Fergusson College
(Autonomous) Pune

Learning Outcomes-Based

Curriculum for

M.Sc. II - Biochemistry

With effect from June 2024

Programme Structure

Semester	Paper Code	Paper Title	Credits
III	**CHB -601**	Molecular Biology **(Theory)**	**4**
	CHB -602	Immunology & Medical Biochemistry **(Theory)**	**4**
	CHB -603	Physiology and Endocrinology (Signaling molecules) **(Theory)**	**4**
	Any two CHB -604 OR	Plant Biochemistry **(Elective I)**	**2**
	CHB -605 OR	Fermentation Technology **(Elective II)**	**2**
	CHB -606 OR	Nutraceuticals **(Elective III)**	**2**
	CHB -607	Pharmaceuticals **(Elective IV)**	**2**
	CHB -620	Biochemistry Practical V Molecular Biology and Immunology **(Practical)**	**2**
	CHB -621	Biochemistry VI Clinical and Nutritional Biochemistry **(Practical)**	**2**
		Total Semester Credits	**20**
IV	**CHB -651**	Genetic Engineering **(Theory)**	**4**
	CHB-652	Toxicology **(Theory)**	**2**
	Any two CHB -653 OR	Stem Cell as Regenerative Medicine **(Elective I)**	**2**
	CHB -654 OR	Advance Studies in Biochemistry **(Elective II)**	**2**
	CHB -655 OR	Developmental Biology **(Elective III)**	**2**
	CHB -656	MOOCS **(Elective IV)**	**2**
	CHB-660	Research Proposal writing	**4**

	CHB-661	Research Project	**6**
		Total Semester Credits	**20**
		Total PG-II Credits	**40**

Course Outcome (COs)

S.Y. M.Sc. Semester III		
Title of the Course and Course Code	**Molecular Biology (Theory) (CHB-601)**	**Number of Credits : 04**
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the general properties of viral, prokaryotic and eukaryotic genomes, structural organization of chromosomes and recall basic concepts related to molecular biology.	
CO2	Explain the molecular mechanism of replication, DNA repair, transcription, translation and related molecular processes in prokaryotes and eukaryotes.	
CO3	Outline the concepts and apply fundamental understanding of molecular biology. Illustrate the molecular processes and predict the role of different inhibitors, proteins, enzymes involved in them.	
CO4	Analyze molecular events in prokaryotic and eukaryotic organisms and compare them. Identify events involved in RNA processing and regulation of gene expressions in prokaryotes and eukaryotes.	

CO5	Justify and review the basics molecular processes in prokaryotes and eukaryotes. Summarize post-translational modification events and protein sorting mechanisms.	
CO6	Compile the molecular processes in prokaryotes and eukaryotes and specify gene regulation mechanism. Review and prepare a summary of scientific topics/papers related to subject and professionally present literature articles.	

Unit No.	**Title of Unit and Contents**
1.	**Molecular structure of Genes and Chromosomes:** 1.1. Definition and organization of viral, prokaryotic and eukaryotic genomes, Structural organization of Eukaryotic chromosomes 1.2. Structure of chromatin, nucleosome, Histones, chromatin organization, higher order organization.
2.	**DNA Replication:** 2.1. Chemistry of DNA synthesis, Enzymes involved in DNA synthesis 2.2. Mechanism of Replication in Prokaryotes and Eukaryotes. Okazaki fragments, Origin of replication Replication fork. 2.3. Inhibitors of DNA synthesis.
3.	**DNA Repair:** 3.1. Repair of DNA damage – Direct reversal of DNA damage 3.2. Replication errors and their repair. 3.3. SOS response,defective repair system and diseases, Ames test
4.	**Homologous Genetic Recombination:** 4.1. Recombination pathways, Holliday model, DSB repair model 4.2. Homologous recombination protein machines: RecBCD, Rec A, RuvAB, RuvC. 4.3. Mobile genetic elements.

