.
Unit: III
3.1 Protein metabolism and related disorders

3.1.1 Biosynthesis & catabolism of – Glycine, Alanine, Aspartic acid, Glutamic acid, Serine, Proline, Hydroxyproline, Catabolism of threonine and basic amino acids. Metabolism of aromatic amino acids, Sulphur containing amino acids, branched chain amino acid, and related inborn errors of metabolism.

3.1.2 Formation of specialized products from amino acids and their functions- glutathione, creatine, creatinine, biogenic amines (dopamine, norepinephrine, tyramine, serotonin, melatonin, GABA, Histamine) polyamines (Putrescine, Spermodine, Spermine) Amino Acids as neuro-transmitters.

3.1.3 Nitrogen Balance, Biological Value of Protein, Protein Energy Malnutrition – PEM, Marasmus, Kwashiorkor.

Unit: IV
4.1 Nucleoprotein Metabolism and related Disorders


4.1.3 Nucleotide coenzyme synthesis. Structural analogs of Purine and Pyrimidine bases and their use as chemotherapeutic agents, Antifolate and Antiviral Agents.

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<td>PS BCH 304</td>
<td>Clinical and Pharmaceutical Biochemistry, Human Nutrition and Dietetics</td>
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## Unit I: Composition and Functions of Body Fluids in Health and Disease

1.1.1 Plasma, lymph, urine, cerebrospinal fluid, gastric juice, pleural fluid, saliva, sweat and tears, synovial fluid,

1.1.2 Blood Chemistry

1.1.3 Erythroid cell development

1.1.4 Blood Coagulation

1.1.5 Porphyrias, Hyperbilirubinemia.

1.1.6 Free radical metabolism: Generation of free radicals, damage produced by reactive oxygen species (ROS), free radical scavenger systems (enzymatic & nonenzymatic).

## Unit II: Pharmacokinetics, Clinical Research, trials and Ethical issues

2.1 Pharmacokinetics

2.1.1 Pharmacokinetics (PK) and drug metabolism, objectives of PK Analysis in drug discovery, fundamental concepts in drug absorption, distribution, metabolism & elimination (ADME) Kinetics of drug following different modes of drug administration.

2.1.2 Introduction to important PK parameters, PK of oral administration & bioavailability

2.2 Clinical Research and Trials

2.2.1 Clinical research- its importance, significance & rationale, Models used in clinical research

2.2.2 Clinical Trials- Stages/ Phases I to IV, milestones in clinical trials.

2.3 Ethical Issues

2.3.1 Values & principles in clinical investigation, international guidelines, patient care in clinical research, conflict of interest.

2.3.2 Ethical review, informed consent vulnerable populations, biological samples databases confidentiality frauds & misconducts

Number of Lectures: 15
## Unit: III

### 3.1 Macronutrients of Nutritional significance

3.1.1 Carbohydrates: Role of Oligosaccharides, Dietary Fibre, Non-starch polysaccharides, Prebiotics and Probiotics, Sugar alcohols in human nutrition, Glycaemic Index, Sweeteners

3.1.2 Lipids: SFA, MCT, MUFA, PUFA, Trans fatty acids, Omega 3, 6 Fatty Acids and their implications on health, Biochemical functions and deficiency disorders of essential fatty acids, fat replacers

3.1.3 Proteins: Nitrogen Balance, Protein Energy Malnutrition-Clinical features, Biochemical and Metabolic Changes, Nutritional Requirements. Anti-nutritional Factors-Trypsin Inhibitors, Pressor Amines, Phytates, Oxalates. Quality of Protein scoring system, Complementary value of Protein

## Unit: IV

### 4.1 Nutrigenomics

4.1.1 Nutrient-Gene Interaction

4.1.2 Drug-Nutrient Interaction

4.1.3 Obesity, Brown and White Adipose Tissue, Specific dynamic action factors affecting thermic effect of food.

4.1.4 Role of Leptin, Ghrelin, Adiponectin in food intake.

4.1.5 Eating Disorders: Anorexia Nervosa, Bulimia Nervosa.

### 4.2 Current topics in Nutrition

4.2.1 Mid-day programme

4.2.2 Chemical and biochemical indices of food quality

4.2.3 Food safety: Laws and regulations, regulatory agencies

4.2.4 Bioactive proteins and peptides as functional food, and Nutraceuticals

4.2.5 Sports Nutrition
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<td>PS BCH 401</td>
<td>Advanced Genetics</td>
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**Unit I:**

