



**Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE - 411004**

**Two Years
M. Sc. Degree Course in Chemistry
(Biochemistry)**

**SYLLABUS
Semester - III & IV**

**Second Year M. Sc.
[Biochemistry]**

[Academic Year 2017-2018]

Deccan Education Society's
FERGUSSON COLLEGE (Autonomous), PUNE – 411004
Department of Chemistry
Two Years M. Sc. Degree Course in Biochemistry
 [Implemented from Academic Year 2017-2018]

M. Sc. Part II Biochemistry Course Structure under CBCS (Autonomous)

Term / Semester	Name of the Paper	Title of Paper	Theory Credits	No. of Lectures / Practicals
First Term / Semester III	CHB5301	Molecular Biology	4	60
	CHB5302	Immunology	4	60
	CHB5303	Physiological Biochemistry	4	60
	CHB5304	Plant Biochemistry and Cell culture	4	60
	CHB5305	Biochemistry Practical V (Molecular Biology and Special Experiments)	4	15 Practicals
	CHB5306	Biochemistry Practical VI (Clinical Biochemistry and Basics of Cell Culture)	4	15 Practicals
	CHB5307	Self Learning Course 3	1	15
Semester III Credits			25	

Term / Semester	Name of the Paper	Title of Paper	Theory Credits	No. of Lectures / Practicals
Second Term / Semester IV	CHB5401	Neurochemistry & Endocrinology	4	60
	CHB5402	Toxicology & Advance Biophysical techniques	4	60
	CHB5403	Genetic Engineering	4	60
		Elective Papers : Any Two		
	CHB5404	Clinical Nutrition & Food technology	2	30
	CHB5407	Nutraceutical and Pharmacology	2	30
	CHB5408	Molecular Oncology	2	30
	CHB5409	Stem cells and Regenerative medicine	2	30
	CHB5405	Biochemistry Practical (Project)	8	30
	CHB5406	Self Learning Course 4	1	15
Semester IV Credits			25	

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Faculty of Science
Extra Credits for Post Graduate Courses

M. Sc. Course in Biochemistry

Semester	Course Code	Title of the Course	No. of Credits
III	XCS0007	Introduction to Cyber Security - III / Information Security - III	1
	XSD0008	Skill Development - III	1
IV	XCS0009	Introduction to Cyber Security - IV / Information Security - IV	1
	XSD0010	Skill Development - IV	1

Semester III

Course Code : CHB5301

Course Title : Molecular Biology

(4 Credits)

Objectives:

1. To understand how viral, prokaryotic and eukaryotic genomes differ from each other and how are they organised in cell.
2. Sketch the concept of the Central Dogma.
3. Explain all the steps for DNA replication in prokaryotes and eukaryotes and be able to compare and contrast eukaryotic and prokaryotic enzymes involved in replication.
4. Distinguish between the DNA template strand and new strand and what is direction of replication.
5. Understand the types of DNA damage and how cell repairs it by various mechanisms.
6. Understand the process of homologous recombination through Holliday model and know the role of enzymes used in homologous recombination.
7. Comprehend the term transcription, understand the process thoroughly and know the enzymes that catalyze the process in Eukaryotes and Prokaryotes.
8. Know about transcription inhibitors and their mechanism of working.
9. Understand post transcriptional modification.
10. Understand the role of sorting sequences in bringing proteins to the correct organelles.
11. Define introns and exons.
12. Describe the various ways of mRNA splicing
13. Explain general process of Translation of mRNA: indicate similarities, differences in prokaryotes and eukaryotes and know about antibiotics/toxins used in translation inhibition.
14. Understand the term 'gene regulation', proteins involved in regulation of genes.
15. Explain how DNA methylation and histone acetylation affects chromatin structure and the regulation of transcription.

Unit I	Molecular structure of Genes and Chromosomes : Definition and organization of viral, prokaryotic and eukaryotic genomes, Structural organization of Eukaryotic chromosomes: structure of chromatin, nucleosome, chromatin organization, higher order organization- chromosome, centromere, telomere, Histones	5L
Unit II	DNA Replication : Chemistry of DNA synthesis, Enzymes involved in DNA synthesis e.g. topoisomerase, helicase, Ligase, DNA polymerase – types, subunits, mechanism, Origin of replication. Mechanism of Replication in Prokaryotes and Eukaryotes. Okazaki fragments, Replication fork. Nick translation. Replication models: phage DNA, phi X 174, SV-40. Inhibitors of DNA synthesis.	10L
Unit III	DNA Repair : Replication errors and their repair – Mismatch Repair, DNA damage, Repair of DNA damage – Direct reversal of DNA damage, Base Excision mechanism, Nucleotide Excision mechanism, Translesion DNA synthesis, Defective repair system and diseases, Ames test	6L

Unit IV	Homologous Recombination : Recombination pathways, Holliday model, DSB repair model, Homologous recombination protein machines: RecBCD, Rec A, Ruv AB, RuvC, SOS response, Biological significance of Homologous recombination in Eukaryotes.	4L
Unit V	Transcription: Mechanism in prokaryotes: RNA polymerases - subunits, promoters, initiation, elongation and termination of transcription-Rho dependent and independent.Mechanism in Eukaryotes: RNA pol I, II, III, subunits, promoters for RNAP I, II, III, Transcription factors, Transcription process, Regulatory. Inhibitors of transcription.	8L
Unit VI	Post-transcriptional modification of RNA : Types of RNA processing, 5' capping and 3' poly A tailing: mechanism and functions, Chemistry of RNA splicing: Type of Introns, Types of Splicing pathways: The Spliceosome machinery, Self splicing, Alternative splicing, RNA editing. Ribozymes.	5L
Unit VII	Translation : Features of Translation components: mRNAs – structure, ORF; tRNAs – structure, adaptor hypothesis; Aminocyl tRNA synthetase – attachment of amino acids; Riobosome, Mechanism in Prokaryotes and Eukaryotes : Intiation, Elongation, Termination, Post translational modifications, Inhibitors of protein synthesis.	8L
Unit VIII	Protein Targeting and Degradation : Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, Peroxisomes, chloroplast, protein degradation.	8L
Unit IX	Regulation of Gene Expression : Principles of Gene regulation: regulation of gene expression in Bacteria, phage lambda, sequences, DNA binding motifs, Gene regulation in Eukaryotes: chromatin remodeling: process, enzymes, transcriptional activators, Introduction to epigenetic regulation.	6L

References:

1. Biochemistry (III/IV/V/VI edition, 2008) L. Stryer, WH Freeman and Co.
2. Molecular biology of the gene (V edition, 2004) J D Watson, Person education Inc.
3. Molecular Cell Biology (7th edition.2013) by Harvey Lodish et al.
4. Molecular biology of the cell (2008) B. Alberts, Garland Pub. In., NY
5. Genes X (2010), B. Lewin, John Wiley and sons, NY.