5.	**Transcription:** 5.1. Mechanism in prokaryotes: RNA polymerases - initiation, elongation and termination of 5.2. Mechanism in Eukaryotes: RNA polymerases subunits, promoters for RNAP I, II, III, Transcription factors, Transcription process 5.3. Inhibitors of transcription.
6.	**Post-transcriptional modification of RNA:** 6.1. Types of RNA processing, 5' capping and 3' poly A tailing: 6.2. Chemistry of RNA splicing: Type of Introns, Types of Splicing pathways. 6.3. RNA editing
7.	**Translation:** 7.1. Features of Translation components: mRNAs, Structure ORF; tRNAs, Aminocyl t-RNA synthetas-attachment of amino acids; Genetic code 7.2. Mechanism in Prokaryotes and Eukaryotes: Initiation, Elongation, Termination 7.3.Post translational modifications, Inhibitors of protein synthesis.
8.	**Protein Targeting Aggregation and Degradation :** 8.1. Signal hypothesis, signal sequences, glycosylation 8.2. Targeting of protein to ER, mitochondria, chloroplast, lysosomes, Peroxisomes 8.3. Protein Aggregation. 8.4. Protein degradation.
9.	**Regulation of Gene Expression:** 9.1. Principles of Gene regulation: regulation of gene expression in Bacteria, phage lambda. 9.2. Gene regulation in Eukaryotes: chromatin remodeling: process, enzymes 9.3. Introduction to epigenetic regulation.

References:

1. Molecular biology of the gene (V edition, 2004) J D Watson, Person education Inc.

2. Biochemistry (III/IV/V/VI edition, 2008) L. Stryer, WH Freeman and Co.

3. MOLBIO Fundamentals of Molecular Biology (2018) by Avinash and Kakoli Upadhayay.

4. Molecular Cell Biology (7th edition.2013) by Harvey Lodish et al.

5. Molecular biology of the cell (2008) B. Alberts, Garland Pub. In., NY

6. Genes X (2010), B. Lewin, John Wiley and sons, NY

Title of the Course and Course Code	**Immunology and Medical Biochemistry (Theory) (CHB-602)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the different terminologies related to immunology and medical biochemistry. different cell and organs involved in immunology and cite the types of immunity.	
CO2	Explain the different cells involved in immunology and their role in drug mechanisms.	
CO3	Outline the concepts and apply fundamental understanding of immunology and medical biochemistry. Illustrate the processes and predict the role of different antigen and antibody.	
CO4	Analyze the reactions between antigen and antibody and the factors responsible for different diseases.	

CO5	Justify and review the basics of the complete system and CSF and oncogenes.	
CO6	Compile the molecular processes of autoimmune diseases genetic Disorders and Counseling for genetic diseases.	

Unit No.	Title of Unit and Contents
	Immunology
1.	**Cellular basis of immunity:** 1.1 immunological memory, specificity, diversity, discrimination between self and non self, 1.2 primary and secondary lymphoid organs, 1.3 Types of Immunity: Innate, Acquired cell mediated and humoral immune responses, 1.4 T and B lymphocytes, T cell subpopulations,
2.	**Antigen and antibody**: 2.1 Nature and Biology of antigens and superantigens, Antigens, Antigenic determinants, antigenicity and immunogenicity 2.2 structure of antibody, constant and variable regions, Fab, F(ab2) Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes,
3.	**Complement System:** 3.1 Classical, alternate and Lectin pathway
4.	**Major Histocompatibility Complex:** 4.1 Structure and functions of class I and class II molecules. MHC restriction. 4.2 Antigen processing and presentation. Effector mechanisms of immune response; macrophage activation. 4.3 Mechanism of humoral and Cell mediated cytotoxicity

5.	**Clonal selection theory of antibody production**: 5.1 Monoclonal and polyclonal antibodies, poly reactive antibodies, catalytic antibodies, abzymes 5.2 Methods of raising antibodies. Monoclonal and polyclonal antibodies, production and purification
6.	**Hypersensitivity and allergy, Immunodeficiency diseases (AIDS):** 6.1 Hypersensitivity reactions: Type I, II, III and IV reactions. 6.2 Immunodeficiency disorders - Phagocytic cell defect- (Chediak-Higashi syndrome) B-cell deficiency- (Bruton's X-linked hypergamma-globulinemia T-cell deficiency disorder- (DiGeorge Syndrome) Combined B-cell & T-cell deficiency disorder (SCID- Severe combined immunodeficiency diseases, Wiskott-Aldrich syndrome) Complement deficiency and secondary immunodeficiency condition carried by drugs, 6.3 Autoimmune Disease Nutritional Factors and AIDS
7.	**Immunodiagnostic Techniques:** 7.1 Precipitation reaction, immunodiffusion, immunoelectrophoresis, 7.2 Agglutination reaction 7.3 Radioimmunoassay, ELISA. Immunoflorescence, 7.4 Chemiluminiscenceimmuno assay, Western blotting technique, Complement fixation test, flow cytometer
	Medical Biochemistry
8.	**Drug Mechanism:** 8.1 WHO definition of health and disease. Disease causing factors. 8.2 Action Of drug at molecular level of selected antibiotics, anti metabolites, analgesics, hallucinogens and other drugs. 8.3 Mechanism of resistance to antibiotics and other drugs. 8.4 Drug resistance and Multiple drug resistance in metabolism.
9.	**Vaccine:** 9.1 Mechanism of active and passive immunization 9.2 Types of Vaccine- Live, Killed, Attenuated 9.3 Subunit Vaccine-Recombinant Vaccine, Polyvalent Vaccine, DNA vaccine.

