

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

I Year - I Semester

Core Course -1: Cell Biology

Course Code: CC01/BM11C1

Credits: 5

Objectives:

- To explain the concept of Chemical Basis of Life
- To describe the internal and external structural organization of cell and its organelles
- To enlighten the functional role of the cellular organelles.

Unit I:

The Chemical Basis of Life; Cells as the basic unit of life - Unicellular and Multicellular Organisms; Plant cell and Animal cells. Different shapes and types of cells. General structural organization of prokaryotic & Eukaryotic cells. Extra cellular matrix and cell junctions. Differences between Prokaryotes and Eukaryotes;

Unit II:

Cytoplasm: Physical, chemical and biological properties. The cytoskeleton – Microtubules, Microfilaments and intermediate filaments, MTOC - Centrosomes – Morphology, ultra-structure and functions.

Unit III:

Endomembrane system - Plasma membrane: Structure, modifications, permeability and other functions – ER, Golgi complex – Morphology, ultra structure and functions. Lysosomes and Peroxisomes-Morphology, ultra structure and functions.

Unit IV:

Cell organelles – Mitochondria– Morphology, ultra structure and functions. Ribosomes – Ultra-structure, subunits – Role in protein synthesis. Chloroplasts – Basic overview

Unit V:

Nucleus – Ultra-structure and organization - Chromosomes: Morphology, structure, chemistry – Types: Giant chromosomes – polytene and lamp-brush chromosomes – Cell division – Mitosis, meiosis, cell cycle and dynamics of cell division.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Know about various patterns and stages of cleavage in animal cells (e.g. Frog's egg)

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Reference Text Books:

1. De Robertis - Cell Biology
2. Cell Biology – C.B. Powar
3. Cell & Molecular Biology – Sheeler P & Bianchi De
4. Biology of the Cell – Wolfe S L
5. Biology of the Cell – Bruce & Albert

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand the cell as a basic unit of life.
- Understand the chemical basis of life.
- Understand about different types of cells.
- Understand the components aiding in cell –cell communication.
- Understand the structural organization of genetic materials in prokaryotic/ eukaryotic
- Understand the detailed structural organization of prokaryotic and eukaryotic cells.
- Understand the ultrastructure of the intracellular organelles.
- Understand the functional role of the intracellular organelles.

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I Year - I Semester

Laboratory Course -1: Cell Biology

Course Code: LC01/BM11CP1

Credits: 3

Objectives:

- To view different types and shapes of cells in human.
- To study the functional property of plasma membrane.
- To study and observe different stages of mitotic cell division

Unit I:

Basics of Instruments- Parts and the working principle of the compound Microscope. Parts and the working principle of the Centrifuge

Unit II:

Experiments to observe prokaryotic and eukaryotic cells 1. Blood smear preparation and leishmann staining to observe different types of cells of blood tissue; 2. Observation of Prokaryotic cell by methylene blue staining; 3. Demonstration of Gram staining method of staining to differentiate the cell wall nature of bacteria and observing gram positive and gram negative bacteria.

Unit III:

Experiments to study the functional property of plasma membrane - Membrane Permeability of RBC. Experiments to observe the different stages of mitosis - Study of mitosis in onion root tip cells

Unit IV:

Cleavage pattern in animal cells- Observation of slides showing cleavage pattern in frog embryos -1. Frog two cell stage 2. Frog 4 cell stage 3. Frog Blastula. To observe different types of cells.

Unit V:

Identification of Cell organelles – study of structural and functional role of Cell organelles using models 1. Mitochondria 2. Golgi complex 3. Ribosomes 4. Fluid Mosaic Model – Plasma membrane 5. Microsomes.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Demo video to show the polytene chromosomes from salivary glands of Chironomous larva.
Demo video to show grasshopper testis squash preparations to view different stages of meiosis.

Reference Text Books:

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Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Perform simple staining to view prokaryotic cell.
- Prepare blood smear to observe different types of blood cells.
- Identify different types of blood cells in a blood smear.
- Operate and handle microscopes for viewing slides.
- Operate and handle centrifuges for separation of plasma or serum.
- Prepare smear of onion root tip to view different stages of mitotic cell division.
- Identify the cleavage pattern in frog embryo.
- Understand the structural details and functional role of cell organelles.

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I Year - II Semester

Core Course -2: Human Anatomy and Physiology

Course Code: CC02/ BM12C2

Credits: 5

Objectives:

- To provide knowledge on general anatomy of human body, including the basic anatomy and medical terminology
- To understand the function of major organ systems and its physiological relationship with each other.
- To introduce the recent trends in Human Anatomy & physiology

Unit I:

Commonly used descriptive terms in Anatomy – Body plans-A brief introduction to bones, joints and muscles of the body – A brief introduction to organ systems of the body – **Skeletal system:** Bones of the upper limb, Bones of the lower limb, the vertebral column, the sternum, ribs and joints, the skull- **Integumentary system:** Skin and its derivatives, functions of skin.

Unit II:

Nervous system: Structure of nerve cell, Brain, spinal cord and peripheral nerves, General function of neuronal cells - Motor system – Autonomic nervous system and its control. **Special sensory organs system:** Visual, Auditory, Vestibular, Chemical sensory system- **Muscular system:** Structure and type of muscles in human body- Molecular mechanism of muscle contraction- Neuromuscular transmission and excitation.

Unit III:

Circulatory system: Structure of heart and blood vessels, systematic circulation, pulmonary circulation, portal circulation, and coronary circulation- Composition of blood and its function- red blood cells and hemoglobin-Blood groups-Transfusion- Leukocytes, granulocytes, Monocyte, Lymphocytes- Hemostasis and blood coagulation- microcirculation-**Lymphatic system:** Lymph vessels, lymphoid organs,lymph circulation and functions of lymphatic system.

Unit IV:

Digestive system: Gastrointestinal tract and associated glands -Secretary functions of alimentary tract: Secretion of saliva, Mechanism of salivary glands regulation, Gastric secretion (Hcl, Pepsin, Mucus, Bicarbonates and Intrinsic factor), Pancreatic secretion, Secretion of bile, small and large intestine- Motility of the gastro intestinal tract -Gastro intestinal hormones-Digestion and absorption- **Respiratory system:** Trachea, lungs including other air passages, Mechanism of pulmonary and alveolar ventilation-Overall process of gas exchange in the lungs and tissues- Hypoxia, Pulmonary Edema, Asthma and COPD.

