SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

SYLLABUS

As per NEP 2020 guidelines

For University Department and affiliated colleges

Master of Science in Biochemistry

PART- II

(Semester III and IV choice-based Credit system)

w. e. f. July 2024

Semester III						
Core courses						**Credits**
Major Core- 10 (T) + 4 (P)						
CHB-601 MJ	Molecular Biology (T)					**4**
CHB-602 MJ	Medical Biochemistry and Immunology (T)					**4**
CHB-603 MJ	Biochemistry of specialized tissues (T)					**2**
CHB-604 MJ	Molecular Biology and Clinical Biochemistry (P)					**4**
Major Elective 4 (T) Any two courses						
CHB-610 MJ	Toxicology (T)					**2**
CHB-611MJ	Physiological biochemistry (T)					**2**
CHB-612 MJ	Applied Plant Biochemistry (T)					**2**
CHB-613 MJ	Developmental Biology (T)					**2**
CHB-631 RP	**Research Project- I (P)**					**4**
Semester IV						
Core courses						
Major Core- 8 (T) + 4 (P)						
CHB-651 MJ	Genetic Engineering (T)					**4**
CHB-652 MJ	Fermentation technology and Tissue Culture (T)					**4**
CHB-653 MJ	Special Experiments (P)					**4**
Major Elective 4 (T) Any two courses						
CHB-660 MJ	Endocrinology (T)					**2**
CHB-661 MJ	Food Technology (T)					**2**
CHB-662 MJ	Drug discovery and development (T)					**2**
CHB-663 MJ	Proteomics and Genomics (T)					**2**
CHB-681 RP	**Research Project- II (P)**					**6**
Total 4 Semesters	Major Core	Major Elective	Research Methodology (RM)	Internship on Job Training (OJT)	Research Project (RP)	Total Credits
	54	**16**	**4**	**4**	**10**	**88**
2 Years- 4 SEM. Award PG Degree in Biochemistry on completion of 88 credits after Three years UG Degree or 1 Year -2 SEM PG Degree (44 Credits) after Four-year UG Degree						

Note:

1. T- Theory, P- Practical
2. Wherever require the BOS can choose theory or practical course as per the need and within the given structure.
3. Each course should be designed with the minimum 2 or maximum 4 credits.

M. SC. BIOCHEMISTRY PART-II SYLLABUS SEMESTER – III

Course Code: **CHB-601 MJ**	Course Title: **MOLECULAR BIOLOGY**	

Course objectives

1. The objectives of molecular biology are to understand the structure, storage, expression, and transmission of genetic information in prokaryotes and eukaryotes.
2. To know the DNA damage and repair system at molecular level
3. To learn detail mechanism of transcription, RNA splicing and its inhibitors
4. Study translation process and protein modifications and target to different organelles in cells

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Molecular Biology	**60 Hrs**
1. DNA Replication: Origin of locus, Enzymes involved in DNA synthesis e.g. topoisomerase, helicase, ligase and others. DNA polymerase I, II, III, , Okazaki fragments, replication fork. Mechanism in Prokaryotes and Eukaryotes. 2. DNA Repair: DNA damages, detection and repair systems. Pyrimidine dimer formation and its repair. Defective repair system and diseases, Ames test. 3. Gene rearrangements: Recombination pathways, Holliday structures, Rec A, B, C, D. SOS response, mobile genetic elements. 4. Transcription and splicing: RNA polymerases, promoters, , initiation, elongation and termination of transcription (Prokaryotes), sigma and Rho factors Inhibitors of transcription. Transcription in Eukaryotes, RNA pol I, II, III, enhancers. Post transcriptional modifications of t, r and m-RNA, 5'-capping, 3'-poly A tailing, RNA editing. 5. Splicing: Splicing phenomenon. Mechanism, spliceosomes, alternative splicing, self-splicing, ribozyme (catalytic RNA). 6. Translation: Role of t-RNA and Ribosome in protein synthesis. Mechanism in Prokaryotes and Eukaryotes. Inhibitors of protein synthesis. 7. Protein targeting: Intracellular protein targeting. Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, Peroxisomes, chloroplast, protein degradation. 8. Eukaryotic chromosome and gene expression: Chromatin structure, transcription factors, chromatin remodeling, control of gene expression at post transcription level.	

Suggested readings

1. Biochemistry (III/IV/V/VI edition, 2008) L. Stryer, WH Freeman and Co.
2. Molecular biology of the gene (VII edition, 2014) J D Watson, Person education Inc.
3. Molecular Cell Biology (8th edition.2016) by Harvey Lodish et al.
4. Molecular biology of the cell 6th edition (2014) B. Alberts, Garland Pub. In., NY
5. Genes X (2010), B. Lewin, John Wiley and sons, NY.

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Course outcomes
After completing this course, the student will acquire a detail knowledge of expression, and transmission of genetic information in prokaryotes and eukaryotes. Understand the pathways involved in repairing of DNA at molecular level. Understanding details mechanism of replication, transcription and translation helps fundamental and molecular interactions in cells.