10.	**Cancer Biology:** 10.1 Etiological factors, Types of cancer cells and morphological alterations primary, secondary tumors benign and malignant tumors. 10.2 Oncogene: proto oncogenes and viral oncogenes, oncogene activation, tumor suppressor genes, DNA tumor viruses, tumor specific antigens and tumor evasion. 10.3 Metastasis: Molecular events in migration, extravasation, chemokines, role of ECM in metastasis. 10.4 Angiogenesis: angiogenetic and antiangiogenetic factors, vasculogenesis. 10.5 Aging and apoptosis

References:

1. Immunology 3rd ed Janis Kuby

2. Essentials of immunology (5th ed) Roit, Blackwell scientific publishing, London

3. Cellular and Molecular Immunology, 3rd ed, Abbas

4. Immunology by Nandini Shetty

5. Immunology by Sudha Gangal

6. Biochemistry of antimicrobial action (4th ed) TJ Franklin, Chapman hall (1989)

7. General Microbiology, Pelczar, Rard and Chan (1987)

8. Mechanism of microbial diseases, M Schaechter et al,Williams and Wilkino Int. Ed.(1989)

9. Biochemistry, L Stryer (3rd ed), Freeman and Co.

10. Textbook of Biochemistry with clinical correlations, Thomas Devlin,(2nd ed),John Wiley and sons

11. Biochemical aspects of human diseases (1983), RL E lkeles, Slackwell scientific publishers, Oxford

Title of the Course and Course Code	**Physiological Biochemistry and Endocrinology (Theory) (CHB-603)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the terminologies, location, and functions of human body parts. Describe in basics of signaling molecules	
CO2	Describe important functional cells of organs and their role.Understand hormone releasing cells, hormone synthesis, their role and metabolism	
CO3	Demonstrate the working and processes in body parts at new or different situations. Apply the knowledge to identify the release and communication pattern of signals.	
CO4	Identify processes with respect to physiology at various stages. Explain the effects and role of molecules in different tissues and cells with respect to disease condition	
CO5	Judge the symptoms, implement exact techniques used in study and diagnosis of diseases and describe the path.	
CO6	Develop the skill to read, understand diagnostic reports and identify the future process.	

Unit No.	**Title of Unit and Contents**
	Physiological Biochemistry

1.	**Blood components and blood clotting:** 1.1 Blood composition, plasma proteins and their diseases. 1.2 Clotting factors, mechanism of coagulation role of vitamin K in clotting process. Conditions that cause excessive bleeding in humans, 1.3 Haematopoiesis, bone marrow stem cell.
2.	**Cytoskeleton components, chemotaxis and cell motility:** 2.1 Microfilaments (Actin and Myosin) 2.2 Microtubules (cilia and flagella of eukaryotic Cells) 2.3 Intermediate filaments, (molecular composition of cytoskeleton) 2.4 Chemotaxis in prokaryotes and eukaryotes.
3.	**Respiration and Circulatory system** 3.1 Mechanics and regulation of respiration, pulmonary and alveolar ventilation and its control, 3.2 Physical principles of gaseous exchange a transport of respiratory gases 3.3 Regulation of acid-base balance: acid-base buffers. 3.4. Blood circulation
4**.**	**Liver:** 4.1. Liver – anatomy, physiological functions. 4.2. Detoxification mechanisms. Liver function tests 4.3. Liver disorders: - hepatitis, cirrhosis, Jaundice: etiology and symptoms.
5**.**	**Kidney:** 5.1. Anatomy, physiological functions (Filtration, absorption and elimination) 5.2. kidney function tests, diseases/disorder,
6**.**	**Muscles (Skeletal muscle, cardiac and smooth muscles):** 6.1 Morphology, ultra-structural organization, protein components of myofibrils- 6.2 Metabolism of muscles. Contraction and relaxation cycle of muscle and Regulation.
7.	**Nervous System:** 7.1 Structure and various components of nervous system and neurons, their types and functions 9.2 Creation and propagation of nerve impulse. Events in generation of action potential 9.3 Types of channels in neurons. cholinergic receptors, electroplaxus as a source of acetylcholine receptor and Nerve poisons 9.4. Neurotransmitters and their receptors