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Unit V:

Renal system: Structure of Kidney, Urinary bladder and urethra- Acid, Base Balance – mechanism of urine formation (glomerular filtration and tubular reabsorption)-**Reproductive system:** Structure of female reproductive gonads and tract. Structure of male reproductive and accessory organs, spermatogenesis, physiology of menstruation, fertilization & oogenesis - **Endocrine system:** General mechanism of hormone action – Hypothalamus and Pituitary gland ,Thyroid gland Parathyroid gland, pineal gland, Adrenal gland & thymus.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Artificial organ, Robotic Internal organs, Developments in 3D bioprinting for tissue and organ regeneration-Bionic physiology-Milestones discoveries in human Anatomy and Physiology.

Reference Text Books:

1. Anatomy and Physiology for Nurses, Jaypee Brothers Medical Publishers (P) Ltd.
2. Inderbir singh, Human Anatomy, Jaypee Brothers Medical Publishers (P) Ltd.
3. Gray, Henry (1918). Anatomy of the Human Body. Philadelphia: Lea & Febiger,
4. Hall. J.E. Guyton and Hall (2011)Textbook of Medical Physiology. 12th ed. Saunders, Elsevier Inc.,
5. Robert M. Berne and Matthew N. Levy Principles of Human Physiology (Third Edition)Mosby Publications
6. Cary A. Thibodeau and Kevin T. Patton Anthony's Text Book of Anatomy &Physiology (7th Edition), Mosby Publications

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Define descriptive terms in Anatomy &Physiology
- Differentiate the levels of organization in the human body and the characteristics of each.
- Identify various organs of different systems of human body
- Explain the major body cavities and its associated organ system
- Describe the functions of organ systems of the body
- Explain the interaction of organ system for the maintenance of homeostasis
- Apply the concepts learned in the theory to laboratory activities and observations
- Explain the Innovations and Breakthroughs in Human Anatomy &Physiology

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

I Year - II Semester

Laboratory Course-2: Human Anatomy & Physiology

Course Code: LC02/BM12CP2

Credits:3

Objectives:

- To substantiate and clarify the theoretical concepts of each human anatomy through models Identification, demonstration and spotter's identification.
- To perform physiological analysis blood and other body fluids.
- To observe and identify various spotter's pertaining to physiology.

1. Human Anatomy Models Identification and Demonstration

- i. Skeletal system
- ii. Digestive system
- iii. Reproductive system
- iv. Nervous system (Brain)
- v. Sensory system (Eye & Ear)
- vi. Circulatory system (Heart)
- vii. Renal system
- viii. Respiratory system

2. Blood Smear Preparation and Staining

3. Estimation of haemoglobin (Sahl's method).

4. Total RBC count

5. Total WBC count (TLC)

6. Differential leukocyte count (DLC)

7. Determination of bleeding time & clotting time

8. Determination of blood group and Rh factor

9. Recording of body temperature, pulse rate, BMI Calculation and blood pressure

10. Study of pregnancy diagnosis test & Contraceptive devices.

- Spotters:**
- 1) Recording ECG and its interpretation.
 - 2) Pacemaker
 - 3) Dialyser
 - 4) Sphygmomanometer

Reference Text Books:

1. S.R. Kale & R.R. Kale, Practical Human Anatomy and Physiology, Nirali Prakashan Publications.
2. S.K. Pandey, Varun Dutt Sharma (2014), Human Anatomy and Physiology: Practical Notebook For 1st Year Diploma in Pharmacy, CBS Publishers & Distributors Pvt. Ltd. (2014)
3. G.K. Pal & P. Pal. (2006). Textbook of Practical Physiology. 2nd Edn. Orient Blackswan.
4. <http://www.bartleby.com/107/>

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5. <http://academic.pgcc.edu/~aimholtz/AandP/Practicals.html>
6. <https://www.getbodysmart.com/a-p-resources>
7. <http://facstaff.cbu.edu/aross/APII/AP218home.htm>

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Identify and locate anatomical terms of human body parts.
- Understand the components of various organ systems.
- Examine blood group and Rh factor determination.
- Analyse pulse rate and blood pressure measurement.
- Demonstrate registration & Measure BMI calculation
- Measure complete blood count (CBC).
- Perform various haematological experiments like, blood smear preparation, haemoglobin estimation and bleeding/clotting time determination.
- Relate the biomedical instruments based on its physiological application.

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II Year - III Semester

Core Course -3: Biochemistry

Course Code: CC03/BM23C3

Credits: 5

Objectives:

- To provide knowledge on the properties of water, acids, bases, pH and biological buffers.
- To learn the concept of bioenergetics and mitochondrial respiratory chain reactions.
- To know the chemistry of macromolecules, functions, metabolic pathways and their control.

Unit I:

Structure and properties of water. Buffers-Acid Base in biological system. Henderson-Hasselbalch equation. Biological importance of Buffers. Bioenergetics-Laws of thermodynamics, standard free energy enthalpy, and entropy. Exergonic and endergonic reactions. Role, of high energy compounds. Electron transport chain (ETC)-Components and reactions of ETC. Oxidative phosphorylation, P/O ratio. Inhibitors of ETC and uncouplers of oxidative phosphorylation.

Unit II:

Carbohydrates: Classification, structure, properties and biological functions of homo polysaccharides and hetero polysaccharides. Structure and biological importance of glycosaminoglycan and proteoglycans. Carbohydrate metabolism-Glycolysis, Citric acid cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis and their regulatory mechanisms.

Unit III:

Amino acids and Protein: Structure, Classification and properties of amino acids. Fibrous and Globular proteins and their functions. Structure of proteins and peptide bond. Ramachandran plot. Levels of organization of proteins. Metabolism of amino acids-glucogenic and ketogenic amino acids. Transamination, deamination and decarboxylation reactions. Urea cycle and its regulation.

Unit IV:

Nucleic acids: Structure of purine and pyrimidine bases. Nucleosides and Nucleotides. Structure of DNA. Physical properties - Buoyant density, viscosity, hypochromicity, denaturation and renaturation. Cot curve and C-value paradox. RNA structure, types and functions. Purine metabolism-Biosynthesis (*de novo* and salvage pathway) and degradation of purine nucleotides. Pyrimidine metabolism-Biosynthesis and catabolism.

Unit V:

Lipids: Structure, classification, properties and biological functions of fatty acids. Role of lipoproteins in biological system. Biosynthesis of phospholipids, glycolipids, Steroids-types structure and functions. Triglycerides-Biosynthesis, degradation and functions. Biosynthesis and degradation of fatty acids (β -oxidation).

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Integration of metabolic pathways and metabolic profiles of major tissues. Metabolic disorders. Alterations in metabolic pathway and human diseases. Targeting metabolism for cancer therapy.