Course Code: **CHB-602 MJ**	Course Title: **MEDICAL BIOCHEMISTRY AND IMMUNOLOGY**	

Course objectives:

MEDICAL BIOCHEMISTRY: Coursework shows how medical biochemistry allows us to understand and treat diseases and role of antibiotics. Also, subject areas include cell cycle control, molecular basis of cancer, heart diseases, blood genetic diseases and hemoglobinopathies. This programme is streamlined for biochemists considering a career in research into the biochemical basis of disease and therapeutic medicine.

IMMUNOLOGY: In this course, the students will be introduced to the basic concepts of immunology as it relates to human and animal health. The course is designed for students to understand the fundamentals of immunology. The course material has been designed to help understand the ability of immune system to defend against invading pathogens, ability to fight microbial infections (innate acquired immunity); hypersensitivity reactions; what are the consequences (autoimmunity) and above all, can we prevent pathogens from attacking us (vaccination).

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
Section I: Medical Biochemistry	**30 Hrs**
1. Mechanism of action at molecular level of selected antibiotics: inhibitors of cell wall, plasma membrane, nucleic acids and protein synthesis. Mechanism of action of anti-metabolites, analgesics, hallucinogens, antiviral, antifungal, antiprotozoal and mechanism of resistance to antibiotics and other drugs. 2. Lysosomes and their physiological role: Structure and function of lysosomes, role in animal and plant cells. Physiological role in various types of digestive phenomenon disturbances to lysosomes (lysosomal pathology), lysosomal storage disease. 3. Molecular basis of hemoglobinopathies: concept of hemoglobinopathies, β and α-Thalassemia, sickle cell anemia, pathophysiology, biochemistry, types of mutations. 4. Ischemic heart disease/CHD: myocardial infarction and coronary heart diseases (pathophysiology); laboratory findings, enzymes involved. 5. Cancer: carcinogenesis, microevolution process, molecular genetics of cancer, causative agents, role of viruses 6. Apoptosis: extrinsic and intrinsic mechanism, role in diseases and physiology	

Suggested readings	
1. Biochemistry of antimicrobial action (4th ed) TJ Franklin, Chapman hall (1989) 2. Mechanism of microbial diseases, M Schaechter et al, Williams and Wilkino Int. 5th Ed.(2012) 3. Microbiology an application based approach, M.J Pelczar, ECS Chan, N.R.Krieg (2009). 4. Bruce A. et al. (2014) Molecular biology of the cell, 6 rd Edition, 5. Biochemical aspects of human diseases (1983), RL Elkeles, Slackwell scientific publishers, Oxford 6. Biochemistry and diseases, Robert Cohn Carl S Roth (1996). 7. Hereditary, Genetics and Genetic diseases, RN Roy, 2011 8. Text book of Medical Physiology- Guyton 12th edition (2010) Saunders Elseviers 9. Molecular biology of the cell, third edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, JD Watson, 6th edition (2014). 10. General Microbiology, Pelczar, Rard and Chan, 5th edition (1993).	
Section II: Immunology	**30 Hrs**
1. Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non-self, primary and secondary lymphoid organs, cell mediated and humoral immune responses, T and B lymphocytes, autoimmune reactions. 2. Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, catalytic antibodies (abzymes). 3. Antigen and antibody: antigen, antigenic determinant, structure of antibody, constant and variable regions, Fab, F(ab2) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes. 4. Multi-gene Organization of Ig Genes: variable region gene rearrangement in light chain and heavy chain and generation of antibody diversity, Class switching among constant region genes. 5. Measurement of antigen- antibody interaction: immuno-diffusion, immuno-electrophoresis, radioimmunoassay, immunofluorescence, ELISA, Western blotting 6. MHC gene complex, Class I and Class II MHC structures 7. Complement system: classical, alternate and lectin pathway 8. T lymphocytes and Cell mediated immunity 9. Hypersensitivity reactions, Blood group antigens and Rh factors, Immunodeficiency diseases (AIDS) 10. Vaccines	
Suggested readings	

1. Immunology 8th ed Janis Kuby (2012).
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 12th edition (2011) – Blackwell Scientific Pub, Oxford.
5. Cellular and Molecular Immunology, 9h edition (2017), Abbas

Course outcomes

This programme is streamlined for biochemistry students considering a career in research into the biochemical basis of disease and therapeutic medicine. Also, conceptual understanding of the subject is the key for successful use of immunology in future careers, be it practice, research, teaching and industry.

Course Code: **CHB-603 MJ**	Course Title: **BIOCHEMISTRY OF SPECIALIZED TISSUES**	

Course objectives:

The main objective of the course is to make students understand the structures and biochemical mechanisms underlying the normal functioning of muscles and nerve conduction. The content also includes biochemical basis of vision and other senses like touch, smell and taste. The course aims to explode, at biochemical and molecular level, the complex communication phenomena between their organs and tissues and their control systems.