8.	**Biochemistry of vision,** 8.1 Structure of eye, lens, and retina, photoreceptor cells (rods and cones), Organization of various cells in retina 8.2 Perception of light, primary events in visual excitation, role of cyclic GMP and phosphodiesterase
	Endocrinology
9.	**Hormones:** 1.1 General characteristics of hormones 1.2 classification on the basis of their location (anterior and posterior pituitary) and chemical nature, Pheromones 1.3. Properties of hormones,
10.	Biosynthesis, release, physiological role and metabolism of anterior, posterior, adrenal and pancreatic hormones Feedback and feed forward mechanism of hormone action
11.	**Hormone receptor types**
13.	**Secondary messengers and their mode of action:** cAMP, cGMP, phosphoproteins, phospho kinases, MAP-Kinase JAK/STAT pathway, Calcium, Phosphoinositols, Calmodulin.
14.	Hormonal Disorders (Hyper and Hypo condition)

References:

1**.** Text book of physiology- Guyton & Hall

2. Principles of Human Anatomy Gerard J. Tortora,Willey Publication

5.Introduction to Endocrinology Chandra S.Negi

6.Vertebrate endocrinology- Noris DO (1985) 2nd ed

8. Textbook of endocrinology –Williams, 6th ed Saundes Co (1981)

9. Endocrine physiology- Martin, CR (1985 (Oxford Univ press (NY)

10. Physiology Katzung

11. Anatomy Litvack Hormony

Title of the Course and Course Code	Plant Biochemistry **Elective I Theory (CHB 605)**	**Number of Credits : 02**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO 1	Describe basic concepts of plant biochemistry. Recall general terms in plant processes	
CO2	Discuss the various processes of plant . Understand the signaling mechanism and germination process in plant	
CO3	Generalize the methods of isolation and purification of plant molecules.	
CO4	Compare various important molecules in plant and their pathways.	
CO5	Evaluate the outcomes of the enzymatic reactions and plant biochemical studies.	
CO6	Specify the role, function and metabolism of different components and processes in plants.	

	Plant Biochemistry	
1.	**Mineral nutrition :** Micro and macro elements, requirement, role, excess and deficiency disorders	
2.	**Photosynthesis :** Chloroplasts, photosystem, mechanism CO2 fixation,C3 and C4 pathways, CAM.	

3.	**Nitrogen and Sulphur metabolism :** Nitrogen cycle, nitrogen fixation, assimilation of nitrate and ammonium ions, nitrogen transformation during development, assimilation of sulfate.	
4.	**Plant hormones :** Types and role in plant growth and development, Auxins gibberellins, cytokinins, ethylenes, abscisic acid, hormones in senescence and abscission.	**5L**
5.	**Secondary metabolites :** Active principles in medicinal plants, Definition types, phenolics, flavanoids, lignins, terpenoids alkaloids, Gum Pectins Rubber: chemistry examples and applications. Phytochemistry of the metabolites of medicinal importance.	**6L**
6.	**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**
7.	**Plant diseases :** Pest types, symptoms, treatment, pesticides.	**5L**

Title of the Course and Course Code	**Fermentation (Elective TheoryII) (CHB-606)**	**Number of Credits : 02**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the meaning of fermentation and related terms.	
CO2	Understand various types of fermentor and its working	

	Know the processing of food and different methods used for it	
CO3	Execute the selection for specific types of microorganism, its growth parameters and method used in food technology	
CO4	Demonstrate the concept behind the type of process selected for fermentation and food processing	
CO5	Evaluate the outcomes of the fermentation and food processing	
CO6	Design a method to study fermentation and food processing for specific product development	

Unit No.	**Title of Unit and Contents**
	Fermentation
1.	**Introduction to fermentation**: 1.1 Sterilization and its importance, maintenance of aseptic conditions 1.2 Design of fermenters, Different methods of fermentation aeration agitation
2.	**Fermentation types:** 2.1 Methods and parameters of cultivation of microorganisms, media for industrial fermentation

3.	**Characteristics and Techniques**: 3.1 Characterization of industrial microorganisms, strain improvement, use of auxotrophic mutants
4.	**Product purification and treatment:** 4.1 Downstream processing, recovery and purification of fermentation products, 4.2 Effluent treatment (Biological and Physical Methods)
5	**Applications:** 5.1 Fuels from microbes, microbial polymers and microbial steroid bio Transformations
6	**Products from microorganisms:** 6.1 Enzymes (Amylases, Proteases, Pectinases), Primary metabolites (Glu, vit B12), Antibiotics (Penicillin), Pigments (Carotenoids), Sweeteners, Beverages (wine, Beer) 6.2 Biofuels and Bioenergy.