Course Code: CHB5302
Course Title: Immunology
(4 Credits)

Objectives:

1. Students will learn the basis of immunity, diseases and difference between communicable and non communicable disease
2. Types of immunity, terminologies used in immunology and cell involved in generation of immunity with its mechanism of action in immunity generation.
3. Study of primary and secondary lymphoid organ, B cells maturity activation and Differentiation, T cells sub classes its organization and rearrangements.
4. Development of cell mediated immunity, humoral immunity and clonal selection theory.
5. Types and structure of antibody and its different fragments. Different methods for production and purification of monoclonal and polyclonal antibodies.
6. Study of detail structure for different types of MHC molecules. Role of MHC molecule in recognition, processing and presenting of antigen molecule. Activation of macrophage.
7. Study of different types of antigen antibody reactions.Mechanism of lattice theory. Types of precipitation and agglutination reaction its mechanism and application.
8. Study of different immunodiagnostic techniques with applications like RIA, ELISA Western blotting.
9. The complement system, its activation and maturation pathway, different proteins involved in complement system.
10. Causative agents of hypersensitivity and immunodeficiency disease. Different types of hypersensitive reaction, its causative factors or cells, symptoms and treatment. Different cell involved in immunodeficiency disorders, symptoms and treatments.
11. Students will learn the history of the discovery of the ABO system and Rh factor. Briefly descriptions of the membrane structure of the red blood cell, the different types of analysis of blood grouping. Disorders related to blood transfusion.
12. Importance of vaccine against various diseases its types and its role in generation of active and passive immunity. Study of different methods and properties of various types of vaccine

Unit I	Introduction and concept of Diseases: Overview of immune system. Disease types Communicable and Non communicable, Intracellular and Extracellular pathogens. Phylogeny of Immune system, innate and acquired immunity, Nature and Biology of antigens and super antigens, Antigens, Antigenic determinants, antigenicity and immunogenicity.	4 L
Unit II	Cells and Organs of immune system : Lymphoid cells, mononuclear, phagocytes, antigen presenting cell, polymorphs, Mast cells and platelets. Primary and secondary Lymphoid Organs, Lymphocyte Traffic. B cell maturation, activation and differentiation. T cell subset and their function. T lymphocytes and cell mediated immunity, T cell sub populations, immune response genes, T cell receptor, structure, organization and rearrangement of TCR genes. T cell receptor complex-TCR- CD3. T cell accessory membrane molecule. Maturation, Activation & Differentiation. Development of Immune System in short.	12L

Unit III	Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, catalytic antibodies (abzymes) : Methods of raising antibodies. Monoclonal and polyclonal antibodies, production and purification.	3L
Unit IV	Major Histocompatibility Complex (MHC) : Structure and functions of class I and class II molecules. MHC restriction. Antigen processing and presentation. Effector mechanisms of immune response; macrophage activation; Mechanism of humoral and Cell mediated cytotoxicity	6L
Unit V	Immunoglobulin Structure : Antibody structure and function, constant and variable regions, Fab, F(ab ₂) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, isotypes, allotypes and idiotypes	4L
Unit VI	Immunodiagnostic techniques : Precipitation reactions: Immunodiffusion, immunoelectrophoresis, Agglutination reactions: Bacterial Agglutination, Hemagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition Radioimmunity assay, ELISA, Chemiluminescence immuno assay, Western blotting technique, Complement fixation test, Immunofluorescence, Immunoelectron microscopy.	10L
Unit VII	Complement system: classical, alternate and lectin pathway	4L
Unit VIII	Hypersensitivity and allergy, immunodeficiency diseases (AIDS) : Hyper sensitivity reaction – Type I, II, III and IV reactions. Immunodeficiency disorders: Phagocytic cell defect (Chediak-Higashi syndrome); B -cell deficiency (Bruton's X-linked hypogammaglobulinemia); T-cell deficiency disorder (DiGeorge Syndrome); Combined B-cell & T-cell deficiency disorder (SCID-Severe combined immunodeficiency diseases, Wiskott-Aldrich syndrome), Complement deficiencies and secondary immunodeficiency conditions carried by drugs, Nutritional factors & AIDS	10L
Unit IX	Blood group substance and Rh factor: Immunological basis of Blood transfusion	2L
Unit X	Vaccine Mechanism : Active and passive immunization, Live, killed, attenuated, sub unit vaccines; Recombinant Vaccines, Polyvalent vaccines, DNA vaccines	5L

References:

1. Immunology 5th ed Janis Kuby
2. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
3. (Editor) By Lippincott Williams & Wilkins Publishers
4. Essential Immunology, Ivan M. Roit (1994)– Blackwell Scientific Pub, Oxford.

5. Cellular and Molecular Immunology, 3rd ed, Abbas
6. Immunology by Nandini Shetty.
7. Immunology by Sudha Gangal

Course Code: CHB5303
Course Title: Physiological Biochemistry
(4 Credits)

Objectives:

1. Students here will study the anatomy of various parts of human body.
2. They will also study biochemistry and functions of these body parts
3. Students will learn sensory organ structures and their biochemistry
4. Students will study blood, types and clotting mechanism
5. Acid base balance in the body
6. Cytoskeleton components and motility of various cells and its importance
7. Basic disorders of various body parts, diagnosis and treatment.

Unit I	Liver: anatomy, physiological functions. Detoxification mechanisms. Liver function tests Liver disorders:- hepatitis, cirrhosis, Jaundice: etiology and symptoms	5 L
Unit II	Kidney: Anatomy, physiological functions, diseases/disorder, kidney function tests	4 L
Unit III	Respiration: Mechanism and regulation of respiration, pulmonary and alveolar ventilation and its control, Principles of gaseous exchange, transport of respiratory gases, respiratory mechanism of acid-base balance. Nervous and chemical control of respiration. Hypoxia acclimatization, cyanosis, dyspnoea, asphyxia, abnormal respiration. Pulmonary function tests. Effect of high and low atmospheric pH.	5 L
Unit IV	Digestion and Absorption of food: Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins, lipids, nucleic acids and vitamins.	5 L
Unit V	Biochemistry of blood clotting: Clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K clotting process, lysis of fibrin clot. Conditions that cause excessive bleeding in humans.	4 L
Unit VI	Regulation of acid-base balance: Types and functions of acid-base buffers, clinical abnormalities associated with acid-base imbalance.	4 L
Unit VII	Reproductive organs: Anatomy and functions.	5 L