1.1 **Regulation of gene expression**

1.1.1 Organization of gene: structural & regulatory elements; split genes

1.1.2 Prokaryotic gene regulation; positive and negative control, induction and repression, attenuation. Example: lac, trp, his operons; SOS regulation

1.1.3 Eukaryotic gene regulation: Role of upstream, downstream and enhancer elements, cis-trans acting elements in gene expression, examples and experimental evidences

1.1.4 Epigenetic inheritance – Mechanisms

1.2 **Medical genetics**

1.2.1 Genetic screening, Genetic diagnosis, Genetic counselling

1.2.2 Genetic Medicine – Gene therapy, Personalised/tailor made medicine, Predictive medicine

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**Unit II:**

2.1 **Chromosomal abnormalities**

2.1.1 Chromosomal aberration

2.1.2 Structural and numerical abnormalities

2.1.3 Euploidy and aneuploidy (Autosomal and Sex chromosomes)

2.1.4 Monosomies (Turner syndrome) Disomies and trisomies (Down Syndrome) and their causes

2.2 **Mutations**

2.2.1 Types of mutations

2.2.2 Physical, chemical and Biological agents causing mutations

2.2.3 Mutational hot spot, reverse mutations, Mutagenesis, Ames test.

2.2.4 Site directed mutagenesis

2.3 **DNA repair Mechanism**

2.3.1 Photoreactivation, nucleotide excision, SOS repair, recombination repair, mismatch repair

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**Unit: III**

### 3.1 Enzymes that act on nucleic acids

- **3.1.1** Enzymes that act on DNA & RNA: DNAases, RNAases and phosphodiesterases

- **3.1.2** Chemical degradation of nucleic acids; significance of nucleic acid degradation in research industry

- **3.1.3** Modification and restriction of DNA; DNA methylases restriction endonucleases – properties and mode of action, palindromes, methylated bases

- **3.1.4** Reverse Transcription

### 3.2 Techniques in nucleic acid analysis

- **3.2.1** Amplification (PCR, different types of PCR), Restriction mapping, Oligonucleotide synthesis, Allele specific oligonucleotide (ASO). Microarray analysis.

- **3.2.2** RFLP, SNPS, RAPD, Quantitative trait loci.

- **3.2.3** Technique based on nucleic acid hybridization, dot-blot, FISH

- **3.2.4** Karyotyping, sex determination.

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**Unit: IV**

### 4.1 Recombinant DNA Technology (RDT)

- **4.1.1** Gene cloning, isolation of genes, obtaining genes from eukaryotic and prokaryotic organisms, problems of isolation of genes, isolation of gene fragments

- **4.1.2** cDNA synthesis, PCR, designing of primers for PCR, chemical synthesis of genes, shotgun experiments, gene bank, gene library

- **4.1.3** Vectors for cloning in bacteria – plasmids, bacteriophages, phages, cosmids, phagemids,

- **4.1.4** cloning in yeast vectors: Yep, Yrp, Ycp;

- **4.1.5** cloning in plant cells, suitable vectors – caulimoviruses, Ti plasmids,

- **4.1.6** cloning in mammalian cells, viral vectors, shuttle vectors

- **4.1.7** Introducing DNA into cells, transformation, microinjection, electroporation, selection of recombinant clones, colony hybridization, Southern & Northern hybridization, use of probes

- **4.1.8** Medical and Biological applications of recombinant DNA technology (RDT), Diagnostic probes for genetic and other diseases, Anti-sense technology and therapeutics, Environmental (degradation of toxic compounds), agricultural, industrial and commercial applications of RDT.
4.2 Human Genome project

4.2.1 Project period and accomplishment
4.2.2 Application and proposed benefits
4.2.3 Ethical Social and legal issues
# Semester IV Syllabus details

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS BCH 402</td>
<td>Advanced Immunology</td>
<td>4</td>
</tr>
</tbody>
</table>

### Unit I:

**1.0 Cytokines**

1.1 General structure and functions  
1.2 Cytokine receptors, cytokine antagonists  
1.3 Cytokine secretion by TH1 and TH2 subsets  
1.4 Cytokine related diseases  
1.5 Therapeutic uses of cytokines  

**1.6 Immune Responses**

1.6.1 Inflammation mediators of inflammation and process of inflammation  
1.6.2 Hypersensitivity Gell and coombs classification types I to IV with mechanisms  
1.6.3 Clinical methods to detect allergens in Type I hypersensitivity reactions. Skin testing method. Determination of total IgE, RIST, RAST.