References :

1. Introduction to ecological biochemistry JB Harbone Acad Press, NY 4th edition (2004)

2. Biochemistry, L Stryer, Freeman and Co, NY, VI edition (2008).

3. Plant physiology, Salisbury and Ross (2007) CBS publishers and distributors

4. Principles of Biochemistry Lehninger, 7th edition (2012).

5. 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

Title of the Course and Course Code	**Nutraceuticals (Theory) (CHB-606)**	**Number of Credits : 04**
CO1	Recall the terms nutraceuticals	
CO2	Understand and learn types, mode of action, their interaction with cell receptors, and interaction with binding agents and inhibitors of nutraceuticals	
CO3	Demonstrate the interaction of molecules, responses and metabolism Predict the effects and working in normal and disease condition	
CO4	Compare different types of nutraceuticals and their role in cancer treatments	
CO5	Select proper molecule in disease management and define its role	
CO6	Formulate the new molecule and design further research in cancer and other diseases.	

Unit No.	**Title of Unit and Contents**	
1.	Introduction of Nutraceuticals	

2.	Types of nutraceuticals, Mode of action and its receptor interactions: , Path of action	
3.	Factors modifying interactions of nutraceuticals with receptor: Structure, functional group, configuration, environment, inhibitors, Interactions of nutraceuticals to enzymes	
4.	Nutraceuticals Metabolism and elimination	
5.	Basic approach to nutraceutical development and use in specific health conditions	
6.	Extraction of nutraceuticals and processing: Extraction of nutraceuticals from plant, animal and bacteria, methods of extraction in brief and processing.	
7.	Disease-management using nutraceuticals (case studies): Examples of some common diseases and use of nutraceuticals	

References:

1. Goodman Gillman's The Pharmacological basis of therapeutics. (2001) Ed. Hardman
2. JG, Limbird LE (Tenth Edition) McGraw Hill press New York.
3. Applied biopharmaceutics and pharmacokinetics (1999) Ed. Shargel L. (4th Edition)Prentice- Hall International, London.
4. Fundamentals of experimental pharmacology. (1984) Ed.Ghosh MN. Scientific book agency, Calcutta.
5. Textbook of receptor pharmacology (1996) Eds. Forman JC, Johansen TJ. CRCPress NewYork
6. Drug Discovery and Evaluation –Pharmacological assays. (1997) Ed.Vogel HG &

   Vogel WH Springer- New York.

7. Methods of Analysis for Functional Foods and Nutraceuticals. Chadwick R., Henson S., Mosley B., Hurst G.W.

Title of the	**Pharmaceuticals**	**Number**

Course and Course Code	**(Theory) (CHB 607)**	**of Credits : 02**
CO 1.	Remember the important terms related to pharmaceuticals	
CO 2.	Understand basic concepts and need for the synthesis or preparation of pharmaceuticals.	
CO 3.	Analyse properties and characteristics for the compounds bear drug potential	
CO4.	Distinguish the qualities of active drug compounds and interpret the outcomes of the effects of molecule	
CO 5.	Justify the mechanism of action of drug molecule	
CO 6	Outline the pharmaceutical role and mechanism of action	

Unit No.	**Pharmaceuticals**	
1.	Bioinformatics approach for drug development:Identification of potential drug molecule, chemical compound library preparation, Identification of target in pathogen, Molecular Docking, Pharmacokinetics, Pharmacodynamics, ADME	
2.	Drug Metabolism and Interaction:Drug receptor interaction, xenobiotics, factors affecting drug mechanism, drug protein and drug -DNA interaction	
3.	Drug Delivery and trials: General Principles of screening, Invivo and invitro mechanisms, cell based assays, biochemical assays animal model, preclinical and clinical trials	
4.	Main feature of clinical trials, methodological and organizational considerations, principles of trial conduct	

References:

1. Pharmaceutical Profiling in drug discovery of Lead selection , Borchardt RT, Kerns EH, Lipinski EA, Thakkar DR and Wang B
2. 3D QSAR in Drug Design: Theory, Methods and Applications ED Kubinyi H. Ledein, ESCOM
3. Indian Pharmacopeia Volume I and II.
4. Practical Pharmaceutical chemistry third edition volume 1. By A. H. Beckett & J. B. Stenlake.
5. Remington‘s Pharmaceutical sciences.
6. Ansel’s Pharmaceutical Analysis.