Course Credit: **2** | Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
BIOCHEMISTRY OF SPECIALIZED TISSUES	**30 Hrs**
1. Muscle contraction and cell motility: skeletal muscle structure of muscle cell, ultra-structural organization, protein components of myofibrils, molecular organization of thick and thin filaments, mechanism of muscle contraction, metabolism of muscle, cardiac muscle contraction, regulation of contraction, contractile proteins in eukaryotic cells other than muscle filaments, chemotaxis. 2. Nerve Conduction: Structure and composition of nervous tissue, creation and propagation of nerve impulse, action potential, Na^+ and K^+ channels, transmission of nerve impulse, cholinergic receptors, electroplates as a source of acetyl choline receptor, acetyl choline esterase, nerve poisons. 3. Biochemistry of vision: Structure of eye, lens, and retina, perception of light, rods and cones, rhodopsin, primary events in visual excitation, cyclic GMP, transducin in generation of nerve impulse, colour vision. 4. Biochemistry of sense of taste, smell, touch and hearing.	
Suggested readings	

1. Textbook of Physiology and Biochemistry. Author, R. A. Agarwal. Publisher, S. Chand, 1978.
2. Text book of physiology- Guyton, 12th edition (2010)
3. Principles of neural science Kandel ER, Schwartz JH, Elsevier, N. Holland, NY, 5th edition (1991)
4. Neurobiology, Shepherd GM, Oxford Univ. Press (1993).
5. Nerve and muscle excitation Junge D, Sinauer assoc, Sanderland, mass (1976).
6. Biochemistry, L Stryer, Freeman and Co, NY, 8th edition (2015).
7. Biochemistry, Zubay, Addison Wesley and Co.2nd edition (1994).

Course outcomes

At the end of the course, the student should be able to explain the mechanisms of function of specialized tissues, involvement of organelles in disease causation, and to use this knowledge in the diagnosis of diseases and drug development.

Course Code: CHB-610 MJ	**Course Title: TOXICOLOGY**	

Course objectives: To understand the significance of toxicological studies in forensic science. To know classification of poisons and their modes of actions. To gain knowledge about absorption of poisons in body fluids. To know about the forensic identification of illicit liquors. To gain knowledge about classification and characteristics of the narcotics, drugs and psychotropic substances. To understand the menace of designer drugs.

Course Credit: 2	Total contact hours: 30 Hrs

Course Contents (Topics & subtopics)	**Reqd. Hours:**
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 exposure. Duration of frequency of exposure. Spectrum of undesired effects: Allergic reactions, Idiosyncratic reactions, Immediate verses delayed toxicity, Reversible verses irreversible toxicity, Local verses systemic toxicity. Interaction of chemicals, Tolerance, Dose response. Selective toxicity. 2. General Toxicology: (a) Forensic Toxicology and Poisons, (b) Diagnosis of poisoning in living and dead, (c) General principles of management of poisoning, (d) Medico-legal aspects of poisons, (e) Antidotes and, types. 3. Poisons, The classification of poisons, their physico-chemical characteristics, and mode of action: (i) Corrosive poisons (Mineral acids, Caustic alkalis, Organic acids, Vegetable acids) (ii) Irritant poisons (Organic poisons - Vegetable and animal; Inorganic poisons - metallic and non-metallic; Mechanical poisons) (iii) Asphyxiant poisons (Carbon monoxide; Carbon dioxide; Hydrogen sulphide and some war gases. (iv)Neurotic poisons (Opium, Nux vomica, Alcohol, Fuels like kerosene and petroleum Cannabis indica, Dhatura, Anaesthetics Sedatives and Hypnotics, Agrochemical Belladonna, Hyoscyamus, Curare, Conium) (v) Cardiac poisons (Digitalis purpurea, Oleander. Aconite, nicotine) (vi) Miscellaneous poisons (Analgesics and Antipyretics, antihistamines, antidepressants, Stimulants, Hallucinogens, Street drugs etc.)	

4. 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 verses delayed toxicity, Reversible verses irreversible toxicity, Local verses systemic toxicity. Interaction of chemicals, Tolerance, Dose response. Selective toxicity. 5. General Toxicology: (a) Forensic Toxicology and Poisons, (b) Diagnosis of poisoning in living and dead, (c) General principles of management of poisoning, (d) Medico-legal aspects of poisons, (e) Antidotes and, types. 6. Poisons, The classification of poisons, their physico-chemical characteristics, and mode of action: (i) Corrosive poisons (Mineral acids, Caustic alkalis, Organic acids, Vegetable acids) (ii) Irritant poisons (Organic poisons - Vegetable and animal; Inorganic poisons - metallic and non-metallic; Mechanical poisons) (iii) Asphyxiant poisons (Carbon monoxide; Carbon dioxide; Hydrogen sulphide and some war gases. (iv)Neurotic poisons (Opium, Nux vomica, Alcohol, Fuels like kerosene and petroleum Cannabis indica, Dhatura, Anaesthetics Sedatives and Hypnotics, Agrochemical Belladonna, Hyoscyamus, Curare, Conium) (v) Cardiac poisons (Digitalis purpurea, Oleander. Aconite, nicotine) (vi) Miscellaneous poisons (Analgesics and Antipyretics, antihistamines, antidepressants, Stimulants, Hallucinogens, Street drugs etc.) 7. Narcotics, drugs, and psychotropic substances. The definition of these substances, and their broad classification 8. Corrosive, irritant, and metallic poisons 9. Biotransformation of toxicants: Phase I and II biotransformation reactions	**30 hrs**

Suggested readings

1. Casarett and Doull's Toxicology by Curtis D. Klaassen; Louis J. Casarett; John Doull
2. Comprehensive Toxicology by Charlene McQueen
3. Encyclopaedia of Toxicology by Philip Wexler
4. Principles of Forensic Toxicology by Barry S. Levine and Sarah Kerrigan

Course outcomes

After studying this course students should be able to get the knowledge about the significance of toxicological studies in forensic science, classification of poisons and their modes of actions, absorption of poisons in body fluids, forensic identification of illicit liquors, classification and characteristics of the narcotics, drugs and psychotropic substances and menace of designer drugs.