### Unit II:

**2.0 Immune Response to infectious diseases**

2.1 Viral, Bacterial, Fungal and Protozoal diseases  
2.2 Helminthes (parasitic worms) infections- effector mechanisms  

**2.3 Immune Response in Transplantation**

2.3.1 Types of graft, immunological basis of graft rejection- 1st set, 2nd set rejection- role of T lymphocytes  
2.3.2 Tissue typing and laboratory investigations- microcytotoxicity test, mixed lymphocyte reaction (HLA Typing)  
2.3.3 Clinical manifestation of graft rejection,  
2.3.4 General and specific immunosuppressive therapy

### Unit III

**3.0 Immunological Tolerance**

3.1 Pathways to B and T cell tolerance  
3.2 General characteristics of B and T cell tolerance  
3.3 Mechanisms of tolerance inductions self-tolerance  
3.4 Potential therapeutic applications of tolerance  
3.5 Autoimmunity and autoimmune Diseases their etiology  
3.5.1 Organ specific autoimmune diseases (Hashimoto’s thyroiditis and insulin dependent diabetes mellitus)  
3.5.2 Diagnostic and prognostic value of auto antibodies- Treatment of autoimmune diseases  
3.5.3 Role of CD4, T cell, MHC and TCR in autoimmunity  
3.5.4 Proposed mechanisms for induction of auto immunity
Unit : IV

4.0 **Tumour Immunology**
4.1 Classification of tumours
4.2 Oncogenes and cancer induction
4.3 Tumour associated antigens Immune Response to tumour antigens, Immunosurveillance, Immunological escape mechanisms
4.4 Immunodiagnostic
4.5 Immunotherapy of tumours
4.6 Apoptosis and immune system
4.7 Immunodeficiencies
   4.7.1 Classification of immunodeficiencies: primary and secondary
   4.7.2 Immunology of HIV/AIDS: Discovery, causes, Structure, process of infection, destruction of CD4 T cells.
   4.7.3 Immunological abnormalities
   4.7.4 Clinical Diagnosis
   4.7.5 Development of vaccine and preventive measures
<table>
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<tr>
<th>Course Code</th>
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<tr>
<td>PS BCH 403</td>
<td>Advanced Metabolism</td>
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</table>

**Unit I:**

1. **Water and Electrolyte Balance, Mineral Metabolism and related disorders. Vitamin/ Mineral Interaction**
   1.1.1 Importance of Water. Total Body Water (TBW) and its distribution, normal water balance. (Intake and output of water, osmolarity of extracellular fluid)
   1.1.3 Metabolism of sodium, potassium, chloride, calcium, phosphorus, magnesium: Dietary sources, RDA, absorption and excretion, metabolic functions, clinical condition related to their plasma level alteration. Regulation of plasma calcium and phosphorus
   1.1.4 Vitamin/ Mineral interaction: Role of Vitamin D in Ca & P metabolism, relationship of vitamin C with Fe, role of vitamin E & its interaction with Se. Interaction between vitamin A, B₃, B₆ and Zn.
   1.1.5 Metabolism of Sulfur and Trace elements (Micro minerals): Cu, Cr, Co, F, I, Fe, Mn, Mo, Se, Zn, Cd.

2. **Hemoglobin Metabolism, Hemoglobinopathies, Porphyrias, Acid base balance**
   2.1.1 Haemoglobin synthesis & degradation. Hb derivatives: Oxy, Reduced, Met, Carboxy, Carbamino
   2.1.2 Abnormal Hb derivatives. Hemoglobinopathies: 1) Haemolytic Anemia-Unstable Hb, 2) Hb with abnormal O₂ affinity-High affinity (Polycythemia)Low affinity (Cyanosis) 3) Hb with structural and synthetic Variation in globin chains : Sickle cell Anemia , Alpha and Beta Thalassemia
   2.1.3 Disorders of Heme synthesis and degradation , Hyperbilirubinemias (Jaundice), Porphyrias.
   2.2 Acid Base Balance
      2.2.1 Acid Base balance: Role of Blood buffers, Kidney, Lungs
      2.2.2 Acidosis & Alkalosis and Compensatory Mechanisms
      2.2.3 Blood Gas Analysis (pH, pO₂, pCO₂, Bicarbonate) and interpretation
# Unit: III

## 3.1 Cancer

3.1.1 Cancer: Origin, characteristics of Benign and Malignant Tumours, classification of Malignant Tumour types, Cancer Metastasis, Carcinogens (Physical, Chemical & Biological). Mechanism of action, Proto-oncogenes, oncogenes, oncogenic viruses. Genetic defects, tumour viruses, inherited genetic defects, acquired chromosomal defects, defects in or suppression of immune response, hormonal factors, growth factors, tumour markers.