Title of the Course and Course Code	**Biochemistry Practical V (Molecular Biology and Immunology) (Practical) (CHB -620)**	**Number of Credits : 02**
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the principle, mechanism and role of reagents used in molecular biology and immunology experiments.	
CO2	Explain the basic theory behind isolation of nucleic acids. Estimate the nucleic acid concentration and infer the purity level.	
CO3	Carry out nucleic acid isolation from various sources and demonstrate bacterial transformation.	
CO4	Differentiate between theory and steps involved in restriction digestion and ligation reaction. Compare the mechanism of PCR, real-time PCR and analyze its data.	
CO5	Review the principle of antigen antibody reaction and justify	

	different immunodiffusion patterns.	
CO6	Perform different tests demonstrating immunological reactions and explain the mechanism.	

Unit No.	**Title of Experiment**
	Molecular Biology (Any Eight)
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 Tm
6.	Restriction digestion of DNA
7.	Preparation of plasmid DNA
8.	Transformation
9.	Ligation study
10.	PCR demonstration
11.	Real time PCR demonstration
	Immunology (Any Four)
1.	Principles of Antigen-antibody interactions, and its applications in research

2.	Agglutination test: Blood typing
3.	Latex agglutination test
4.	Precipitation test: Radial immunodiffusion test, Ouchterlony immunodiffusion
5.	Immunoelectrophoresis
6.	ELISA, RIA demonstration
7.	Antibody conjugation with enzyme tag, Purification of IgG antibodies
8.	Western blotting
9.	**Note:** Any other equivalent practical

References:

1**.** An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. (2015) 3rd Edition

2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Sing.

3. Practical Biochemistry – J. Jayaraman (2011).

4. Biochemical methods – Sadasivam and Manickam 3rd edition (2007).

5. Biochemistry –Practical Approach – Kieth Wilson and J. Walker 5th edition (2006).

6. Laboratory handbook on Biochemistry, S Shanmugam, 2010, PHI Pvt Ltd, New Delhi (2010).

Title of the Course and Course Code	Biochemistry VI Clinical and Nutritional Biochemistry (Practical) (CHB -621)	Number of Credits : 02
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the basic aspects of clinical biochemistry and Remember the principle behind estimation of nutritional contents of food	
CO2	Discuss different principles behind clinical biochemistry experiments and methods for nutritional content estimations	
CO3	Carry out the experiments and interpret the results. Calculate cell count and predict the viability.	
CO4	Analyze the experimental data and relate it with clinical parameters.	
CO5	Compare the experimental values with normal values and justify the deviations.	
CO6	Plan and perform experiments for unknown samples	

Unit No.	Title of Unit and Contents
1.	**Experiment for kidney function test**. A. Urine analysis. B. Serum Creatinine C. Urea estimation D. BUN E. uric acid.
2.	E**xperiment for liver function test.** A. SGOT B. SGPT C. ALP (Acid and Alkaline) 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 D. Estimation of glycosylated hemoglobin
4.	**Different enzymes studies** A. LDH and its isozymes B. serum amylase
5.	Estimation of serum calcium.
	Nutritional Chemistry
6.	Moisture content of food sample
7.	Protein content in normal and sprouted grains
8.	Crude Fiber and Ash content in Food sample
9.	Vitamin estimation form food sample (Vit C, /Vit B/ Vit A/ Vit E)
10.	Amino acid estimation (Essential and Non essential amino acid in food)
11.	Estimation of polysaccharides from food sample
12.	Extraction of Proteins from food sample
13.	Food adulteration tests
14.	Determination of acidity of given food sample
15.	Micro-nutrient and protein estimation of normal and fermented food

References:

1. Practical Biochemistry- David Plummer 3rd edition (2015).

2. Practical Biochemistry – J. Jayaraman (2011).

3. Biochemical methods – Sadasivam and Manickam 3rd edition (2007).

4. Biochemistry –Practical Approach – Kieth Wilson and J. Walker 5th edition (2006).

5. Introductory Practical Biochemistry- Randhir Singh and Sawhney (1999).

6. Laboratory handbook on Biochemistry, S Shanmugam, 2010, PHI Pvt Ltd, New Delhi (2010).

S.Y. M.Sc. Semester IV		
Title of the Course and Course Code	**Genetic Engineering (CHB-651)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe basic concepts of genetic engineering. Recall role of enzymes, vectors, host and types of modification techniques	
CO2	Explain the tools and techniques used in recombinant DNA technology. Outline cloning strategies and compare different vectors and hosts for expression of foreign genes.	
CO3	Apply knowledge of genetic engineering to prepare recombinant proteins in appropriate hosts, transgenic plants and animals.	
CO4	Analyze and compare different genetic engineering techniques along with their applications.	
CO5	Review different gene editing tools, methods of rDNA technologies and their applications	

CO6	Design the process for gene cloning and producing recombinant proteins in suitable hosts. Prepare a written and oral presentation of scientific topics and research papers related to genetic engineering.	