Course Code: **CHB-611 MJ**	Course Title: **PHYSIOLOGICAL BIOCHEMISTRY**	

Course objectives:

Students are expected to understand various organ systems viz., Liver, Kidney, digestive tract, connective tissue especially blood components from cellular to system level, and communicate successfully how the systems' components work and what roles they play. Students should be able to demonstrate a substantial factual knowledge base and grasp the basic concepts of organs. Students will be enlightened with the role of Physiology in the biological, biomedical sciences and research.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	Reqd. Hours
	30 Hrs
1. Liver: anatomy, physiological functions, Liver function tests, Liver disorders: hepatitis, cirrhosis, Jaundice: etiology and symptoms 2. Kidney: anatomy, physiological functions, diseases/disorder, diagnostic tests 3. Respiration: Principles of gaseous exchange during respiration, Bohr effect, transport of oxygen and carbon dioxide in the blood, regulation of respiration. Acid base balance. 4. Digestion and Absorption of food: GIT, regulation of saliva, gastric, pancreatic, Intestinal and bile secretion (i.e. digestion), Absorption – (carbohydrate, protein, lipid, minerals and vitamin) transport and excretion of nutrients. 5. Composition of blood, anaemias and polycythaemia, Blood brain barriers, Blood clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K clotting process, lysis of fibrin clot. 6. Mineral metabolism.	
Suggested readings	
Reference Books 1. Harper's Biochemistry- 30th edition (2015). 2. Biochemistry, L Stryer, Freeman and Co, NY, VI edition (2008). 3. Textbook of Physiology, Guyton, 12th edition (2010). 4. Biochemistry, Zubay, Addison Wesley and Co. (1983). 5. Textbook of Physiology and Biochemistry by R. A. Agarwal and S. Chand, 1978	
Course outcomes	
At the end of the course, the student should be able to explain the mechanisms of function of specialized tissues, involvement of organelles in disease causation, and to use this knowledge in the diagnosis of diseases and drug development.	

Course Code: **CHB-612 MJ**	Course Title: **APPLIED PLANT BIOCHEMISTRY**	
Course objectives: 1. This course covers biochemical processes specific to plants and is aimed to allow students to gain an understanding and appreciation of how biochemical components are synthesized and utilized by plants during growth and development. 2. The course includes topics in photosynthesis, nitrogen, and sulphur metabolism, secondary metabolites and applications.		
Course Credit: **2**	Total contact hours: **30 Hrs**	
Course Contents (Topics & subtopics)		**Reqd. Hours**
Applied Plant Biochemistry		**30 Hrs**
1 Plants micro and macro elements: requirement, role, excess and deficiency disorders. 2 Photosynthesis: chloroplasts, photosystem, mechanism CO_2 fixation, C3 and C4		

pathways 3 Plant growth hormones: types and role in plant growth and development, Auxins gibberellins, cytokinins, ethylenes, abscisic acid, hormones in senescence and abscission. 4 Nitrogen and Sulfur metabolism in Plants: Nitrogen cycle, nitrogen fixation, assimilation of nitrate and ammonium ions, nitrogen transformation during development, assimilation of sulfate. 5 Secondary metabolites: classification, phenolics, flavanoids, lignins, terpenoids alkaloids, Gums, Pectins Rubber and applications 6 Phytoremediation 7 Advanced farming techniques: Green house, Hydroponics, etc.	
Suggested readings: 1. Biochemistry, L Stryer, Freeman and Co, NY, VI edition (2008). 2. Plant physiology, Salisbury and Ross (2007) CBS publishers and distributors 3. Principles of Biochemistry Lehninger, 7th edition (2012). 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 (1966) 8. Plant Biochemistry- Dey (1997)	
Course outcomes	
Upon completion of the course, students will be familiar with a range of plant specific biochemical pathways, will gain an appreciation for the complexity of plant metabolism and the intricate ways pathways intersect and influence each other. Students will have an opportunity to apply their recent knowledge of biochemistry to current agricultural problems.	

Course Code: **CHB-613 MJ**	Course Title: **DEVELOPMENTAL BIOLOGY**	
Course objectives: Developmental biology aims to understand how an organism develops how a single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks. It helps to understand the molecular, genetic, cellular, and integrative aspects of building an organism. It also explains how a variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features that arise on the trajectory from embryo to adult, or more generally throughout a life cycle		
Course Credit: **2**	Total contact hours: **30 Hrs**	
Course Contents (Topics & subtopics)		**Reqd. Hours**