# Unit: IV

## 4.1 Stem Cell

4.1.1 Stem cell systems: Essentials of stem cell, Basic principles and methodologies. Types of stem cells and their properties. Totipotent, multipotent, pluripotent stem cells. Sources of stem cells with advantages and disadvantages. Cell cycle regulators in stem?

4.1.2 Stem cells of epithelial skin, skeletal muscle, heart, embryonic kidney, adult liver, pancreas, GI tract. Methods: Isolation and propagation of stem cells. Characterization, microarray analysis and differentiation of stem cells.

4.1.3 Stem Cell Research: Therapeutic applications of stem cells. Problems in stem cell research. The ethics of human stem cell research. Stem cell based therapies: FDA products and preclinical regulatory consideration.

## 4.2 Aging

4.2.1 Aging: Definition, Symptoms, Aging theories (Free Radical theory, Glycation Theory). Molecular, Biochemical Mechanisms.

4.2.2 Mitochondria and ageing protein damage & maintenance, neurodegeneration, DNA Damage & Repair, Telomeres, Telomerase, Cellular senescence and Apoptosis in ageing.

4.2.3 Longevity Genes. Sirtunis, Deacetylases, hormones, Immune system, Inflammation, Cancer & Aging. Biomarkers of aging, method to show Aging. Regenerative medicine, stem cells and rejuvenation.

4.2.4 Change of metabolities in aging.
## Semester IV Syllabus details

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PS BCH 404</td>
<td>Clinical and Pharmaceutical Biochemistry, Human Nutrition and Dietetics</td>
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</table>

### Unit I:

#### 1.1 Organ Function Tests. Biochemical Assessments and Changes in Endocrine Disorders

- 1.1.1 Liver Function test
- 1.1.2 Renal Function test including mechanism of urine formation (15)
- 1.1.3 Gastric and Pancreatic Function test
- 1.1.4 Thyroid Function test
- 1.1.5 Cardiac Profile
- 1.1.6 Biochemical assessment and changes in Endocrine disorder (Pituitary, Thyroid, Adrenal Medulla, Adrenal Cortex, Ovaries, ...)

### Unit II:

#### 2.0 Mechanism of Drug Action and structure-Function Relationship and New Drug Investigation and Application

#### 2.1 Mechanism of Drug Action and structure-Function Relationship

- 2.1.1 Molecular basis of drug action & pharmacological selectivity
- 2.1.2 Drug receptor theory, stimulus response, classification of receptors & strategy in receptor binding studies, receptor preparation & receptor binding kinetics (15)
- 2.1.3 Structure-function relationship with respect to proteins, enzymes, ion, channels and other drug targets, computer-based drug designing.

#### 2.2 New Drug Investigation (NDI) and Application

- 2.2.1 New Drug Investigation: Documents/ Information too filing NDI- animal pharmacology & toxicology studies, manufacturing information, clinical protocols and investigator information.
- 2.2.2 New Drug Application (NDA): Introduction to NDA, NDA forms, contents of NDA, Preparation & Submission of documents, guidance documents for NDAS (10)
### Unit: III

#### 3.1 Diet in Health and Disease

3.1.1 Nutrition during pregnancy, lactation, infancy, childhood, adolescence, adulthood, ageing.

3.1.2 Nutrition for health & weight management.

3.1.3 Nutrition for Exercise and Sport performance.

3.1.4 Nutrition for bone health.

3.1.5 Nutrition for therapeutic condition: Hypertension, CVD, GI disorders, (peptic ulcer, *H. Pylori*), Diabetes mellitus, anemia, Renal disorders, CRF, ARF, Jaundice

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### Unit: IV

#### 4.1 Techniques in Nutrition

4.1.1 Assessment of Nutritional Status: A B C D, i.e. Anthropometry, Biochemical Indices, Clinical; Examination, Dietary Assessment

4.1.2 Role of National and International Agencies in combating malnutrition WHO, FAO, UNICEF, ICAR, NIN, ICMR, Food Nutrition Board, CFTRI, NSI, IDA, ICDS.