Unit VIII	Muscles (Skeletal muscle, cardiac and smooth muscles): Morphology, ultra structural organization, protein components of myofibrils- Actin , Myosin, Troponin, Tropomyosin , molecular organization of thick and thin filaments, proteins in muscles other than muscle filaments, mechanism of muscle contraction, metabolism of muscles. Contraction and relaxation cycle of muscle and regulation.	8 L
Unit IX	Cytoskeleton components, chemotaxis and cell motility: Microfilaments, microtubules, intermediate filaments, cilia and flagella of eukaryotic Cells (molecular composition of cytoskeleton), chemotaxis in prokaryotes and eukaryotes.	2L
Unit X	Nervous tissue: Structure and various components of neuron, their types and functions, creation and propagation of nerve impulse. Generation of action potential, types of channels in neurons. cholinergic receptors, electroplaxes as a source of acetyl choline receptor and Nerve poisons	4L
Unit XI	Biochemistry of vision: Structure of eye, lens, and retina, photoreceptor cells (rods and cones), perception of light, primary events in visual excitation, cyclic GMP, role of various proteins of eye, generation of nerve impulse, colour vision.	2L
Unit XII	Biochemistry of sense of taste, smell and hearing: Structure of taste buds and olfactory cells, role of cells in perception of taste (various chemical groups) and smell.	4L
Unit XIII	Biochemistry of sense of touch: Structural components of skin and touch receptors, types of touch receptors, Structural components of ear, receptors of sound waves, perception of sound mechanism of body balance.	4L
Unit XIV	Disorders of various body parts: Disorders related to skeletal and cardiac muscle, cytoskeleton components, nervous tissue, eye, ear, skin, and nose. Diagnostic methods of various disorders and treatment in general.	2L

References:

1. Text book of physiology- Guyton
2. Principles of neural science Kandel ER, Schwartz JH, Elsevier, N.Holland, NY
3. Neurobiology, Shepherd GM , Oxford Univ. Press
4. Nerve and muscle excitation Junge D, Sinauer assoc, Sanderland, mass
5. Biochemistry , L Stryer, Freeman and Co, NY
6. Biochemistry, Zubay, Addison Wesley and Co
7. Biochemistry, L Stryer, Freeman and Co, NY
8. Biochemistry, Zubay, Addison Wesley and Co.
9. Textbook of Physiology, Guyton
10. Physiology, Berne and Levy
11. Harper's Biochemistry- 27th edition
12. Text book of Human Biochemistry- Ed. G. P. Talwar

Course Code: CHB5304**Course Title: Plant Biochemistry and Cell Culture
(4 Credits)****Objectives:**

1. Students here will study the different micro and macro elements its properties, daily requirement and its disorders related to its concentration (low or high).
2. Know the structure of chloroplast and photosystem I and II.
3. Study of different pathways like C3 and C4.
4. Study of nitrogen cycle and nitrogen fixation (symbiotic and non-symbiotic mechanism) and role of micro-organism in nitrogen fixation.
5. Study of different plant hormones and their role in its growth and development
6. Understand about secondary metabolites, its types, applications, isolation methods and estimation.
7. Students will study the method of Seed germination different seed storage proteins and its properties.
8. Study of types of plant diseases, its symptoms, causative factors, its treatment.
9. Study of different types of pesticides, its role on crops, its advantage and disadvantage.
10. In Cell culture, students will learn the introduction, history, cell culture laboratory organization.
11. Study of different sterilization techniques for laboratory and media.
12. Detection of contaminants and preventive steps.
13. Study of different media used in plant and animal culture, preparation methods.
14. Study of types of culture and its development.
15. Different methods of cell preservation like cryopreservation, tissue banking.

Unit I	Mineral nutrition : Micro and macro elements, requirement, role, excess and deficiency disorders	2L
Unit II	Photosynthesis : Chloroplasts, photosystem, mechanism CO ₂ fixation, C ₃ and C ₄ pathways, CAM.	5L
Unit III	Nitrogen and Sulphur metabolism : Nitrogen cycle, nitrogen fixation, assimilation of nitrate and ammonium ions, nitrogen transformation during development, assimilation of sulfate.	4L
Unit IV	Plant hormones : Types and role in plant growth and development, Auxins gibberellins, cytokinins, ethylenes, abscisic acid, hormones in senescence and abscission.	5L
Unit V	Secondary metabolites : Definition types, phenolics, flavanoids, lignins, terpenoids alkaloids, Gum Pectins Rubber: chemistry examples and applications	4L
Unit VI	Biochemistry and physiology of seed germination and dormancy, seed storage proteins : Structure, anatomy and molecular components; Cytoskeleton– an overview. Plant cell cycle and its regulation. Energy production in plant cells and its control. Metabolism of sucrose and starch.	5L

Unit VII	Plant diseases : Pest types, symptoms, treatment, pesticides.	5L
Unit VIII	Cell Culture Introduction to Sterilization and cell culture laboratory: Definition, principle and significance of tissue culture. Maintenance of sterility, Sterilization of cell culture media and reagents. Prevention of Cross contamination Detection of Mycoplasma and viral contaminants.	4L
Unit IX	Media requirements : Requirements of a different media used in plant and animal tissue culture laboratory, Special nutrients in tissue culture. Sterilization and role of growth regulators, Preparation of medium and sterilization techniques. Advantages and disadvantages of natural and synthetic media	5L
Unit X	PCC Techniques : Callus and cell suspension culture, Micropropagation, Conditioning of tissue culture. Plants (weaning and hardening), Somatic cell hybridization, Haploid (anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis, Somaclonal variations, Cybrids and Allopheny, Agrobacterium mediated hairy root culture.	6L
Unit XI	Cell culture methods and ACC Techniques : Types of tissue culture systems: cell culture, tissue culture, organ culture, embryo culture; Types of cell culture: Primary culture, diploid culture, cell line normal tissue ,cancer tissue; Techniques of making primary cell culture: a) Non enzymatic: Hanging drop, Tissue explant culture b) Enzymatic : trypsin, dispase, collagenase etc. Organ culture : definition, techniques, Grid method, Raft method ,Tracheal organ culture; Cell environment : a) Substratum (glass/plastic) different tissue cultire flasks, Petri plates, tubes, 24 well plates, b) Balanced salt solutions, Hanks, Earle, Dulbecc, c) Media : Natural serum, (fetal, adult) plasma, milk, coconut water, amniotic fluid, Synthetic MEM M199, L 15, DMEM. RPMI 1640, d) incubators, desiccators with candle; Sterility and disinfection, Storage of cells, media, sera, tissue reagents, Factors affecting success of cell culture, Cytotoxicity.	10L
Unit XII	Applications of Cell culture : Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance.	5L

References:

1. Biochemistry, L Stryer, Freeman and Co, NY
2. Plant physiology, Salisbury and Ross (2007) CBS publishers and distributors
3. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox
4. Biochemistry and Physiology of Plant Hormones, Thomas Moore
5. Plant Biochemistry- Hans Walter Heldt
6. Introduction to Plant Biochemistry- T.W. Goodwin and E.L. Mercer
7. Plant Physiology- Devlin

8. Plant Biochemistry- Dey
9. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition by Ian Freshney.
10. Principle and practice of Animal Tissue Culture by Sudha Gangal
11. Cell and Tissue Culture –Alan Doyle and J. Bryan Griffiths

Course Code : CHB5305

**Course Title : Biochemistry Practical V (Molecular Biology And Special Experiment)
(4 Credits)**

Molecular Biology (Any nine)