Developmental Biology	**30 Hrs**
1. Theories of Evolution: the time scale and some evolutionary principles. Chemical evolution and origin of life. Prototypes of metabolic pathways. 2. Genesis of oxygen generating photosynthesis and aerobic respiration. Methanogens- evolution of prokaryotes 3. Evolution of protists 4. Origin of eukaryotes: Theories regarding origin of mitochondria and chloroplast, the five-kingdom classification of living organisms, outline of eukaryote evolution- evolution of primates. 5. Molecular Evolution: Construction of phylogenetic trees- molecular data set based on sequences, Evolution of proteins and nucleic acid – elastic analysis, Evolution of introns, Evolutionary view of exon domain relationships 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.	
Suggested readings 1. Gilbert SF. Developmental Biology. 6th edition. Sunderland (MA): Sinauer Associates; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK9983 2. Fundamental Concept Of Developmental Biology Paperback – 1 January 2012 by Das N (Author) 3. Development Biology: from a Cell to an Organism (Genetics and Evolution)" by Russ Hodge	
Course outcomes: Developmental biology displays a rich array of material and conceptual practices that can be analyzed to better understand the scientific reasoning exhibited in experimental life science. It enlightens the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism which renders many applications in different fields like fertility and tissue engineering. It also points in the direction of new ideas for metaphysics, especially when that endeavor explicitly considers the input of empirically successful sciences. .	

Course Code: **CHB-604 MJ**	Course Title: **Molecular Biology and Clinical Biochemistry (P)**	

Course objectives:

Molecular Biology (P): In this course students will follow laboratory protocols to perform molecular biology techniques. The students will get theoretical and practical introduction to important methods and techniques molecular biology. These include DNA, RNA isolation from different sources, PCR, plasmid isolation, restriction analysis, gel electrophoresis.

Clinical Biochemistry (P)- To make students understand the fundamental biochemistry knowledge related to health and abnormalities which commonly occur in the clinical field. Students should be able to determine various substances including substrates, enzymes, biochemical components, etc. Also, students will be able to explain the clinical significance of the clinical laboratory tests.

Course Credit: **4**	Total contact hours: **120 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
MOLECULAR BIOLOGY	**60 Hrs**
1. Isolation of DNA from bacterial/ liver/ plant/ yeast source 2. Isolation of RNA from bacteria/ plant/yeast/ mammalian source. 3. Spectrophotometric analysis of nucleic acids 4. Determination of Tm 5. Agarose gel electrophoresis of DNA and molecular size determination 6. Restriction digestion of DNA 7. Preparation of plasmid DNA 8. Transduction 9. Transformation 10. Conjugation and bacterial gene expression analysis 11. Ligation study 12. PCR analysis	
EXPERIMENTS IN CLINICAL BIOCHEMISTRY	**60 Hrs**
1. Estimation of cholesterol and lipoproteins in serum 2. Estimation of Blood sugar 3. Estimation of SGPT and SGOT in serum 4. Estimation of alkaline and acid phosphatase from serum 5. Estimation of glycosylated hemoglobin in blood 6. Estimation of serum LDH and its isozymes 7. Estimation of serum amylase 8. Estimation of serum bilirubin 9. Estimation of blood urea 10. Estimation of blood uric acid 11. Estimation of blood Creatine and Creatinine 12. Estimation of total protein and albumin from serum 13. Blood group typing	

Suggested readings	
Reference Books: 1. Practical Biochemistry in clinical medicine by Prof. R. L. Nath, M.Sc., Ph.D. Academic Publishers, Calcutta, 2nd Ed. 1990, pages 488 2. Practical Biochemistry- David Plummer 3rd edition (2015). 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).	
Course outcomes	
Molecular Biology (P): On completion of the course the student should have the knowledge of the general safety routines for laboratory work in molecular biology. Student will develop the skill to plan experimental work based on a protocol, can properly connect experimental procedures, critically evaluate and discuss obtained experimental results within the field of molecular biology and biochemistry. **Clinical Biochemistry (P):** At the end of the course students should be able to review the information from each category of tests and develop a protocol for disease diagnosis and apply them for diagnosis and monitoring of disease. They will be able to create awareness of different lifestyle diseases increasingly found in present day.	

Course Code: **CHB-631 RP**	Course Title: **RESEARCH PROJECT- I (P)**	
Course Credit: 4	Total contact hours: 120hrs	
Course objectives: To understand research hypothesis, review of literature, project proposal planning with aims and objectives and timelines for specific objectives of research project and expected outcome.		

M. SC. BIOCHEMISTRY PART-II, SEMESTER IV

Course Code: CHB-651 MJ	**Course Title:** **GENETIC ENGINEERING**	
Course objectives: The goal is to develop a thorough understanding of DNA structure, function and expression and specifically as it relates to recombinant DNA and genetic technology.		
Course Credit: 4	**Total contact hours: 60 Hrs**	
Course Contents (Topics & subtopics)		**Reqd.**