Unit No.	Title of Unit and Contents
	Genetic Engineering
1.	**Genetic engineering concepts** Genetic engineering concepts: early development in genetics, concept of gene cloning and its importance
2.	**Manipulation of DNA** Important enzymes used in genetic engineering, Restriction endonucleases - types, Restriction-Modification system, Nomenclature, Recognition sequences, etc
3.	**Cloning vectors** Introduction, properties, types: cloning and expression vector, host , Vectors for E. coli, Bacteriophage vectors, Cosmid vectors, Eukaryotic cloning vectors: Yeast vectors, YAC, Shuttle vector, Ti plasmid, Ri plasmid, example of viral vectors for mammals, insects and plants
4.	**Introduction of DNA in living cells** Transformation, identification of recombinant clones, transfection, identification of recombinant phage. Cloning strategies: Genomic libraries, cDNA libraries
5.	**Identification and Selection of recombinant DNA clones** Hybridizations - colony, blotting (radioactive and non-radioactive procedures), plaque hybridization probing, Differential screening, reporter genes etc.
6.	**Expression of foreign gene** Expression of industrially important products like recombinant hormones, recombinant vaccines etc.

7.	**Sequencing genes and genomes** DNA sequencing using dideoxy chain termination method, primer walking, Next-generation sequencing methods; pyrosequencing, DNA profiling: RFLP, AFLP etc., Gene annotation
8.	**Nucleic acid amplification techniques** Polymerase chain reaction: concept, procedure, variations, applications and advantages of PCR, real-time PCR method and applications
9.	**Transgenic plants and animals** Introduction, Gene transfer methods in plants and animals , vectors and Applications of Transgenic plants and animals
10.	**Protein Engineering** In vitro mutagenesis, Oligonucleotide directed, PCR based, applications of protein engineering
11.	**Advance tools in GE and their applications** Introduction to gene editing tools and their applications like RNA interference, CRISPR-Cas9, FISH, GISH, Microarrays, etc.

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.

Title of the Course and Course Code	**Toxicology** **(Theory) (CHB-652)**	**Number of Credits : 02**

Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Introduction to toxicology and its types	
CO2	Classify the different classes of toxicology with example	
CO3	Apply the knowledge for identifying the lethality of compounds by animal experiments.	
CO4	Analyze the different areas and applications of toxicology, doses responsible for toxicity, its risk and safety measures.	
CO5	Evaluate the interaction of chemicals dose response, its selectivity with animals and justify descriptive animal toxicity test. Determine the effect of mutagenesis on genetic toxicity, teratology and reproduction.	
CO6	Arrange different biotransformation reactions with their phases, detoxification and toxication reactions and its effect on body mechanism. Specify the role of Cytochrome P-450 monooxygenase system	

Unit No.	**Title of Unit and Contents**	
	Toxicology	
1.	**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 18 exposure. Duration of frequency of exposure. Spectrum of undesired effects: Allergic reactions, Idiosyncratic reactions, Immediate verses delayed toxicity, Reversible versus irreversible toxicity, Local	

	versus systemic toxicity. Interaction of chemicals, Tolerance, Dose response. Selective toxicity.	
2.	**Evaluation of Toxicity** Descriptive Animal toxicity tests: Acute lethality, Sub acute, sub chronic and chronic toxicity testing. Teratology and reproduction, Mutagenecity.	
3.	**Biotransformation of toxicants:** Phase I and II biotransformation reactions, Detoxification and toxication. Components of Cytochrome P-450 monooxygenase system, Mechanism of phase I and II reactions. Bioactvation, Toxicity of insecticides i.e. carbamates, organophosphorous, and chlorinated insecticides metals, animal and plant toxins, industrial solvents and vapors.	
4.	**Applications of toxicology:** Forensic, clinical and occupational health and industrial hygeine	

References:

1. Haye's principles and methods of Toxicology Ed. A Wallace Hayes, Pub. Raven press, NY, 6th Edition (2014).

2. Casarett and Doull's Toxicology ed. John Doull, Curtio D Kleassen and Mary D Aunder, McMillan publisher Co, NY, 3rd edition (2003).

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 (1959).