4.1.3 Recommended Dietary allowances (RDA), factors affecting RDA, Methods used to calculate RDA, Practical application of RDA, Reference man and woman.

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</table>
M.Sc. (Part II)

Syllabus details for Semester –III practicals

PS BCH P301

1. Isolation of DNA (Crude) from germinating moong seeds & qualitative test.

2. Isolation of RNA (Crude) from Baker’s Yeast & qualitative test.

Demonstration Experiments

1. Determination of base composition of DNA.

2. Staining of Cellular RNA & DNA and microscopic examination.

3. Study of bacterial conjugation

4. Study of bacterial transformation.

5. Study of mutation in E. coli by UV.


7. Chemical Mutagenesis in Yeasts.

8. Polymerase chain Reaction (PCR).


10. Restriction Digestion & separation of DNA restriction fragments


12. Tm of DNA.

13. AMES Test.

14. DNA Sequencing
   a) Maxam Gilbert Method
   b) Sanger’s Method

15. Blotting Techniques
   a) Southern
   b) Western
   c) Northern
**PS BCH P302**

2. Haematological test- Bleeding time, clotting time, PCV, Hb by Sahli’s method, ESR, Blood spectroscopy, (only oxy Hb, meth Hb, acid and alkali hematin, reduced Hb), RBC count, WBC count, Total and differential WBC count.

**Demonstration Experiments**

1. Immunofluorescence
2. Flow Cytometry
3. RIA, ELISA

**PSBCHP303:**

1. Glucose Tolerance Test
3. Adenosine Deaminase estimation
4. Serum Uric Acid Estimation (Caraway method)

**Demonstration experiments**

1. Estimation of Blood Ammonia

**PSBCHO 304**

1. Gastric Function Tests
2. Estimation of CSF – Glucose, Protein & Chlorides
3. Estimation of Malondialdehyde (MDA), (Thiobarbituric Acid Method)
4. Urine Protein estimation
5. Haemoglobin (Drabkins Method)
6. Estimation of Aspirin (Volumetric Method)
7. Preparation of Methyl Salicylate
8. Isolation and Estimation of Oxalates from spinach/ Aloe vera

**Demonstration Experiments**

1. Glycemic Index Determination
Syllabus details for Semester –IV practicals

FOR PSBCH P 401

GUIDELINE TO CARRY OUT PROJECTWORK

1. The main purpose of introduction Project Work at MSc Part II is to make the students familiar with Research Methodology i.e. reference work, experimental work, statistical analysis of experimental data, interpretation of results obtained, writing of project work and compilation of bibliography in proper order. This will not only help train the inquisitive minds of the students, but also inspire them to take up research-oriented higher studies and career.

2. Duration of Project work :-
   Development on the nature of the research problem and the infrastructure available in the respective Biochemistry Departments or Research Institutes or Industries, the duration of Project Work in recommended as follows:-
   a. 06 Months:- From May 01 to Oct 31 of the given calendar year (the project work will commence immediately after the conclusion of Semester II of MSc Part – I on April 30 of given academic year)
   b. 03 Months:- From May 01 to July 31 or from mid- June to mid- September (either in summer vacation upto July 31 of Semester III or immediately after the commencement of Semester III in mid- June upto mid- September
   c. Entire Sem-III i.e. mid- June to Oct 31 depending on the first and the last working days of Sem III.

3. Each student shall complete a small research project during his/ her academic year of MSc Part- III However, the initial reference work can be started in MSc part- I and summer vacation to MSc Part-II

4. Nature of Research Project:-
   The following will be considered as the Research Project.
   a. Experimental based involving laboratory analytical work, or
   b. Survey based Field work with statistical analysis of data collected, or
   c. Industrial training based provided that the candidate has undergone actual hands on training in instrumental analytical techniques.
5. **Schedule for Submission of project Work:-**
   a. Experiment work or Field work or Industrial training must be completed by October 31.
   b. The duration of Diwali Vacation and the part of Sem IV upto December 31 shall be utilized for finalizing the written contents of the project work.
   c. The final copy of the project work (2 Copies) will have to submitted to the respective HOD by January 15 of Sem IV.