Reference Text Books:

1. Nelson, D. L., & Cox, M. M. (2013). Lehninger Principles of Biochemistry. 6th Edn. Publisher: W H Freeman & Co., USA.
2. Murray, R. K., Bender, D. A., Botham, K.M., Kennelly, P. J., Rodwell, V. W., Weil, P. A. (2009). Harper's Illustrated Biochemistry, 28th Edn. Publisher: The McGraw-Hill Companies, Inc. USA.
3. Voet, D., & Voet, J. G. (2011). Biochemistry. 4th Edn. Publisher: John Wiley & Sons (Asia) Pvt. Ltd.
4. Stryer, L. (2014). Biochemistry. 4th Edn. Publisher: W H Freeman & Co., USA.
5. Satyanarayana, U., & Chakrapani, U. (2013). Biochemistry. 4th Edn. [eBook edition], Publisher: Elsevier and Books and Allied (P) Ltd., India.
6. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2016). Textbook of Biochemistry for Medical Students. 8th Edn. Publisher: Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India.
7. Bhagavan, N. V. (2002). Medical Biochemistry. 4th Edn. Publisher: Harcourt/Academic Press, USA.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the structure and importance of water and physiological buffer systems.
- Describe principle of bioenergetics, exergonic and endergonic reactions.
- Elucidate the mechanism of electron transport chain and ATP generation in living cells.
- Illustrate the chemistry, properties and biological functions of macromolecules including carbohydrates, proteins, nucleic acids and lipids.
- Describe the biosynthesis (anabolism) of glucose, glycogen, amino acids and nucleic acids and lipids.
- Explain the pathways of glucose oxidation, degradation of amino acids and urea cycle and its regulation.
- Know about the catabolism of purine and pyrimidine bases, fatty acids, phospholipids and triglycerides.
- Integrate the metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.

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Laboratory Course: Biochemistry

Course Code: LC03/BM23CP3

Credits: 3

Objectives:

- To impart thorough knowledge on different solutions and reagent preparation for chemical measurements.
 - To perform the qualitative test of carbohydrates and amino acids.
 - To quantify the amount of reducing sugars, amino acids and proteins in the sample.
1. Different concentration of solutions - Normality (N), Molarity (M) and Percentage (%) solutions.
 2. Calculation and preparation of various Normal, Molar and Percentage solutions and making dilutions.
 3. Preparation of Stock solutions and working standards for quantitative estimation.
 4. Preparation of buffer solutions.
 5. Training to use weighing balance and pH meter.
 6. Qualitative Analysis of Carbohydrates: Analysis of Glucose, Fructose, Ribose, Galactose, Lactose, Maltose, Sucrose and Starch. Identification of both monosaccharides and disaccharides in mixtures.
 7. Qualitative Analysis of Amino acids: Analysis of Tyrosine, Tryptophan, Arginine, Cysteine, methionine and Histidine.
 8. Quantitative Analysis:
 - a) Estimation of amino acid by Ninhydrin method.
 - b) Determination of reducing sugar (Total Carbohydrate) by Anthrone method
 - c) Determination of protein by Lowry's method.

Reference Text Books

1. Jayaraman, J. (2011). Laboratory Manual in Biochemistry. 2nd Edn. Publisher: New Age International Publishers, Bangalore.
2. Plummer, D. T. (2004). An Introduction to Practical Biochemistry. 3rd Edn. Publisher: TataMcGraw-Hill Education Pvt. Ltd., New Delhi.
3. Anil Kumar, Sarika, G., & Neha, G. (2012). Biochemical Tests: Principles and Protocol. Publisher: Viva Books Pvt. Ltd.
4. Sadasivam, S., & Manickam, A. (2006). Biochemical Methods. Publisher: New Age International Publishers.
5. Sawhney, S. K., & Randhir Singh. (1996). Introductory Practical Biochemistry. Publisher:

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Narosa Publishing House Pvt. Ltd., India.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Prepare all types of laboratory solutions for biochemical studies.
- Skilled in weighing of chemical using analytical balance and preparation of buffers of various pH.
- Analyse and identify qualitatively the presence of sugars and amino acids in any biological sample.
- Perform biochemical assays pertaining to the quantification of major biomolecules such as carbohydrates, total protein and amino acids.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

II Year - III Semester

Non Major Elective Course : HUMAN PATHOLOGY

Course Code: NMEC01/BM23NM1

Credits: 2

Objectives:

- To gain complete knowledge about the various types of diseases in the systems of the human body
- It includes the diagnostic methods, treatments and prevention of diseases
- Describes the histological slide preparation about the healthy tissues and also the diseased tissues of experimental animals.

Unit I: Cellular responses to injury, Acute inflammation, Healing and Repair, Chronic inflammation, infections of histological importance, Amyloidosis, disorders of growth, Neoplasia, Atherosclerosis, Thrombosis, Embolism and Infarction.

Unit II: Cardiovascular system, Respiratory system, Alimentary system, Hepatobiliary system and Pancreas, Urinary system, lymphoid and Haemopoietic system.

Unit III: Female reproductive system, breast, male reproductive system, Endocrine system, Skin, Skeletal system and Nervous system

Unit IV: Microtome, Fixation of tissues, Dehydration, Clearing, Embedding and sectioning

Unit V : Routine staining of section and stained sections- Decalcification and staining of bone, staining of organisms, parasites and fungi in sections, histological methods for nervous system, Cryo sections in histopathological analysis.

References

1. Alans Stevens, James S. Lowe and Barbara Young (2002). Wheater's Basic Histopathology, 4th Edition, Churchill Livingstone pub.
2. Charles F. A. Culling, T. A. Hyde, Martin J. Inwood, Leslie D. Mellor, F. Sergovich, Frank Spencer, Sam Thomson (1976). Lynch's Medical Laboratory Technology, 3rd Edition, W.B. Saunders Company (Section 3 only)

Course outcomes:

A basic foundation in pathology

1. Can able to describe the pathology
2. Describe the techniques used in pathology
3. List and describe the characteristics of the branches of pathology.
4. Define infectious and non-infectious diseases.
5. Identify and define medical terminology used in pathology

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6. Identify and define disease mechanism of day-today life
7. Identify and define selected diagnostic procedures.
8. Identify and define selected therapeutic procedures.
9. Identify and define selected medications relating to the certain diseases.

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II Year - IV Semester

Core Course 4- PRINCIPLES OF GENETICS

Course Code: CC04/BM24C4

Credits: 5

Objectives:

- To gain knowledge on the laws and patterns of genetic inheritance.
- Understanding the methods involved in genetic analysis.
- To gain insights on genetic abnormalities and their impact on diseases.