	Hours:
1. Genetic engineering concepts: concept of gene cloning and its importance. 2. Manipulation of DNA: Enzymes in genetic engineering, Restriction endonucleases, restriction map, Ligase, polymerase modifying enzymes, ligation; putting sticky ends to blunt ended molecules. 3. Polymerase chain reaction: concept, types, methods and applications 4. Cloning vectors: Vectors for E. coli: Plasmids, M 13 bacteriophage vectors, λ bacteriophage, Cosmid. Eukaryotic cloning vectors: Cloning vectors for yeast, other fungi, YAC, cloning vectors for higher plants, Ti plasmid, Ri plasmid, plant viruses for cloning, cloning vectors for insects, viruses as cloning vectors for mammals. 5. Introduction of DNA in living cells: Transformation, identification of recombinants, introduction of phage DNA into bacterial cells (transfection), identification of recombinant phage. 6. Expression of foreign gene: gene expression in E coli, production of recombinant proteins in Eukaryotes, fungi, yeast, mammalian and insect cells systems. 7. Selection of recombinant DNA clones: colony and plaque hybridization probing, Southern blotting, 8. RNA interference and its applications 9. Recombinant DNA technology applications in medicine and industry: Recombinant hormones, recombinant vaccines. Human proteins (antibodies, clotting factors, antibody engineering) RFLP and application in forensic science 10. CRISPR/Cas9: Principles and applications	60

Suggested readings

1. Daniel L. Hartl & Elizabeth W. Jones: Genetics – analysis of Genes & Genomes
2. Benjamin A. Pierce: genetics – a conceptual approach
3. Griffiths, Wessler, Lewontin, Gelbart, Suzuki & Miller: Introduction to Genetic analysis
4. Principles of Gene Manipulation and Genomics by Sandy B. Primrose, Richard Twyman
5. Lewin's GENES XII or any advanced edition
6. Brown T. A. (2020) Gene cloning and DNA Analysis, 8 th Edition, Wiley Blackwell Publication, USA.

Course outcomes

After studying this course students should be able to get the knowledge about the different techniques used gene manipulation and gain insights into past as well as current advancements in recombinant DNA technology.

Course Code: **CHB-652 MJ**	**FERMENTATION TECHNOLOGY AND TISSUE CULTURE**	

Course objectives:

FERMENTATION TECHNOLOGY: To give the students' knowledge of design of fermenters, types of fermenters, equipment & instruments used in fermentation and sterilization processers. To acquaint the students with fermentation media, inoculum preparation, scale up processes and various downstream processes used in fermentation industries

TISSUE CULTURE: The objective of tissue culture is to understand the basic concept of animal and plant tissue culture. To deliver the knowledge of component, conditions required for development of tissue culture laboratory. To explain the isolation, development, maintenance of animal cell lines, cell fusion techniques, to give knowledge of cytotoxicity assays. To acquire the knowledge of plant tissue culture techniques

Course Credit: **4**	Total contact hours: **60 Hrs**

Course Contents (Topics and subtopics)	**Reqd. Hours**
FERMENTATION TECHNOLOGY (2 credit)	30 Hrs
Section I: Fermentation Technology 1. Characteristics of industrial microorganisms 2. Strain improvement, use of auxotrophic mutants 3. Methods and parameters of cultivation of microorganisms, media for industrial fermentation 4. Fermenters, design of fermenters, fermentation process, and maintenance of aseptic conditions, aeration and agitation. 5. Downstream processing, recovery and purification of fermentation products, effluent treatment 6. Applications of fermentation technology: Manufacturing by fermentative process: beer, Citric acid, Glutamic acid, lipase, Penicillin, L-asparginase	
Section I: TISSUE CULTURE (2 credit)	30 Hrs
Animal tissue culture 1. Animal cell culture: Historical Background, Advantages of tissue culture, Laboratory organization: Design of ATC laboratory, the regulations and recommendations for biosafety laboratory and cabinets, Equipment's used in animal tissue culture: Laminar Airflow Hoods, CO_2 incubator, Culture Vessels. 2. Media requirements for cell culturing: Preparation of medium and sterilization techniques, Advantages and disadvantages of natural and synthetic media 3. Primary Cell Culture: Initiation of a Primary Cell Culture, Isolation of the Tissue, Types of Primary Culture, Cell Lines, Subculturing, Cross-contamination and Misidentification, Mycoplasma Contamination, Naming a Cell Line, Choosing a Cell Line, Routine Maintenance, Significance of Cell Morphology, viable cell count, antibiotic free stock culture. Types of animal cell cultures, 4. Methods of cell preservation 5. Cytotoxicity assays, applications of cytotoxicity assays. 6. Cell fusion methods: Techniques involved in cell fusion, Hybridoma cells: definition; preparation; properties and use of hybridoma technology. 7. Contact inhibition, Organ culture and cell and tissue banking **Plant tissue culture** 1. Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it's control and measures. 2. Media and Culture Preparation: Role of Micro and macro nutrients, Vitamins and	

carbon source in tissue culture, Media preparation- pH, Temprature, Solidifying agents, Slant Preparations etc. Maintenance of cultures, Environmental Conditions, explants characteristic, Tests for Viability of Cultured Cells

3. PTC Techniques: Callus and cell suspension culture, , Conditioning of tissue culture plants (weaning and hardening), Micropropogation, Embryo culture, Somatic embryogenesis, Protoplast culture, Somatic Hybridization, Somaclonal variations, Agrobacterium mediated hairy root culture
4. Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance

Suggested readings

Reference books:

1 Principles of Fermentation technology, PF Stanbury, A Whitaker, SJ Hall (2008)
2 Molecular biology and biotechnology- edited by JM Walker and FB Gingold, Royal society of chemistry 5th edition (2009)
3 Industrial Microbiology – Casida 2nd edition (2016).
4 General Microbiology Stainer R.Y. et al (1987) 5th Ed., Macmillan
5 Culture of Animal Cell: R. I. Freshney (Wiley-Liss)
6 Animal Cell Culture-Practical Approach: R. W. Jhon (Masters Oxford)
7 Biotechnology: U. Satyanarayana (Books & allied Pvt. Ltd.)
8 Principle and practice of Animal tissue culture by Sudha Gangal, 2nd edition (2010).
9 Plant cell tissue and Organ culture by Gamborg Phillips (1995).
10 Plant tissue culture basic and applied T B Jhaand B Gosh (2005).
11 Plant Tissue Culture, Kalyan Kumar De

Course outcomes

- Students will gain the knowledge of design of fermenters, types of fermenters, equipment, instruments used, sterilization processers. Students will be well versed with fermentation media, inoculum preparation, Scale up. Processes and with the various downstream processes of fermentation industries.
- After completing animal and plant tissue culture course, the student will acquire sufficient knowledge about animal and plant tissue culture handling, maintaining and techniques used to in routine analysis on plant and animal cell lines/tissues.

Course Code: **CHB-653 MJ**	**SPECIAL EXPERIMENTS (P)**	4 credits

Course objectives:

This course includes specific biochemical assays and biophysical techniques that encompass a diverse range of methods that examine cell culture, separation of cellular components and their characterization at molecular level. The techniques provide quantitative data about molecular interactions, structural changes, and dynamic processes, offering a deeper understanding of the physical and chemical properties of biological systems. By complementing traditional

biochemical and pharmacological approaches, biophysical techniques provide a comprehensive view of drug-target interactions.

Course Credit: **4**	Total contact hours: **120 Hrs**

Course Contents (Topics and subtopics)	**Reqd. Hours**
SPECIAL EXPERIMENTS (P)	120 h
ATC, PTC, Fermentation and some special experiments 1. Sub-Cellular fractionation with respect to marker enzymes 2. Isolation of PGP microorganisms and its characterization 3. Fermentation studies of suitable secondary metabolites with respect to media design and parameter optimization. 4. Phytochemical screening of any suitable secondary metabolite and chemical characterization. 5. Plant Tissue Culture: media preparation, callus culture of suitable explant 6. Handling and maintaining of the cell line 7. Cell counting and subculturing of the cell line 8. Cell viability staining 9. Cytotoxicity assay by MTT/ XTT 10. Immobilization studies of enzymes/whole cells on suitable matrix. 11. Identification of functional groups in a compound using IR (any solvent/ solution) 12. Identification of compound using NMR spectroscopy. 13. Demonstration of sophisticated analytical instrument working (GC/ GCMS/ LCMS/ XRD/ SEM/ ELISA) 14. In vitro antioxidant assay of suitable plant extract (FRAP assay/ total antioxidant capacity/ hydroxyl radical scavenging assay)	
Suggested readings	
1. D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series. 2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009). 3. R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012). 4. D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006). 5. R. L. Switzer, Experimental biochemistry (W. H. Freeman and Co, New York, 3rd ed., 1999). 6. J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006; http://site.ebrary.com/id/10229235). 7. B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin; New York, 2nd ed., 2002).	
Course outcomes	

This course provides a strong research base to students to understand biochemistry principles through good and innovative practical approaches. On completion of the course students will be able to demonstrate the knowledge of techniques used for determining various biochemical and biophysical parameters.

Course Code: **CHB-660 MJ**	Course Title: **Endocrinology**	

Course objectives:

Endocrinology field gives a unique opportunity to broaden students' knowledge and helps to better understand how other key endocrine tissues can also contribute to the metabolic diseases. How specialize glands and the hormones they produce affect important processes that control physiological growth metabolism, blood pressure, cholesterol, hunger, thirst, body temperature and more.

Course Credit: **2**	Total contact hours: **60 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
1. General characteristics of hormones, chemistry, structure and metabolism 2. Hormones biosynthesis, regulation of hormone secretion, transport and clearance 3. Hormones receptors, secondary messengers and their mode of action and intracellular signaling 4. Mechanism of action of hormones of hypothalamus, pituitary, thyroid, pancreas, adrenals glands. 5. Gastro intestinal hormones, parathyroid hormone, calcitonin, calcium and phosphate metabolism, vitamin D, bone, and teeth 6. Disorders related to hormones and target cells insensitivity	**30 Hrs**
Suggested readings	
Reference books: 1. Textbook of Physiology, Guyton, 12th edition (2010). 2. Biochemistry, Zubay, Addison Wesley and Co. (1983). 3. Vertebrate endocrinology- Noris DO 5th ed (2013). 4. Endocrine physiology- Martin, CR (1985(Oxford Univ press (NY) 5. Physiological chemistry –Harper 17ed Lange medical 6. Biochemistry- Zubay (1983) Addison, Wesley publ. Co. 7. Text book of endocrinology –Williams, 13th edition Saundes Co (2016). 8. Biochemical endocrinology E. Frieden (1983)	
Course outcomes	
The course will enable students to demonstrate/illustrate how every aspect of our physiology and behavior is directly controlled or modified by hormones using reproduction, growth, development, stress, and metabolism as examples. They can apply the understanding of endocrine pathways by designing tests that will help to diagnose a condition.	