1. Isolation of DNA from bacteria/ liver/ plant/ yeast source
2. Isolation of RNA from bacteria/ plant/yeast/ mammalian source.
3. Spectrophotometric analysis of nucleic acids
4. Agarose gel electrophoresis of DNA and molecular size determination
5. Determination of T_m
6. Restriction digestion of DNA
7. Preparation of plasmid DNA
8. Transformation
9. Ligation study
10. PCR
11. Real time PCR analysis

Special Experiments (Any six)

1. Extraction, isolation of sub cellular organelle with respect to marker enzyme and its activity
2. Extraction of phytochemicals, screening (qualitative) and quantitative measurements
3. Extraction of antioxidant from natural source and its activity.
4. Identification of functional groups in a compounds using IR (Working and interpretation of IR)
5. Activity of Acetyl choline esterase
6. Extraction of protein from natural source and nitrogen estimation by Kjeldahl method
7. Peptide synthesis (Dipeptide/Tripeptide)
8. Essential oil extraction and characterization
9. Immobilization of enzyme and activity of entrapped enzyme (Amylase/Invertase)
10. Precipitation and agglutination reactions (Blood grouping, Oucterlony double diffusion)
11. Dot Blot immunoassay

Industrial Visit

12. Industrial Visit/laboratory visit

Course Code : CHB5306

Course Title : Biochemistry Practical VI (Clinical Biochemistry And Cell Culture Techniques)

(4 Credits)

(Any 15 Experiments To Be Conducted)

Clinical biochemistry

1. **Experiment for kidney function test.**
 - A. Urine analysis.
 - B. Serum Creatinine
 - C. Urea estimation
 - D. BUN
2. **Experiment for liver function test.**
 - A. SGOT
 - B. SGPT
 - C. ALP
 - D. Albumin
 - E. Proteins
 - F. Bilirubin
 - G. Cholesterol
3. **Blood sugar estimation.**
 - A. Glucose oxidase and peroxidase method
 - B. Folin-Wu method
 - C. Glucose tolerance test
4. **Different enzymes studies**
 - A. LDH and its isozymes
 - B. serum amylase

Cell Culture Techniques

1. Acquaintance with cell culture laboratory, Culture place: culture cubical P1 to P4; Laminar flowsystem
2. Preparatory techniques: Washing of glassware, dry and steam sterilisation. Maintenance of aseptic conditions, Sterilization techniques, Media preparation: Filter sterilization, and media storage. Serum inactivation.
3. Culturing and sub-culturing of animal cell lines and its maintenance.
4. Cell counting, viable cell count, trypsinization, cryopreservation and revival.
5. Culturing and sub-culturing of callus in different media its characterization.
6. Chick embryo fibroblast culture

References:

1. Practical Biochemistry- David Plummer
2. Practical Biochemistry – J. Jayaraman
3. Biochemical methods – Sadasivam and Manickam
4. Biochemistry –Practical Approach – Kieth Wilson and J. Walker
5. Introductory Practical Biochemistry- Randhir Singh and Sawhney
6. Laboratory handbook on Biochemistry, S Shanmugam, 2010, PHI Pvt Ltd, New Delhi.
7. Culture of animal cell – R. Ian Freshney
8. Cell and Tissue Culture –Alan Doyle and J. Bryan Griffiths
9. Basic Cell Culture Protocol – Cheryl D Helgason
10. Basic principle of cell culture – Freshney.

Scheme of Biochemistry Practical Examination

Note :

1. The practical examination in the subject will be conducted for SIX HOURS duration.
2. The practical examination in the subject will be conducted for 50 marks.
3. Certified Biochemistry Laboratory Journal is compulsory for the examination.
4. Oral/viva examination is compulsory.
5. Books /printed material, cyclostyled or typed material will be allowed during the practical examination.
6. Examiners will arrange Q1 and Q2 experiments for conducting practical examination.
7. Lucky draw system will be followed for the students for practical examination by the examiners.
8. Log table and calculators are allowed during the practical examination.
9. Mobile/s is/are strictly not allowed during the practical examination in laboratory.

The candidate has to perform the following question/s for examination.

CHB5105: Biochemistry Practical V (Molecular Biology And Special Experiment)

- Q.I Molecular Biology Experiment (Any one) 20 Marks**
- A. Isolation and estimation of DNA from bacteria
 - B. Isolation and estimation of DNA from goat liver.
 - C. Isolation and estimation of DNA from plant leaves.
 - D. Isolation and estimation of DNA from yeast source
 - E. Isolation and estimation of RNA from bacteria source
 - F. Isolation and estimation of RNA from mammalian source
 - G. Isolation and estimation of RNA from plant source
 - H. Isolation and estimation of RNA from yeast source
 - I. Agarose gel electrophoresis of DNA and molecular size determination
 - J. Determination of T_m
 - K. Restriction digestion of DNA
 - L. Preparation of plasmid DNA
 - M. Ligation study
- Q.II Special Experiment 20 Marks**
- A. Extraction, isolation of sub cellular organelle with respect to marker enzyme and its activity
 - B. Extraction of phytochemicals, screening (qualitative) and quantitative measurements
 - C. Extraction of antioxidant from natural source and its activity.
 - D. Identification of functional groups in a compounds using IR.
 - E. Activity of Acetyl choline esterase
 - F. Extraction of protein from natural source and nitrogen estimation by Kjeldahl method
 - G. Immobilization of enzyme and activity of entrapped enzyme (Amylase/Invertase).
 - H. Blood group analysis.
 - I. Oucterlony double diffusion.
- Q.III Oral /Viva 05 Marks**
- Q.IV Laboratory Journal 05 Marks**

CHB5106: Biochemistry Practical VI (Clinical Biochemistry And Cell Culture Techniques)

Q.I	Clinical Biochemistry Experiment	20 Marks
	<ul style="list-style-type: none"> A. Estimation of serum Creatinine B. Urea estimation C. Serum Glutamate Oxaloacetate Transferase D. Serum Glutamate Pyruvate Transferase E. Serum Alkaline Phosphatase F. Estimation of serum Albumin G. Estimation of serum Proteins H. Bilirubin estimation I. Cholesterol estimation from serum J. Blood sugar estimation by Glucose oxidase and peroxidase method K. Blood sugar estimation Folin-Wu method L. Glucose tolerance test M. Estimation of Lactate dehydrogenase from serum. N. Estimation of serum amylase 	
Q.II	Cell Culture Experiment	20 Marks
	<ul style="list-style-type: none"> A. Viable Cell Counting. B. Chick Embryo Fibroblast culture 	
Q.III	Oral /Viva	05 Marks
Q.IV	Laboratory Journal	05 Marks
	Total Marks	50 Marks