UNIT I:

Introduction to Genetics, Mendel and the laws of inheritance, Cellular and Molecular Basis of Inheritance - Chromosome structure, Mutations and Mutagenesis. Chromosomes – Human chromosome, chromosome nomenclature, chromosomal abnormalities.

UNIT II:

Patterns of inheritance – family studies, Population genetics – Allele frequencies, gene polymorphism, segregation analysis, genetic linkage. Polygenic and multifactorial inheritance – heritability and multifactorial disorders. Gene mapping and identification of human disease genes.

UNIT III:

Clinical Genetics – Congenital abnormalities and dysmorphic syndromes, Genetic counseling, Chromosomal breakage syndromes. Single gene disorders – Huntington disease, neurofibromatosis, cystic fibrosis, cardiomyopathies, Duchenne muscular dystrophy and Hemophilia, Genetic instability.

UNIT IV:

Screening of diseases – carrier testing, population screening and genetic registers. Probability theory, Autosomal dominant/recessive inheritance, Bayes' theorem and empiric risks.

UNIT V:

Genetherapy-Ex-vivo and in vivo gene therapy, Gene delivery systems (i) viral and (ii) non viral. Ethical issues in medical genetics.

UNIT VI:

Cytogenetic testing, Chromosomal Translocations, Genetic analysis using family histories.

Reference:

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1. Human Molecular Genetics, 3rd Edition, Tom Strachan, Andrew P. Read.
2. Emery's Elements of Medical Genetics 12th edition, Peter Turnpeeny Sian Ellard, Elsevier publications.
3. Human Molecular Genetics, Jack J Pasternak 2nd Edition, John Wiley and sons.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the importance of Genetics.
- Describe the principles of inheritance.
- Illustrate the genetic abnormalities associated with diseases
- Describe various methods of evaluating genetic diseases.
- Know the therapeutic strategies for genetic disease
- Elucidate the mechanism underlying mutations
- Methods involving estimation of genetic patterns
- Understanding various genetic diseases.

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II Year - IV Semester

Allied Course -2: Microbiology

Course Code: AIICC02/BM24AC4

Credits: 5

Objectives:

To learn about the history, basic concepts and recent developments in microbiology.
To know about the principles of microscopy and advancement in microscopy.
To learn the structural organization, microbial genetics, bacterial growth, nutritional requirements of bacteria.

Unit I:

History, scope and its recent developments in Microbiology – Spontaneous generation – Biogenesis – Contribution of Leeuwenhoek – Louis Pasteur – John Tyndall – Joseph Lister – Robert Koch. Microscopy – light microscopy – simple & compound, dark-field, phase contrast, fluorescence and electron microscopy. Binomial nomenclature of microbes.

Unit II:

Sterilization principle – dry heat, moist heat, filtration, pasteurization, radiation. Disinfection- Antimicrobial chemotherapy, antibiotics, sources, mode of action, test for sensitivity to antimicrobial agents and its quality control.

Unit III:

Bacterial anatomy – cell wall, capsule, flagella, pili, sporulation – structure and function. Culture techniques- types of media, preparation of media. Enumeration of bacteria by Plate and MPN method. Preservation of culture. Microbial identification – pure culture, morphological, physiological and biochemical properties.

Unit IV:

Nutritional requirements of bacteria, autotrophs, heterotrophs. Bacterial growth curve. The influence of environmental factors on microbial growth – water activity, pH, temperature, O₂ concentration, pressure, radiation. Potable water treatment; Sewage (waste water) treatment – Primary, secondary and tertiary treatment.

Unit V:

Microbial genetics – Plasmids - conjugation, transformation and transduction. Applied microbiology – Recombinant vaccines, Biofertilizers (Rhizobium, BGA, Mycorrhizae), Biopesticides, Vitamins, Hormones (Insulin, Thyroxine, Human growth hormone).

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Understanding market research before launching of any consumer products, understanding success stories of clinical trials before launching of Biofertilizers and Antibiotics in market.

Reference Text Books:

1. Pelczar, A Jr M.J. Chan and Kreig, N.R. (2021). Microbiology, Mc Graw Hill, Inc, New York.
2. Ananthanarayan R. and C.K. Jeyaram Panikar. (1994). Text book of Microbiology. Orient Longman
3. R.C. Dubey and D.K. Maheswari. S. A text book of Microbiology .Chand & Co. Ltd., New Delhi (1st edition)
4. Frazier, W.C. and Westhoff, D.C. (1988). Food Microbiology. 4th edition. McGraw Hill, NY.
5. Atlas, R. and Bartha R. (1992). Microbial Ecology: Fundamental and Applications. 2nd edition. Englewood. C.A. Benjamin/cummings.
6. Subbha Rao, N.S. (1995). Biofertilizers in Agriculture and Forestry. 3rd Ed. Oxford & IBH Pub. Co, Press.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Gain knowledge of historical perspective in microbiology.
- Understand the principle of different types of microscope.
- Differentiate various sterilization methods.
- Comprehend antibiotics, sources and mode of action.
- Understand the nutritional requirements of bacteria and include environmental factors involved in microbial growth.
- Apply different water treatment methods.
- Work on microbial genetics.
- Add knowledge on metagenomics.

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II Year - IV Semester

Allied Laboratory Course – 2: Microbiology

Course Code: AILC01/BM24AP1

Credits: 3

Objectives:

- To know about the basic information on enumeration of bacteria from environment and clinical samples.
 - To learn about the culture techniques for maintenance of pure culture
 - To identify the bacteria up to genus level by using biochemical characterization
1. Preparation and cleaning of glass wares
 2. Collection and processing of samples for bacteriological analysis
 3. Preparation and sterilization of bacteriological media.
 4. Enumeration of bacteria by
 - a) Pour plate method
 - b) Spread plate method
 5. Pure culture technique
 - a) Phase streaking
 - b) Continuous streaking
 6. Estimation of total *coliform* bacteria by MPN technique
 - a) Presumptive test
 - b) Confirmed test
 - c) Completed test
 7. Smear preparation
 8. Simple staining
 9. Gram staining or differential staining
 10. Negative staining
 11. Detection of Catalase and Oxidase enzymes

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12. Citrate Utilization test
13. Oxidation and fermentation test
14. Antibiotic sensitivity test – Disc diffusion test
15. Motility test- Hanging drop technique

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- The collection and processing of the sample before the isolation of the microbes.
- The conditions required for the maintenance of pure cultures.
- Various staining methods to screen the organisms.
- Accomplishing the growth curve for the bacteria.
- Biochemical and physiological studies to be followed to characterize the microbe.
- Antibiotic sensitivity assay.