Course Code: **CHB-661 MJ**	Course Title: **Food Technology**	

The food technology course will provide the knowledge on the conversion of raw agricultural produce into processed, packaged, shelf-stable food products and intermediate raw materials; different aspects of food preservation; establishment, maintenance and assurance of food quality; design and maintenance of food process machines.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
1. Foods proximate compositions. 2. Proteins concentrates and hydrolysates, unconventional sources- OCP, SCP etc. 3. Starches and Sugars: starch production and uses, manufacture of natural and synthetic sweeteners and syrups 4. Effect of Food processing: Sprouting, fermentation, heat processing, irradiation 5. Enzymes in food processing, meat tenderization and fruit juice technology 6. Food safety: Biochemistry of food spoilage and preservations 7. Food additives, flavoring agents and colors 8. Food Adulteration and Food quality control standards monitoring agencies	**30 Hrs**

Suggested readings

1. Enzymes and food processing- GG Birch, N Blackbrough (1981)
2. Nutrition and food processing- MG Miller, G Tobin, AVI publishing Co, Creem Holm (1980)
3. Introduction to food sciences and technology –GF Stewart and MA Amerine 2nd edition (1973) Academic Press

Course outcomes

Students will get the ability to apply principles of food technology in industry, understand, identify and analyze the problem related to the food industry and ability to find an appropriate solution for the same. They will be able to design, implement and evaluate a research-based project to meet demands of the society. They will develop an ability to work in Food industries, research organizations and academia as well as to design or process food products as per the needs and specifications.

Course Code: **CHB-662 MJ**	Course Title: **Drug discovery and development** (T)	

Course objectives:

This course will explore the process of drug development process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening. Safety evaluation, bioavailability, clinical trials, and the essentials of patent law will also be discussed. Along the way students will learn about molecular recognition, compute raided drug design, and toxicology as applied to the development of new medicines.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	**Reqd. Hours**
1. Drug development: challenges in the development of drugs, discovery of drug candidates: serendipity, screening or design, analyses of genomes holds great promise for drug discovery, stages of drug development. 2. Drug transport: How antimicrobial agents and liposomes reach their targets, cellular permeability, barrier to drug penetration, some examples of modes of penetration of antimicrobial agents. 3. Molecular structure of drugs and biological activity: Relationship between chemical structure and biological activity, selectivity of drug action and drug receptors, Acid-Base properties of drugs, Ionization, solubility, stereochemistry and biological activity, Lipinski rules 4. Drug Design: Screening of natural products, screening of organic compounds, target dedicated screening, rational drug design based on therapeutic targets, via drug metabolism studies, Determination of the pharmacophore and refinement of the lead structure, clinical trials, FDA guidelines for drug discovery and development	**30 Hrs**

Suggested readings

1. Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1 st edition 2006.
2. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.
3. An introduction to medicinal chemistry. G. L. Patrick. 5 th Edition Oxford UK, Oxford University Press, 2013.
4. Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
5. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005.

Course outcomes

On completion of this course students should have gained a basic knowledge of physical and computational methods used in drug discovery and will be able to describe and discuss the process of drug discovery and development, the challenges usually faced in each step of the drug discovery

process. Also, they will be able to demonstrate their ability to work and communicate scientific

information effectively in the field of recognition of new molecular entities that may be of value in the treatment of diseases that qualify as presenting unmet medical needs.

CHB-663 MJ	Course Title: Proteomics and Genomics (T)	2

Course objectives:

An organism's genes direct the production of proteins with the assistance of enzymes and messenger molecules. Genomics aims at the collective characterization and quantification of genes. Proteomics complements genomics and is useful to test hypotheses based on genes. Even though all cells of a multicellular organism have the same set of genes, the set of proteins produced in different tissues is different and dependent on gene expression. Thus, the genome provides a blueprint, the final architecture depends on several factors that can change the progression of events that generate the proteome.

Course Credit: **2**	Total contact hours: **30 Hrs**

Course Contents (Topics & subtopics)	Reqd. Hours
1. Construction of genomic and cDNA library 2. Protein Engineering: In vitro mutagenesis, Oligonucleotide directed, PCR based, applications of protein engineering 3. DNA Microarray 4. Principle of Genome assembly and annotation 5. Transcriptome and proteome analysis 6. Sequencing genes and genomes: chain termination using dNTPs, pyrosequencing, shotgun and clone contig approaches, chromosome walking, and genetic maps.	**30 Hrs**

Suggested readings

1. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006.
2. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.
3. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
4. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.

Course outcomes

A key challenge in medicine and public health is the translation of scientific discoveries to health applications. Translating proteomics research findings is challenging in the face of complex and dynamic cellular-level processes. Integrating genomic and proteomic data may help reveal important relationships such as proteogenomic is providing new knowledge revolutionizing the field of medical diagnostics and could yield a powerful arsenal of therapies that offer the promise of cures instead of just amelioration of symptoms.

Course Code: **CHB-681 RP**	Course Title: **Research Project- II (P)**	**6 credits**
	Student is required to carry out project work on a suitable topic and submit a dissertation based upon it.	

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