**CHB5307: Self Learning Course - III:
(1 Credit, 15 L)**

Clinical Research

1. Introduction to Clinical Research
2. Ethics and Guidelines in Clinical Research
3. Clinical trial- Types/Phases, Management
4. Regulations in Clinical Research – Role of FDA, Clinical trial regulations in India
5. Clinical Data Management – SOPs, Clinical Data Management plans, Case report form designs, Computer system validation, Data entry, validation, Quality control

Objectives

1. Define Clinical Research
2. Understand about the Institutional Ethics Committee and Institutional Review Board and other guidelines related to clinical trials within an organization
3. To know about different phases of clinical trials and its importance
4. Understand FDA regulations relating to Good Clinical Practice and Clinical Trials
5. Distinguish between research subjects and patients
6. Evaluate the impact of human subjects protections in clinical research

References:

1. Basic Principles of Clinical Research and Methodology, Editor S.K. Gupta, 2007
2. Understanding Clinical Research, Renato D. Lopes, Robert A. Harrison
3. A concise guide to Clinical Trials , Allen Hackshaw, Willey- Blockwell
4. Text book of Clinical Trials edited by Dand Mochin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons

Semester IV

Course Code: CHB5401

**Course Title: Neurochemistry & Endocrinology
(4 Credits)**

Objectives:

1. Students will study organization central nervous system, role of CSF and BBB
2. They will also learn types, functions, and receptors of neurotransmitters.
3. Students are expected to have a knowledge of memory, concept of learning and sleep cycles.
4. Students will learn various disorders related CNS
5. Students will be introduced with human hormones, their types and functions
6. They will study chemical nature, synthesis, transport and target tissues of hormones.
7. Concept of secondary messengers and other chemicals like hormones will be taught.
8. They should know the Hyper and hypo conditions of hormones and related disorders.

Unit I	Anatomical organization of Brain and spinal cord: Constituents of central nervous system, spinal cord, peripheral nervous system. Afferent and efferent pathways. Blood brain barriers (BBB), cerebrospinal fluid (CSF)- Normal and Abnormal constituents.	4L
Unit II	Correlation between Brain, Nerve cells and behaviour: Functions of brain, nerve cells with respect to behaviour	2L
Unit III	Neurotransmitters: Types of neurotransmitters, Synthesis, storage, uptake, degradation and mechanism of action of acetyl choline, GABA, serotonin, dopamine, glutamate, aspartate, nitrous oxide and neuropeptides (Endorphins, enkephalins and substance P)	6L
Unit IV	Receptors for signal transduction: Types of receptors: on the basis of ligand and location in neurons. Types of sensory receptors, properties of receptors, sensory modalities and sensory circuits.	4L
Unit VII	Learning and memory: Short term memory and long term potentiation, neurons and neurotransmitters involved in learning and memory function. NMDA and AMPA receptors, retrograde messengers in synaptic transmission. Role of CAM kinase II, calcium, protein kinase, cAMP, cGMP, calcium clamodulin and other proteins in learning and memory process.	4L
Unit VIII	Circadian rhythms: Cycle of sleep and wakefulness, role of neurotransmitters in circadium rhythm	4L
Unit IX	Disorders of Nervous system and detection tests Disorders of various parts of brain (Aphasia, Wernick's syndrome),	6L

	spinal cord (Meningitis, sclerosis), sensory neurons, motor neurons (Neuropathies). Disorders related to learning and memory. Parkinson's disease, Alzheimer, Dementia. Hallucination and haullucinogens. Diagnosis, preventive measures and treatment for disorders.	
Unit X	General characteristics of hormones : General characteristics and properties of hormones, classification on the basis of their location (anterior and posterior pituitary) and chemical nature	2L
Unit XI	Chemistry, structure, synthesis, secretion, transport, metabolism & mechanism of action of hormone: Study of thyroid, prolactin, FSH, LH, growth hormone, adrenocorticotrophic hormones (ACTH corticotropins), oxytocin, vasopressin, hormones of pancreas and gastrointestinal track, steroid hormones (aldosterone and testosterone), prostaglandins. Biological functions of all hormones.	8L
Unit XII	Disorders related to hormones: Hyper and hypo secretion conditions, deficiency syndrome, disease condition detection techniques and treatment or prevention.	6L
Unit XIII	Secondary messengers and their mode of action: cAMP, cGMP, phosphoproteins, phosphokinases, JAK/STAT pathway, Calcium, Phosphoinositols, Calmodulin, Zinc fingers and other proteins.	6L
Unit XIV	Cell Surface and intracellular receptors for hormones EGF, NGF, PDGF and Enkephalin: Various cell surface and membrane receptors and other hormone like factors	4L
Unit XV	Hormonal inter relationship, overproduction and Target cell insensitivity: Correlation between hormones, role of hormones during exercise	4L

References:

1. Vertebrate endocrinology- Noris DO (1985) 2nd ed
2. Endocrine physiology- Martin, CR (1985)(O xford Univ press (NY)
3. Physiological chemistry –Harper 17ed Lange medical
4. Biochemistry- Zubay (1983) Addison, Wesley publ. Co.
5. Text book of endocrinology –Williams, 6thed Saundes Co (1981)
6. Biochemical endocrinology E. Frieden (1983)

Course Code: CHB5402

**Course Title: Toxicology & Advanced Biophysical Technique
(4 Credits)**

Objectives:

1. Students will study different area of toxicology, classes and doses responsible for toxicity its characterization, risk and safety measures.
2. Different modes of action of toxic compounds and different allergic reaction. Interaction of chemicals dose response and its selectivity
3. Study of different toxicity test like acute, sub acute sub chronic.
4. Study of teratology and reproduction
5. Biotransformation reactions, phase I and Phase II reaction, its mechanism detoxication and toxication reaction, role of Cytochrome P-450 monooxygenase system.
6. Study of the role of insecticide and pesticide its mode of action and preventive measures.
7. Different application of toxicology like forensic science, clinical occupational and industrial hygien.
8. Study of Law of Spectroscopy.
9. Theory, principle, Instrumentation, working and application of NMR, ESR, IR, Fluorescent microscopy, ORD and CD and biosensors.
10. Introduction of Mass spectrometry, LCMS, GCMS, MALDI-MS and MALDI-TOF-MS
11. Introduction to electron microscopy, SEM and TEM

Unit I	Principles of Toxicology : Different areas of toxicology, spectrum of toxic dose, risk and safety. Classification of toxic agents, characteristics of exposure, route and site of exposure. Duration of frequency of exposure. Spectrum of undesired effects: Allergic reactions, Idiosyncratic reactions, Immediate versus delayed toxicity, Reversible versus irreversible toxicity, Local versus systemic toxicity. Interaction of chemicals, Tolerance, Dose response. Selective toxicity.	5L
Unit II	Target Organ Toxicity and its Evaluation : Descriptive Animal toxicity tests: Acute lethality, Sub acute, sub chronic and chronic toxicity testing. Teratology and reproduction, Mutagenicity and Genetic toxicity	7L
Unit III	Biotransformation of toxicants : Phase I and II biotransformation reactions, Detoxication and toxication. Components of Cytochrome P-450 monooxygenase system, Mechanism of phase I and II reactions. Bioactivation, Toxicity of insecticides i.e. organophosphorous, carbamates and chlorinated insecticides metals, animal and plant toxins, industrial solvents and vapors.	12L
Unit IV	Applications of toxicology : Forensic, clinical and occupational health and industrial hygiene	6L
Unit V	Advanced Biophysical Techniques :	4L