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II Year - III Semester

Non-Major Elective Course -2: Applied Microbiology

Course Code: NMEC02/BM24NM2

Credits: 2

Objectives:

- To learn about the history, basic concepts and recent developments in microbiology.
- To know about the principles of microscopy and advancement in microscopy.
- To study the structural organization, microbial genetics, bacterial growth and nutritional requirements of bacteria.
- To gain information about the physiological and biochemical properties.
- To know about the antibiotics and its mode of action.

Unit I:

History, scope and its recent developments in Microbiology – Spontaneous generation – Biogenesis – Contribution of Leeuwenhoek – Louis Pasteur – John Tyndall – Joseph Lister – Robert Koch. Microscopy – light microscopy – simple & compound, dark-field, phase contrast, fluorescence and electron microscopy. Binomial nomenclature of microbes.

Unit II:

Sterilization principle – dry heat, moist heat, filtration, pasteurization, radiation. Disinfection- Antimicrobial chemotherapy, antibiotics, sources, mode of action, test for sensitivity to antimicrobial agents.

Unit III:

Culture techniques- types of media, preparation of media. Enumeration of bacteria by Plate and MPN method. Preservation of culture. Microbial identification – pure culture, morphological, physiological and biochemical properties.

Unit IV:

Hepatitis, Pox, Oncogenic and Human Immuno Deficiency (HIV) viruses. Viral vaccines –their preparation and Immunization schedules.

Unit V:

Recombinant vaccines, Biofertilizers (Rhizobium, BGA, Mycorrhizae), Biopesticides, Vitamins, Hormones (Insulin, Human growth hormone).

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Understanding market research before launching of any consumer products, understanding success stories of clinical trials before launching of Biofertilizers and Antibiotics in market.

Reference Text Books:

1. Ananthanarayan R. and C.K. Jeyaram Panikar. (1994). Text book of Microbiology. OrientLongman
2. R.C.Dubey and D.K. Maheswari. S. A text book of Microbiology.Chand & Co. Ltd., NewDelhi (1st edition)
3. Atlas ,R. and Bartha R. (2017). Microbial Ecology: Fundamental and Applications. 2nd edition.Englewood. C.A.Benjamin/cummings.
4. Subbha Rao, N.S. (1995). Biofertilizers in Agriculture and Forestry. 3rd Ed. Oxford & IBHPub.Co, Press.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understanding the basic knowledge on medically important microbes.
- Acquire the information on culture collection, transportation and quality control.
- Understand the principle of different types of microscope.
- Differentiate various sterilization methods.
- This study reveals the information about the microbial diseases.

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III Year - V Semester

Core Course -5: Molecular Biology

Course Code: CC05/ BM35C5

Credits:5

Objectives:

- This course gives an overview of molecular biology and its core principles in central dogma of life.
- It covers the basic properties of Nucleic acids, DNA replication, repair & recombination
- It imparts the detailed mechanism of transcription and translation mechanism for Prokaryotes and eukaryotes.

Unit I:

Structure and Properties of Nucleic acids : Nucleic acid as the genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment)- Components of DNA and RNA -Watson and Crick model of DNA structure, Various forms of DNA- Physical properties of nucleic acids; Denaturation and renaturation, Cot curves – Structure and function of mRNA, rRNA, tRNA- Chromatin structure-Euchromatin, Heterochromatin-Central Dogma of Molecular Biology.

UNIT II:

Replication: Principle and mechanism of replication- Conservative, Semi conservative, Uni-directional and bi-directional mode of replication- Enzymes and accessory proteins involved in replication- Prokaryotic and Eukaryotic DNA replication. DNA damage & repair (Direct repair systems, mismatch repair system, base excision repair and recombination repair)

UNIT III:

Transcription: Concept of transcription, RNA polymerases, transcriptional factors, regulatory elements, Mechanism of transcription in Prokaryotes and eukaryotes, Distinction between prokaryotic and eukaryotic transcription. Concept and mechanism of post transcriptional modification- 5' capping, polyadenylation, splicing of nuclear pre-mRNA, nuclear export of mRNA- mRNA stability

UNIT IV:

Genetic code: Characteristics, Wobble hypothesis- **Translation** (*prokaryotes and Eukaryotes*): Ribosome structure and assembly, Activation of amino acid, Aminoacyl tRNA synthetases, Mechanism of protein synthesis (Initiation, Elongation and Termination), Post translational processing of proteins.

UNIT V:

Regulation of gene expression (*Prokaryotes & Eukaryotes*): Principles of transcriptional regulation, *cis* acting elements and *trans* acting factors- Operon model (inducible systems like *lac*-operon, *arabinose* operon and repressible systems like *trp* operon), Riboswitch - Role of chromatin in regulating gene expression and gene silencing-Enhancers, Repressors, Insulators, Gene amplification & rearrangements, Transposons, RNA processing and editing.

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UNIT VI: Current Contours: (Not for Final Exam only for Discussion)

Key discoveries in molecular biology- Genome sequencing tools-Gene expression and analyzing methods-Synthetic genome -Future of molecular biology in medicine

Reference Text Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. Garland publishing Inc,
2. Lehninger's Principles of Biochemistry, Publisher: W. H. Freeman; ISBN: 071677108X
3. Darnell, Lodish and Baltimore. Molecular Cell Biology, Scientific American Publishing Inc,
4. Genes VIII- by Benjamin Lewin, Oxford University Press, Nelson Cox.
5. T.A. Brown, Genome 4 , Garland Science publishers
6. E.D.P. De Robertis, E.M.F. De Robertis. Jr, Cell and Molecular Biology, Eight edition, Wolters Kluwer India.
7. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. The Benjamin / Cummings Pub. Co. Inc,
8. Ajoy Paul, Text book of Cell and molecular biology.
9. Rastogi, S.C., (2004), Cell Biology, 2nd Edition, New Age International Publishers, New Delhi.
10. <https://www.sanfoundry.com/molecular-biology-questions-answers-genome-organization-1/>
11. <https://www.khanacademy.org/science/biology>

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Clarify the central dogma of life in the cell
- Understand the nucleic acid structure and properties
- Demonstrate DNA is the Universal genetic material
- Describe the principles of DNA replication in prokaryotic and eukaryotic cells
- Explain the molecular mechanisms behind DNA damage and DNA-repair systems
- Analyse the steps involved in transcription in prokaryotes & eukaryotes
- Understand the genetic code and its characteristics.
- Describe the principles and controls of gene regulation in prokaryotes & eukaryotes.