6. The project containing about 50-100 pages. Should be divided into the following parts:-
   a. Certification of completion of Project Work from the HOD.
   b. Acknowledgement.
   c. Introduction
   d. Review of Related Literature
   e. Aims and Objectives
   f. Signification of research problems selected
   g. Plan of work
   h. Material and Methods
   i. Results
   j. Discussion
   k. Bibliography

7. The project should not be submitted at the time of University Practical Examination, as the same will be assessed internally.
GUIDELINE FOR THE INTERNAL ASSESSMENT OF PROJECT WORK

1. The practical 401 of Sem IV (Course Code No. PSBCHP 401) 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 January 15 of Sem IV.

3. One copy of the certified project will be submitted to the HOD; while the other copy will be retained by the students for his/ her personal record.

4. After the certification of the project, the HOD will invite a PG – Recognized Teacher of Biochemistry Dept of any other College/ Institute/ Research centre for the assessment of Research Project.

5. The candidate is required to present the Research Project to the invited examiner followed by Viva- Voce examination based on the project work by the examiner.

6. The following Marking Scheme shall be considered while assessing the project work

<table>
<thead>
<tr>
<th>Particular</th>
<th>Marks</th>
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<tbody>
<tr>
<td>a) Project Work (Contents Submitted in the bound form)</td>
<td>30</td>
</tr>
<tr>
<td>b) Presentation of Project Work to Examiner</td>
<td>10</td>
</tr>
<tr>
<td>c) Viva- voce Exam based in Project Work</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

25
Syllabus details for Semister –IV practicals

Practical paper II- Advanced Immunology

**PS BCH P402**

1. Serological tests- Rheumatoid arthritis factor, c- reactive protein, vidal, VDRL, Pregnancy test

**Demonstration experiments**

1. Allergen Testing
2. HLA typing
3. HIV detection- screening tests

**PSBCHP403:**

1. Estimation of serum Acid Phosphatase.
2. Estimation of serum Electrolytes. (Na & K).
3. Estimation of Vitamin C From food sample ( Dichlorophenol indophenols Dye method )
4. Estimation of Iron and Iron Binding Capacity
5. Estimation of Magnesium and Phosphorus, from serum

**Demonstration Experiments:**

1. Estimation of Serum Glycosylated Haemoglobin
2. Arterial Blood Gas Analysis
3. Estimation of Vitamin A and Vitamin D
4. Microbial assay of Vitamin B12

**PSBCHO 404**

2. Renal Function Tests: Urea and Creatinine Clearance Test with Clinical Interpretation
3. Urine Report- Abnormal constituents

**Demonstration Experiments:**

1. Antibiotic Assay
Format of Mark sheet to be prepared for entering the marks of internal Assessments of the project work done by MSc. Part II students

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Univ. Seat No.*</th>
<th>Name of Candidate *</th>
<th>Marks scored out of 50 (To be added to the marks of Pract 401)</th>
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<tr>
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<td>30 10 10 Total (50)</td>
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</tbody>
</table>

Circular seal of college

Signature of Invited Examiner with Date

*To be filled in by the University Examination House.

** To be arranged on the alphabetical order of surname.

7. For each college, three copies of such mark sheets, duly signed by the Invited Examiner, will be prepared. Two copies of these marksheets will be sealed in an envelope and sent to the Mumbai, Kalina Campus, Mumbai- 400 098, at least two weeks before the commencement of the University Practical Examination.

8. The remaining third copy of the marksheet will be retained by the HOD of the respective Colleges in the sealed envelope as a “Confidential Record”

9. The following details will be clearly written on the sealed envelope to be submitted to the Controller of Examinations.
10. The same details will be entered on the sealed envelope kept as a Confidential Record in the department, which will be preserved for at least next 2/3/5 academic years.

11. The marks scored by a candidate in Project Work will be carried forward for subsequent examination if he/she appear for more than one attempt at the University Practical Examination.