	Spectroscopic methods : (a) NMR, (b) ESR, (c) IR, (d) Fluorescence, (e) ORD and CD	
Unit VI	Biosensors : Introduction, types, Microchips, Cell Biosensors and application.	2L
Unit VII	Mass Spectrometry : LCMS, GCMS, MALDI-MS, MALDI-TOF-MS	10L
Unit VIII	SEM and TEM : Introduction, importance of electron microscopy, theory, sample preparation, working, principle, instrumentation and application.	4L

References:

1. Haye's principles and methods of Toxicology Ed. A Wallace Hayes, Pub. Raven press, NY
2. Casarett and Doull's Toxicology ed. John Doull, Curtio D Kleassen and Mary D Aunder McMillan publisher Co, NY
3. Appraisal of the safety of chemicals in foods, drugs and cosmetics. Ed. The Editorial Committee of Association of Food and Drug Officials of the United States
4. Toxicology- Mechanisms and analytical methods, Vol I and II, ed Stewart CP and Stolman A, Pub Academic press
5. Veterinary toxicology by RJ Garner ed Beilliere, tindall and Cox London
6. The chemistry and microbiology of pollution (1975) IJ Higgins and RG Burns Acad Press, NY
7. Introduction to ecological biochemistry JB Harbone Acad Press, NY (1977)
8. Physical Biochemistry by D. Freifelder IInd Edition Freeman publication (1982)
9. Biochemical techniques by Wilson and Walker.
10. Biophysical techniques by Upadhye and Upadhye.
11. Biochemistry by L. Stryer 4th edition
12. Molecular biology of gene by J. D. Watson
13. Fundamentals of biochemistry by D. Voet, J. Voet and C.W. Prott
14. Molecular cell biology 4th ed. Lodish B., Zipursky Matsudaira, Ball

Course Code : CHB5403
Course Title : Genetic Engineering
(4 Credits)

Objectives:

1. Understand concepts of Genetic engineering, its importance and they should be able to design a conventional cloning protocol.
2. Understand the role of enzymes involved in genetic engineering.
3. To know how a gene sequence can be modified to suit the cloning need.
4. Comprehend what a cloning vector means and what is its importance in cloning.
5. Types of cloning vectors and their features.
6. Understand meaning of transformation and transfection terms.
7. Learn how to prepare cDNA and genomic library and what is its importance.
8. To identify and select cells carrying recombinant DNA from other cells.
9. To know about the methods to produce recombinant proteins from different cell systems, their advantages and disadvantages.
10. To know different ways to sequence genome
11. Understand what is PCR and how to amplify a gene by using PCR
12. Compare PCR and quantitative PCR.
13. Study different chemical and physical methods to transfer a foreign gene into animals and plants and what are the vectors required for that.
14. Study the steps involved in the production of biopharmaceuticals – recombinant hormones, vaccines and human proteins.
15. Understand RNA interference, molecular mechanism of RNAi and its application.
16. Understand gene editing tool like CRISPR-Cas9 technique its uses.
17. Use of FISH, GISH, Microarray technique principle, procedure and application

Unit I	Genetic engineering concepts : Genetic engineering concepts: early development in genetics, concept of gene cloning and its importance.	2L
Unit II	Manipulation of DNA : Important enzymes used in genetic engineering, Restriction endonucleases - types, Restriction-Modification system, Nomenclature, Recognition sequences, cleavage pattern, ligation, modification of cuts ends	4L
Unit III	Cloning vectors : Introduction, properties, types: cloning and expression vector, host, Vectors for E.coli: plasmid vectors - pBR322, pUC18/19, Bacteriophage vectors - lambda phage vectors, phage M13 vectors, Cosmid vectors, Eukaryotic cloning vectors : Yeast vectors, YAC, Shuttle vector, Ti plasmid, Ri plasmid, examples of cloning vectors for insects, viral vectors for mammals, insects and plants	8L
Unit IV	Introduction of DNA in living cells : Transformation, identification of clones having recombinant DNA (recombinants), introduction of phage DNA into bacterial cells (transfection), identification of recombinant phage. Cloning strategies: Genomic libraries, cDNA libraries	5L

Unit V	Identification and Selection of recombinant DNA clones Hybridizations - colony, blotting (radioactive and non-radioactive procedures), plaque hybridization probing, Differential screening, reporter genes	3L
Unit VI	Expression of foreign gene: Gene expression in E coli, production of recombinant proteins in Eukaryotes, yeast, mammalian and insect cells systems. Expression of industrially important products (recombinant hormones, recombinant vaccines etc)	7L
Unit VII	Sequencing genes and genomes : DNA sequencing – Maxam-Gilbert method, Sanger’s dideoxy chain termination, primer walking, Next-generation sequencing method, genome mapping, RFLP, foot printing using DNase 1, Gene annotation	7L
Unit VIII	Nucleic acid amplification techniques : Polymerase chain reaction: concept, procedure, variations, applications and advantages of PCR, real-time PCR method and applications	4L
Unit IX	Transgenic plants : Gene transfer methods, vectors; Applications of Transgenic plants: herbicide resistance, insect resistance, drought resistance, GMO food, Antisense RNA approach and other applications	6L
Unit X	Transgenic animals : Introduction about transgenic animals, Gene transfer strategies – chemical and physical methods, production of recombinant proteins (Insulin, hormone, antibodies, clotting factors etc) and other applications, Knockout mice, Knock in Mice, Model mice for diseases	6L
Unit XI	Protein Engineering : In vitro mutagenesis, Oligonucleotide directed, PCR based, applications of protein engineering	4L
Unit XII	Advance tools in GE and their applications : RNA interference, CRISPR-Cas9, FISH, GISH, Microarrays	4L

References:

1. Gene cloning- An introduction, T.A Brown, 2nd and 3rd ed, Chapman &Hall.
2. Recombinant DNA- genes and genomes a short course JD Watson, R.M.Myers, A.M.Caudy, J.A.Witkowski, WH Freeman &Co. 2007 (II/ III rd ed)
3. Principles of Gene manipulation, SB Primrose (6th ed).
4. Principles and Techniques of Biochemistry and Molecular Biology, K Wilson and J Walker, 7th edn
5. Genetic Engineering, Smita Rastogi, Neelam Pathak, Oxford University press, 2009.
6. Biotechnology by B.D.Singh

Elective Papers (Any two)

Course Code: CHB5404

Course Title: Clinical Nutrition & Food Technology

Objectives:

1. Understand Nutritional status of Indian population.
2. Effect of various factors on food pattern.
3. Students will know types of food given to patients.
4. Diet pattern in some of the common diseases.
5. Students will know malnutrition and effect on mental development.
6. Role of food in behavioural pattern and food requirements for infant and old age people.
7. Effect of tranquilizers
8. Study of dietary intake for metabolic errors
9. Toxic food and its effect on health.
10. Study of food of plant and animal origin.
11. Importance of food of plant and animal origin with minerals nutrients etc.
12. Study of different experiments carried to monitor food quality.
13. Study of different food analysis and food processing.
14. Study of different enzymes involved in toxins, alcohol and amino acids.
15. Study of enzymes involved in food spoilage.
16. Study of principle of food preservation, food additives, flavouring agents.
17. Study of genetically modified foods.