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III YEAR - V SEMESTER

Core Course – 7: Pharmacology and Toxicology

Course Code: CC07/BM35C7

Credits: 5

Objectives:

- The subject is designed to strengthen the basic knowledge in the field of pharmacology.
- To impart recent advances in the drugs used for the treatment of various diseases.
- In addition, this subject helps the students to understand the concepts of drug action and mechanisms involved.

Unit I:

General Pharmacology: Introduction to Pharmacology, Sources of Drugs, Dosage forms, Routes of Drug administration, Pharmacokinetics (ADME), Pharmacodynamics- (Receptors-Classification of receptors), Combined effect of drugs, Factors modifying drug action,

Unit II:

Pharmacology of Central Nervous System: General anesthetics, sedatives, hypnotics, opioid Analgesics, Anti-Anxiety, Cognition enhancers. Pharmacology of drugs acting on ANS: Adrenergic and cholinergic drugs Pharmacology of Peripheral Nervous System: Local Anaesthetics, Skeletal Muscle Relaxants, Anti-inflammatory drugs.

Unit III:

Pharmacology of Gastrointestinal tract system: Antacids, anti-ulcer drugs, Laxatives and Anti-diarrhoeal drugs, Emetics and anti-emetics. Pharmacology of Urinary System: Diuretics and Anti-diuretics. Chemotherapy: General principles of chemotherapy, Antibiotics – Penicillins, Chloramphenicol, Chemotherapy of malignancy.

Unit IV:

Pharmacology of Cardiac Vascular System: Cardiac glycosides and drugs for heart failure, Anti-hypertensive drugs. Pharmacology of Respiratory system: Anti-asthmatic drugs including bronchodilators, Anti-tussives and expectorants. Pharmacology of Endocrine System: Insulin, oral hypoglycaemic agents & glucagon.

Unit V:

Toxicology: Principles of toxicology. Acute, sub acute and chronic toxicity, ICH Guidelines on Safety Studies, Reproductive Toxicology- Risk Assessment in Reproductive Toxicity, Mutagenicity- Mechanism of Mutaagenesis, Carcinogenicity, Toxicokinetics. Abnormal action of drugs such as tolerance, addiction, habituation, idiosyncrasy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylaxis, adverse drug reactions

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Chronopharmacology - Biological and circadian rhythms, applications of chronotherapy in various diseases like cardiovascular disease, diabetes, asthma and peptic ulcer. Free radicals Pharmacology- Generation of free radicals, role of free radicals in various diseases such as diabetes, neurodegenerative diseases and cancer. Protective activity of certain important antioxidant. Recent Advances in Treatment-Alzheimer's disease, Parkinson's disease, Cancer, Diabetes mellitus

Reference Text Books:

1. Tripathi, K.D., (2015). "Essentials of Medical Pharmacology", 7th Edition, Jaypee Brothers Medical Publishers (P) Ltd.
2. Satoskar, R.S., Bhandarkar, S.D. and Rege, N., (2015). "Pharmacology and Pharmacotherapeutics", 24th edition, Popular Prakashan (P) Ltd.
3. H. L. Sharma, K. K. Sharma, (2017). Principles of Pharmacology, Paras Medical Publishers, 3rd Edition,
4. Regulatory Toxicology, Second Edition, Christopher P Changelis, Shayne Cox Gad, Joseph F Holson, Publisher: Informa Healthcare
5. Laurence L. Brunton, Bjorn C. Knollmann, Randa Hilal-Dandan, " Goodman and Gilman's.
6. "The Pharmacological Basis of Therapeutics", 13th edition, McGraw-Hill Education / Medical, 2017.
7. Humphrey P. Rang, Maureen M .Dale ,James M .Ritter , Rod J. Flower, Graeme Henderson, (2015). "Rang & Dale's Pharmacology", 8th edition, Churchill Livingstone.
8. Katzung, B.G., Trevor AJ (2015) Basic and Clinical Pharmacology, McGraw-Hill Education, 13th Edition.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Discuss the pharmacotherapy of certain diseases.
- Explain the mechanism of drug actions at cellular and molecular level
- To understand the pharmacological actions of different categories of drugs.
- Understand the adverse effects, contraindications and clinical uses of drugs used in treatment of diseases
- Apply the basic pharmacological knowledge in the prevention and treatment of diseases.
- Appreciate correlation of pharmacology with other bio medical sciences
- To understand what drugs do to the living organisms and how their effects can be applied to therapeutics?
- To understand the concepts of drug action and mechanism involved.

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III Year - V Semester

Laboratory Course - 4: Molecular Biology

Course Code: LC04/BM35CP4

Credits:3

Objectives:

- To impart knowledge of basic techniques such as genomic DNA and plasmid DNA isolation
- To gain hands on experience in gel-electrophoresis techniques.
- To develop & train students with the knowledge of PCR& blotting techniques.

1. Extraction of plasmid DNA
2. Extraction of genomic DNA .
3. Quantification of DNA- UV-Visible spectrophotometer and analysis of purity
4. Agarose gel electrophoresis
5. Restriction enzyme digestion
6. Isolation of DNA fragment from agarose gel
7. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
8. Blotting Techniques (Southern, Northern & Western blot) (Demo)

Reference Text Books:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.
2. Sambrook, Joseph and David W. Russell “ The Condensed Protocols : From Molecular Cloning : A Laboratory Manual” Cold Spring Harbor , 2006.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Know the basic concept and principles of molecular biology techniques
- Gain hands on experience in extraction of genomic & plasmid DNA
- Learn the basic methods of DNA quantification and purification
- Gain the practical knowledge of agarose gel electrophoresis
- Perform the experimental procedure of PCR technique
- Provide the students with skills of molecular reagents & solution preparations
- Demonstrate practical skills in different molecular biology laboratory equipment's and their handling
- Enable them to begin a career in academic research or R& D in Biotechnological& Pharmaceutical Industries

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III Year - V Semester

Skill Based Elective Course-1: Biotechniques

Course Code: SEC01/BM35S1BT

Credits: 5

Objectives:

- To study the fundamental principles of various biochemical techniques and methods applied in biological research.
- To understand different approaches employed in the characterization of biomolecules.
- To develop various strategies to comprehend the complex biological processes.

Unit I:

General principles of biochemical investigations. *In vivo* and *In vitro* models. Cell disruption methods, homogenates and subcellular fractionation. Centrifugation techniques: Basic principle of sedimentation, RPM, RCF and Svedberg unit. Centrifuges and their uses. Rotors and its types. Preparative and analytical centrifugation: Methods and applications of differential and density gradient centrifugation (rate zonal and isopycnic). Analytical ultracentrifugation: Technique and applications.