4. Toxicology- Mechanisms and analytical methods, Vol I and II, ed Stewart CP and Stolman A, Pub Academic press (1960).

Title of the Course and Course Code	**Stem cells as regenerative medicines (Theory) (CHB-653)**	**Number of Credits : 02**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Remember the terms related to stem cells	
CO2	Outline the concept of stem cells, their types and growth parameters .	
CO3	Demonstrate stem cell behavior and its induction for use as medicine	
CO4	Discriminate pattern of stem cell as therapy and its in vitro and in vivo growth	
CO5	Determine the role of stem cells in developing disorders.	
CO6	Compile the use of stem cells as regenerative medicine	

Unit No.	**Title of Unit and Contents**
	Stem Cells as Regenerative Medicine
1.	History and introduction to stem cell. Types of stem cells with their characteristics
2..	Stem cell Niche, transcription factors and cell surface receptors of stem cells
3.	MSCs (latest advances) Therapeutic applications of MSCs Stem cell bioengineering (iPSC)

4.	Stem cell transplantation (Liver, Bone marrow)
5.	Ethical regulation for stem cell handling

References:

1. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, USA)
2. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.
3. Essentials of Stem Cell Biology, 2nd edition, (2009) Robert Lanza, et al. Elsevier Academic Press, USA
4. Stem cells and the future of regenerative medicine, 1st edition, (2002), National research council and Institute of medicine, National Academic press, Washington DC
5. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

Title of the Course and Course Code	**Advanced studies in Biochemistry** **Theory (CHB 654)**	**Number of Credits : 02**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the advanced terms and techniques in biochemistry	
CO2	Understand the requirements and advanced research in biochemistry. Explain various new topics, new methods and recent techniques for biochemical studies.	
CO3	Interpret the data from research paper and various source, outline the data in presentation format	
CO4	Organize the data properly and distinguish between previous and new information about the topic.	

CO5	Justify the content in the information and evaluate the data related to various advanced techniques.	
CO6	Create the proper flow of information and present the data.	

Unit No.	**Title of Unit and Contents**	
1.	Techniques in study of proteomics	
2.	Advanced techniques in Lipidomics	
3.	Recent trends in study of metabolomics	
4.	Advanced techniques in protein folding studies	
5.	Tools in rational drug design	
6.	Recent advances in lectins	
7.	New diagnostic and treatment strategies for cancer	
8.	Role of Galectins in cancer	
9.	Advanced methods in diagnosis and treatment of neurological disorders	
10.	Viral glycans / Enzymes and disease mechanism	

References:

1. **https://tinyurl.com/92sftuu6**
2. **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5085849/**
3. **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850886/**
4. Metabolomics: From fundamentals **to** clinical applications Alessandra Sussilini, Springer
5. Clinical neurology David Greenberg McGraw Hill

Title of the Course and Course Code	Developmental Biology (Theory) (CHB-655)	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic terms in development unicellular and multicellular organism	
CO2	Understand the process of cell division and growth with specific examples.	
CO3	Outline the concepts and apply fundamental understanding of molecular biology. Illustrate the molecular processes and predict the role of various transcriptional and translational factors, on growth and development.	
CO4	Analyze molecular events in prokaryotic and eukaryotic organisms and compare them.	
CO5	Justify and review the basic molecular processes in prokaryotes and eukaryotes. Summarize post-translational modification events	
CO6	Compile the molecular processes in prokaryotes and eukaryotes and specify gene regulation mechanisms.	

Unit No.	Title of Unit and Contents

1.	**Introduction** Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division
2.	**Early Embryonic Development** Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers.
3.	**Late Embryonic Development** Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)
4.	**Post Embryonic Development** Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories
5.	**Implications of Developmental Biology** Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis
6.	**Developmental Biology** Cell differentiation, hierarchy of genes, measurement of time during development, nature of differentiation, DNA rearrangements & amplification, genetic control of morphogenesis, plant molecular genetics.

References:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology

4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

Title of the Course and Course Code	**Research Proposal Writing (Theory) (CHB-660)**	**Number of Credits : 4**
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Identify the area of research considering possible applications	
CO2	Check the novelty of the research problem through literature survey	
CO3	Design the scheme/outline of research work	
CO4	Prepare the estimation of various requirements under budget heads	
CO5	Prepare execution plan for the proposed project work	
CO6	Prepare the project proposal	

Title of the Course and Course Code	**Research Project (Theory) (CHB-661)**	**Number of Credits : 6**

Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the rationale behind the project work and show a sound knowledge of the selected topic..	
CO2	Outline experimental design and articulate appropriate methods to achieve the stated objectives of the project.	
CO3	Carry out literature survey, experiments; interpret and examine the findings of the experiments.	
CO4	Compare, criticize and relate the obtained results to the scientific evidence and discuss it.	
CO5	Determine the applications of projects and future aspects	
CO6	Prepare a formal project report in the form of a dissertation and research articles. Develop an ability to communicate effectively orally and in writing and defend their research work to a panel of experts.	

****