Unit I	Food habits and nutritional status of India: Food pattern in India with respect to location and production, effect of life style, impact of modernization and technology	3L
Unit II	Diet in disease condition	3L
Unit III	Malnutrition and mental development , Behavior, Infunt and Geriatric Nutrition and Tranquilizers : Types of malnutrition: Kwashiorkor- Marasmus, symptoms, diagnosis, treatment and preventive measures. Effect of malnutrition on development of brain and behaviour. Food requirement in various stages of age	3L
Unit IV	Nutritional Management of Inborn Errors of Metabolism, Amino acid Therapy : Inborn errors of metabolism, its causes, presumptive measures through diet	4L
Unit V	Food Toxins, Adverse Effects of Alcohol, Tobacco, Tea 1. Various food toxins 2. Adverse effects of alcohol, tobacco and tea	3L
Unit VI	Food of Animal and Plant Origin : few examples	2L
Unit VII	Monitoring food quality: analytical methods to check the quality	3L
Unit VIII	Enzymes in food analysis and processing, toxins in food. Use of alcohols, amino acids and glucose in food	3L

Unit IX	Biochemistry of food spoilage, principles of food preservations : reasons, causative agents, preservatives	3L
Unit X	Food additives and flavouring agents and genetically modified foods : examples and applications	3L

References:

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore
4. Amino acids in therapy – Leon Chaitwo, Thorsons publishers Inc. NY
5. Physiological chemistry- Hawk
6. Enzymes and food processing- GG Birch, N Blackbrough (1981)
7. Nutrition and food processing- MG Miller , G Tobin, AVI publishing Co, Creem Holm (1980)
8. Introduction to food sciences and technology –GF Stewart and MA Amerine (1973) Academic Press

Course Code: CHB5408

Course Title: Nutraceuticals and Pharmacology

(2 Credits)

Objectives:

1. Students will be introduced the meaning of terms nutraceuticals and pharmacology and need of these.
2. They will learn types, mode of action, their interaction with cell receptors, and interaction with binding agents and inhibitors of drug and nutraceuticals.
3. Students should know metabolism of such molecules after action
4. They will be introduced with the basic approach in drug discovery and nutraceuticals extraction and processing.
5. Students will be given the awareness of ethical aspects for the use of drug and nutraceuticals.
6. Students will learn disease management using drug and nutraceuticals.

Unit I	Introduction and history of Nutraceuticals and Pharmacology	2 L
Unit II	Mode of action of Nutraceuticals and drug receptor interactions: Types of drugs, Path of action of nutraceutical and drug molecules, receptors involved in it and interaction between them	4L
Unit III	Factors modifying interactions of nutraceuticals and drug with receptor: Structure, functional group, configuration, environment, inhibitors, Interactions of drug and nutraceuticals to enzymes	4L
Unit IV	Drug and nutraceuticals Metabolism: Metabolism of drug and nutraceutical after action.	2 L
Unit V	Basic approach to drug discovery and development: Requirement of new drug, synthesis criteria in general and processing	4 L
Unit VI	Extraction of nutraceuticals and processing: Extraction of nutraceuticals from plant, animal and bacteria, methods of extraction in brief and processing.	4 L
Unit VII	Pharmacological screening models for therapeutic areas: Microbial cell, plant cell and mammalian models and related ethical aspects in India	6 L
Unit VIII	Monitoring of multi-component phytopharmaceuticals: Various components in phytopharmaceuticals and its study.	2 L
Unit IX	Disease-management using nutraceuticals (case studies): Examples of some common diseases and use of nutraceuticals	2 L

References :

1. Goodman Gillman's The Pharmacological basis of therapeutics. (2001) Ed. Hardman JG, Limbird LE (Tenth Edition) McGraw Hill press New York.
2. Applied biopharmaceutics and pharmacokinetics (1999) Ed. Shargel L. (4th Edition) Prentice- Hall International, London.
3. Fundamentals of experimental pharmacology. (1984) Ed. Ghosh MN. Scientific book agency, Calcutta.
4. Text book of receptor pharmacology (1996) Eds. Forman JC, Johansen TJ. CRC Press, New York
5. Drug Discovery and Evaluation –Pharmacological assays. (1997) Ed. Vogel HG & Vogel WH Springer- New York.
6. Methods of Analysis for Functional Foods and Nutraceuticals. Chadwick R., Henson S., Mosley B., Hurst G.W.
7. A guide to understanding dietary supplements. Tracy T.S. et al.
8. Pharmacology-related journals from PubMedCentral (refer study pack for papers)

Course Code: CHB5408
Course Title: Molecular Oncology
(2 Credits)

Objectives:

1. Students will learn about the different cancer causing agents of cancer, the distinguishing features of a cancer, mechanism by which cancers evolve.
2. Explain what is meant by "metastasis" and the mechanisms by which it occurs? What are benign and malignant tumors?
3. Students will learn the genetics of cancer and what are Oncogenes ?
4. Molecular Processes including genes controlling cell proliferation and biological activity of the main proto-oncogenes and tumor suppressor genes. Role of cell cycle check points and its relation to cancer.
5. Events related to Apoptosis, Necrosis. What are the signalling pathways involved in cancer progression?
6. Students will understand the basic mechanisms of tumor cell dormancy ? What is
7. importance of cell-cell interactions and cell-matrix interactions?
8. What are morphogens and how they work and the events related to Angiogenesis.
9. Students will understand that there are different types of cancer described by the body part, origin and different between types of cancers
10. Students will understand how immune system mounts an immune response against tumours, how tumours evade immunity and what are antigens specific to tumours? Strategies for Immunotherapy. What are different types of vaccines used for cancer therapy?
11. Students will understand about the cancers specific biomarkers used for diagnosis and prognosis, Imaging techniques and its application for cancer diagnosis?
12. Role of nanotechnology in cancer therapeutics and How bioinformatics tool is helping in personalising cancer therapy?
13. What treatments are available for cancers? Clinical research going on in the cancer treatment strategies. What is miRNA and how it can be used in treating cancers?