Unit II:

Microscopy: Basic principle, instrumentation and applications of Light microscopy, Fluorescence microscopy, Phase contrast microscopy and Electron microscopy (TEM and SEM). Spectroscopic techniques: Principle of Colorimeter, Beer-Lambert's Law, instrumentation and applications of UV-Visible Spectrophotometry and Fluorescence Spectrophotometry.

Unit III:

Electrophoresis: General principle, methods and applications. Factors affecting electrophoresis. Types of electrophoresis: Paper and Gel electrophoresis: Equipments and applications. Components of an electrophoresis unit, technique, staining and destaining procedure. Gel matrices: Agarose gel, Polyacrylamide gel electrophoresis (PAGE). Native gel and SDS-PAGE. 2D-Gel electrophoresis, Isoelectric focusing.

Unit IV:

Chromatography: Principle and basic techniques of chromatography. Partition or distribution coefficient. Modes of chromatography: Column and Thin Layer (planar) chromatography Principle, performance and application of Paper, Partition, Adsorption, Ion-exchange, Molecular exclusion (Gel filtration) and Affinity chromatography. Gas-liquid chromatography, High performance liquid chromatography (HPLC) and Fast protein liquid chromatography (FPLC): Separation conditions, detectors and applications.

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Unit V:

Radio-isotopic (Tracer) Methods: Isotopes and radio-isotopes, properties of radioisotopes, half-life ($T_{1/2}$). Units of radioactivity. Principle of tracer techniques. Applications of radioisotopes in biological research and clinical diagnosis (^3H , ^{14}C , ^{32}P , ^{131}I , ^{35}S). Carbon dating. Detection and measurement of radioactivity. Autoradiography, principle and applications of Liquid Scintillation counter and Geiger-Muller (GM) counter.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Cell fractionation techniques, Methods for purification of proteins, Techniques pertaining to the identification of three-dimensional structure of proteins, X-Ray Crystallography.

Reference Text Books:

6. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th Edn. Publisher: Cambridge University Press, New Delhi, India.
7. David, S. (2009). Physical Biochemistry: Principles and Applications, 2nd Edn. Publisher: John Wiley & Sons Ltd. UK.
8. Upadhyay, A., Upadhyay, K., & Nath, A. (2014). Biophysical chemistry: Principles and Techniques, 4th Edn. Publisher: Himalaya Publishing House, India.
9. Arumugan, N., & Kumaresan, V. Biotechniques.
10. Ghosal, S., & Srivastava, A. K. (2009). Fundamentals of Bio Analytical Techniques and Instrumentation. Publisher: PHI Learning Pvt. Ltd. India.
11. Shourie, A., & Chapadgaonkar, S. S. (2015). Bioanalytical Techniques. Publisher: The energy and Resources Institute, TERI Press, India.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Display the phenomena of sedimentation as applied in analytical centrifugation.
- Comprehend the principles behind common analytical techniques.
- Show the proficiency in the analyses of biomolecules as applied in the techniques of electrophoresis.
- Describe the advantages and disadvantages of particular instrumentation systems.
- Integrate various biophysical and biochemical techniques to discourse biological measurements.
- Present the precise scientific principles related to bioassays.
- Separate and identify the biomolecules from various biological sources.
- Evaluate and apply the procedure with additional practical experience.

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III Year - VI Semester

Core Course -9: Clinical Microbiology

Course Code: CC09/BM36C9

Credits: 5

Objectives:

- To acquire depth knowledge in medically important bacteria.
- To gain information about the bacterial infection occurs in digestive, reproductive, urinary system.
- To get information about the fungi and their toxins.

Unit I: General

General properties of medically important bacteria. Recommendation for collection, transport of specimens, Isolation of bacteria from clinical specimens- Primary media for isolation and their quality control – Antibiotic sensitivity disc, testing procedure and their quality control.

Unit II: Bacteriology

- a) Digestive system – *Escherichia coli*, *Salmonella*, *Shigella* and *Vibrio*.
- b) Urinary system – *Leptospira sp.*, and *proteus*
- c) Respiratory system – *Mycobacterium tuberculosis*

Unit III: Bacteriology

- a) Reproductive system – *Neisseria* and *Treponema*
- b) Nervous system – *Clostridium tetani*

Unit IV: Virology

General properties of viruses – Detection of viruses and antigens in clinical specimens – Serological diagnosis of virus infections. Hepatitis, Pox, Oncogenic and Human Immuno Deficiency (HIV) viruses. Viral vaccines – their preparation and Immunization schedules.

Unit V: Mycology and Parasitology

Introduction to Medical Mycology – morphology of fungi. Detection and recovery of fungi from clinical specimens. Yeast of medical importance – *Candida* and *Cryptococcus*.

Introduction to Medical Parasitology – Protozoan – *Entamoeba* – *Plasmodium*, *Trypanosoma*. Laboratory techniques in parasitology- Examination of faeces for ova and cysts – Concentration methods.

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Understanding market research before launching of any consumer products, understanding Preventive measures of Diseases and development of drugs production in market.

Reference Books:

1. Prescott, L.M., J.P. Harley and D.A.Klein.(1993). Microbiology.2nd edition. W.M.C Brown publishers.
2. David Greenwood, Richard B Slack and John F. (2019). Medical Microbiology – Peutherer.Chirchill Livingstone (London) 16th edition.
3. Jawetz., E. J.L. Melnic and E.A. Adelberg (2000). Review of Medical Microbiology. 19th edition. Lange medical publications.U.S.A.
4. Ananthanarayan R. and C.K. Jeyaram Panikar.(1994). Text book of Microbiology. Orient Longman.
5. R.C.Dubey and D.K. Maheswari. S. A text book of Microbiology .Chand & Co. Ltd., New Delhi (1st edition).
6. Timbury M.C.(1986). Medical Virology, 9th edn., Churchill Livingston London.
7. Jagadish Chandar (1996). A Text book of Medical Mycology. Interprint. New Delhi.
8. Subhash Chandra Parijia. Text book of Medical parasitology (Protozoology & Helminthology) 2nd edition (2005).Medical books publishers, Chennai. New Delhi.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understanding the basic knowledge on medically important microbes.
- Acquire the information on culture collection, transportation and quality control.
- Get a clear idea on Enterobacteriaceae family and its pathogenicity.
- This study helps in understanding the pathogenicity of the microbes in nervous system.
- This study reveals the information about the microbial diseases.
- Acquire information on mycology, mycotoxins and medically important yeasts.
- Get information on Parasites and its pathogenicity.
- Better understanding of laboratory techniques used in parasitology.