12. Under no circumstances will there be re-assessment/re-evaluation of the Project Work and the marks assigned there for (out of 50 as part of Pract 401) will be final.
Suggested Readings for paper 301 and 401 and Practical 301 and 401:

8. Hayes, William, Genetics of Bacteria and Viruses, CBS Publisher, New Delhi.

Suggested Readings for paper 302 and 402 and Practical 302 and 402:

9. Hood Leroy E., Immunology, 2nd Ed., 1976, Benjamin Cummings Publication
Suggested Readings for paper 303 and 403 and Practical 303 and 403:

4. Todd et al – Clinical Diagnosis and Management, 17th edition, WB Saunders, Philadelphia
5. Stokes Joan et al – Clinical Microbiology, Edward Arnold, London
8. Rodrigues Fred K Carbohydrate chemistry with clinical correlations, New Age International, New Delhi

Suggested Readings for paper 304 and 404 and Practical 304 and 404:

5. Gopalan C et al, Dietary Allowances for Indians, NIH, Hyderabad.


15. Pharmaceutical chemistry, G Melentyeva L L Antonova Mir Publishers, Moscow

16. Chemical Pharmacology, R B Barlow, 2\textsuperscript{nd} Ed, Methven and CO. New Fetters Lane

17. Medicinal Chemistry, Vol I, 3\textsuperscript{rd} Ed, Alfred Burga, Wiley Inter sciences

18. Textbook of paramedical chemistry, Jayshree Ghosh, S chand and company, New Delhi

19. Pharmacology, B Suresh, 1\textsuperscript{st} Ed. Shanti, Publication.
**Scheme of Theory examination M.Sc. Part I & Part II (Sem I to Sem IV)**

1) Each theory paper shall carry 60 marks

2) Each theory paper shall be 2 1/2 hours duration

3) Each theory paper shall contain 05 questions of 12 marks each as follows:

   - Q I : Based on Unit I
   - Q II : Based on Unit II
   - Q III : Based on Unit III
   - Q IV : Based on Unit IV
   - Q V : Based on Unit I to Unit IV

4) Marking system for **Questions I to IV**

   - Sub Q A : Attempt any one out of two ------- 02 marks each
   - Sub Q B : Attempt any one out of two ------- 04 marks each
   - Sub Q C : Attempt any one out of two ------- 06 marks each
   - Sub Qs B & C may be further sub-divided into 2 marks x 2 and 3 marks x 2 if necessary.

5) Marking system for **Questions V**

   - Q no V shall contain 08 sub-questions i.e

     Two sub questions based on each of the units I to IV.

     Each sub question shall carry 03 marks.

     - Sub Q (a) and Sub Q (b) : Based on Unit I
     - Sub Q (c) and Sub Q (d) : Based on Unit II
     - Sub Q (e) and Sub Q (f) : Based on Unit III
     - Sub Q (g) and Sub Q (h) : Based on Unit IV

     Student shall attempt one sub question (a) OR (b) and (c) OR (d) and (e) OR (f) and (g) OR (h). Thus a student shall attempt a total of 04 sub questions carrying 03 marks each from Q No V.
Scheme of Practical Examination at MSc Part I and MSC Part II (Semi I to IV) [Except for Practical Exam for PS BCH P 401]

1) Each practical (PS BCH P 101 to PS BCH P 404) shall carry 50 Marks.

2) Distribution of 50 Marks shall be as follow:- (Except PS BCH P 401)

Experiments Marks

- a) Any Two Experiments 40
  (20 Marks each)
- b) Certified Journal 05
- c) Viva- voce Exam 05

TOTAL 50

3) Duration of University Practical Examination

A) For PS BCH P 101, 102, 103, 104, 201, 202, 203, 204, 301, 302, 303, 304.
   a) Two days with 2 Sessions on each day i.e. Total 4 Sessions.
   b) Each Sessions shall be of 3 1/2 Hours.
   c) Morning Session: 09.00 am to 12:30 pm
      Afternoon Session: 01:00 pm to 04:30 pm
   d) DAYSESSIONPRACTICALS

      1st Morning PS BCH P 101 or 201 or 301
      1st Afternoon PS BCH P 102 or 202 or 302
      2nd Morning PS BCH P 103 or 203 or 303
      2nd Afternoon PS BCH P 104 or 204 or 304

B) For PS BCH P 401:
   Project Work carrying 50 Marks to be evaluated internally in Feb / Mar of Sem IV as per the guidelines included in the syllabus.

C) For PS BCH P 402, 403 & 404:
   a) Only 03 Sessions spread over 1 ½ days as given below:-

   b) DAY SESSION PRACTICALS

      1st Morning PS BCH P 402
      1st Afternoon PS BCH P 403
      2nd Morning PS BCH P 404

4) Students are required to submit the “Certified Journals” at the time of University Practical Examination.