Unit I	Introduction to Cancer Biology : What is carcinogenesis? Theories behind the cause of cancer, Initiation, Promotion and Progression of Cancer. Cancer and carcinogens: Role of DNA damage, repair and mutations, viruses and carcinogens. Benign and Malignant tumours, Tissue specificity, Hyperplasia and Precancerous lesions.	5L
Unit II	Genetic, molecular and cellular mechanisms of cancer : Genome stability, Transcriptional controls in cancer, Suppression and activation of oncogenes during transformation of cell, Viral oncogenes, examples ERB, HER-2, rel, large T-antigen etc. Cell cycle regulation and its alteration in cancer, Apoptosis, Necrosis, Signalling pathways in cancer involving p53, Ras and Rb, Growth factors.	5L
Unit III	Tumour environment and cell interactions :	5L

	Tumour cell dormancy in microenvironment, Cell-Cell interactions, Cell matrix interactions, Invasive characters, activity of Morphogens, Angiogenesis, Tumour Stem Cells.	
Unit IV	Types of Cancers : Leukaemia: types of chromosomal translocations. Hodgkin's lymphoma, Burkitt's Lymphoma, HPV+ uterus cancer, Prostate cancer,	3L
Unit V	Immunology and Tumours : Immune responses in tumour growth, Immune suppression by tumours, Tumour specific antigens and Immune response, immunotherapy by immune modulations. Cancer Vaccines- Whole cell vaccines, Peptide vaccines, Dendritic vaccines, Prophylaxis.	5L
Unit VI	Cancer research : Tumour specific Biomarkers for efficient diagnosis and prognosis Imaging-Use of different Imaging Modalities for assessing molecular and functional aspects of Tumour cells. DNA Microarrays- for individual specific analysis of target tumour, example-lymphochip. Metastasis detection- Techniques and Challenges. Nanotechnology in tumour therapy- Nano vectors for targeted drug delivery. Bioinformatics- Early diagnosis, Personalized therapy by comparing patient's tumour genetic profile to data of genetic profiles, respective treatments and responses globally. Treatment of cancer symptoms at molecular level targeting specific molecules, drug discovery. Introduction about clinical research of proposed treatment strategies for ensuring safety, efficacy and early implementation. miRNAs- role in tumours and use in therapy	7L

References:

1. Molecular Biology of Cancer-Mechanisms, Targets and Therapeutics, Lauren Pecorino
Advances in Cancer Research, D. Avededo
2. The Cell : A Molecular Approach by Geoffery M. Cooper
3. Molecular Oncology: Principles and Recent Advances by Javier Camacho
4. Principles of Molecular Oncology , Edited by MH Bronchud, MA Foote, G Giaccone, O Olopade and P Workman

Course Code: CHB5409

**Course Title: Stem Cells in Regenerative Medicine
(2 Credits)**

Objectives:

1. Understand meaning of stem cells and know their types.
2. To know how they are derived and extent of plasticity?
3. Study the techniques for stem cell culture, generation of pluripotent stem cells, their maintenance and *in vitro* differentiation
4. Study the process of Trans-differentiation and its example
5. Understand the term regenerative medicine, its applications.
6. Know about cord blood banking and stem cell banking.
7. Understand how stem cells can be used in Neurodegenerative disorders and spinal cord injury.
8. Know applications of stem cells where they can be made to convert into β cells, skin cells and muscle cells.

Unit I	Introduction to Stem Cell Biology : What are stem cells? Concept of Pluripotency, Origin of stem cells at embryo level and embryonic germ cells, Symmetric and asymmetric cell division, self-renewability, plasticity, transcription factors and molecular characteristics of embryonic stem cells. Concept of adult stem cells and study of representative examples of adult stem cell Populations. Bone marrow stem cells- HSCs and MSCs, Neural Stem cells(NSCs), Mesenchymal Stem cells(MSCs), Endodermal stem cells.Stem cell niche and interactions with environment.	6L
Unit II	Working with Stem cells : Embryonic Stem cell culture, Differentiation to desired cell types. Need of cellular reprogramming. History of induced pluripotent stem cells. Generation of iPSCs, Maintenance and <i>in vitro</i> differentiation. <i>In vitro</i> differentiation - In Vitro Differentiation of Embryonic and Adult Stem Cells into Hepatocytes.Understanding Trans-differentiation; Neuronal trans- differentiation from Mesenchymal Stem cells.	6L
Unit III	Applications in Regenerative Medicine : Introduction of regenerative medicine, Cord blood banking, stem cell banks.Neurodegenerative disorders and Spinal cord injury, Diabetes: Stem Cells as insulin producing β cells, Reviving skin in conditions of burns and skin ulcers, Stem cells in restoring disrupted musculo-skeletal abilities, Myocardial regeneration, Osteoarthritis	8L
Unit IV	Regeneration in Lower Animals : Invertebrates – Hydra, Planeria, Star fish, Crustacea, Arthropoda; Vertebrates – Amphibia-limb, Reptilia-tail, Aves, Mammals- Liver, pancreas, skin, hair	7L
Unit V	Regeneration in Plants	3L

References:

1. Essentials of Stem Cell Biology, Robert Lanza.
2. Culture of Animal cells: A Manual of Basic Technique and Specialized Applications, R Ian Freshney
3. Stem Cells Biology and Regenerative Medicine, Ed: Turksen, Kursad
4. Stem Cells & Regenerative Medicine, Ed: Appasani, Krisnarao, Raghu E

CHB5405: Biochemistry Practical VII (Project) (8 Credits)

Scheme of Project presentation

Note :

- 1. Certified Research project thesis is compulsory for the examination.**
- 2. The project presentation will be conducted for SIX HOURS duration.**
- 2. The project presentation will be conducted for 100 marks.**
- 3. Oral/viva examination is compulsory**
- 5. Mobile/s is/are strictly not allowed during the project presentation.**

Project work is assessed as follows,

1	Title of project	05Marks
2	Experimental work	15 Marks
3.	Characterization of product	20 Marks
4.	References/Reference work	10 Marks
5.	Project thesis	05 Marks
6.	Preparation of slides	10 Marks
7.	Overall presentation	20 Marks
8.	Defense of project work	10 Marks
9.	Purpose/Benefit of Project	05 Marks

CHB5406: Self Learning - IV
(1 Credit, 15 L)

Nanotechnology

1. Introduction to Nanotechnology
2. Nanomaterial: Uses and applications
3. Processing and properties of Nanostructured Materials
4. Physicochemical methods for characterization of Nanomaterials
5. Nanotechnology in Health Care
6. Other applications

Objectives:

1. To understand the concept of nanotechnology in biomedical application
2. Student should be able to write summary on above any topic with reference to research paper.
3. Student's interest in research project should be able to give seminar on their topic of interest.

References:

1. Nanobiotechnology: Subbiah Balaji, MJP publisher, Chennai, 2010.
2. An Introduction to Nanoscience and Nanotechnology by Alain Nouailhat, John Wiley & Sons, Inc.
3. Nanotechnologies: Principles, Applications, Implications and Hands-on Activities by Luisa Filippini and Duncan Sutherland, European Union, 2012.