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III Year - VI Semester

Core Course -10: Human Pathology

Course Code: CC10/BM36C10

Credits: 5

Objectives:

- To provide a comprehensive knowledge on system pathology emphasizing on cellular changes under various disease conditions.
- To study the diagnostic molecular pathology techniques and its clinical applications.
- To describe the various staining practices with significance in pathology.

Unit I:

General Pathology: Etiology and Pathogenesis of cell injury, Mechanism of cell injury and morphological changes during cell injury, Cellular adaptations, Intracellular accumulations, Extracellular deposits (Amyloidosis), Circulatory disturbances of blood: Thrombosis, embolism, ischaemia and infarction (Definition and effects only). Inflammation: Definition, types (Acute and Chronic) and general features, Healing and Repair (Wound healing). Disorders of growth, Neoplasia: Definition, classification and microscopic features. Grading and staging of cancer.

Unit II:

Systemic Pathology I (Pathological process and Histological features only): Haematopoietic system (Anemia), Lymphoid system (Leukemia), Cardiovascular system (Myocardial infarction), Respiratory system (Pulmonary tuberculosis), Alimentary tract (Gastritis), Hepatobiliary system (Hepatitis & Cirrhosis), Pancreas (Pancreatitis) and Urinary system (Glomerulonephritis).

Unit III:

Systemic Pathology II (Pathological process and Histological features only): Male and Female reproductive system (Endometrial hyperplasia, Carcinoma of prostate), Endocrine system (Pituitary adenoma, Hashimoto's thyroiditis), Skin (Dermatitis), Skeletal system (Osteomyelitis) and Nervous system (Meningitis & Glioma).

Unit IV:

Histopathology techniques and Routine staining: Pathologic examination of tissues–Paraffin-embedded sections. Tissue resection, Fixation and Fixatives, Dehydration, Embedding and Sectioning (Microtome), Mounting, Clearing and Staining. Cryo sections in histopathological examination. Routine staining methods - Hematoxylin and Eosin (H & E) staining, Gram's staining and Romanowsky staining (Hematology). Dyes and its classification, Mordant, Types of staining methods [Vital, routine (H & E) and special staining], Regressive & Progressive methods.

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Unit V:

Special Stains (Histochemistry): Decalcification and staining of bone. Staining of organisms: Simple staining and differential staining (Gram staining, Giemsa and Acid fast staining), identification of Fungi (Lactophenil cotton blue staining). Special stains (Stains for the detection of connective tissue, collagen, carbohydrates & minerals - Periodic Acid Schiff, Silver stain, Trichrome staining).

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Molecular pathology of cancer, microscopic examination of tissue biopsy samples and diagnosis of tumors. The challenges in pathological screening and the essential training in pathology. Digital imaging systems and advancement in technology in the clinical laboratory lines.

Reference Text Books:

1. Vinay Kumar, Abbas, A. K., & Aster, J. C. (2017). Robbins Basic Pathology. 10th Edn. Publisher: Elsevier Publications, Canada.
2. Harsh Mohan. (2015). Textbook of Pathology. 7th Edn. Publisher: Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India.
3. Young, B., Stewart, W., & O'Dowd. G. (2009). Wheater's Basic Pathology: A Text, Atlas and Review of Histopathology. 5th Edn. Publisher: Elsevier Health Sciences, Churchill Livingstone Publications, UK .
4. Travis, G., Brown, W. L., Kemp, Dennis, K., & Burns. (2008). Pathology: The Big Picture. 1st Edn. Publisher: McGraw-Hill Companies.
5. Stevens, A., James, S., Lowe, & Barbara, Y. (2002). Wheater's Basic Histopathology. 4th Edn. Publisher: Elsevier Health Sciences, Churchill Livingstone Publications, UK.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand the etiology and pathogenesis of wide human diseases.
- Explain the molecular basis of disease and describe pathological changes effectively.
- Gain knowledge on basic tissue processing methods for molecular diagnosis.
- Examine the organisation of tissues, cells and molecules by histological studies.
- Analyse the morphological properties of abnormalities in tissues and cells.
- Explain the properties of common histological stain (**Haematoxylin and eosin**) and its **significance** in the diagnoses of various pathologies.
- Describe the special stains that are used to identify particular structures and tissues.
- Support the diagnostic and research activities on the province of molecular onco-pathology.

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III Year -VI Semester

Skill Based Elective Course:2: Forensic Science

Course Code: SEC02/BM36S2FS

Credits: 5

Objectives:

- A student of biology would be highly enriched in getting an exposure to the field of forensic science with subject specific skills.
- Understand the importance of Physical/biological evidences encountered in crime scene investigation.
- To create awareness about various crime matters and advance techniques in crime detection.
- To generate talented human resource in the area of forensic problem solving

Unit I:

Forensic Science: Definition, History and Development- Identification: Age (From physical morphological features, Dentation, Estimation of age from bones), Determination of sex from bones-Forensic importance of hair-Forensic Science Laboratories - DFSS, SFSL, CFSLs,, NCRB & NICFS

Unit II:

Crime Scene examination: Documentation of crime scene - Recognition, Collection, Preservation of physical& trace evidences - Types of crime scene search- Crime Scene Photography- Superimposition- Lie detection (Polygraphy)- Track marks and Bite marks- Tachographs- Cyber Forensics

Unit III:

Finger prints: Classification, Preservation, Development, Lifting and Comparison, Automated Fingerprint Identification System (AFIS), Importance of finger prints-Lip prints (Cheiloscopy), iris and retina-**Examination of biological fluids:** Blood, Seminal and Saliva- Sexual offences and its medicolegal importance,Disputed Paternity & Maternity

Unit IV:

Cause and Mechanism of Death: Unnatural deaths, Thermal and electrical exposure, Asphyxial deaths, Infanticide,Criminal assaults, Poisoning, Vehicular accidents -**Changes after Death:** Immediate changes, Early changes, Late changes. **Autopsy:** Aims and objectives of conducting autopsy- Artefacts

Unit V:

Forensic Toxicology: Introduction, Narcotic drugs - Alcoholic beverages, Licit and illicit liquors, Classification of poisons: corrosive poisons: Sulphuric acid, HCL, Carboic acid, Oxalic acid -Metallic poisons: Lead, Arsenic, Mercury- Irritant poisons: Organic Irritants, Snake venom, Inorganic irritants (Phosphorus, Chlorine, Bromine), Mechanical irritants (powdered glass)-Food poisoning-Dope tests

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Unit VI: Current Contours: (Not for Final Exam only for Discussion):

Concept of brain death and its relevance.- Medico – legal aspects of: Potency and impotency, Legitimacy and Paternity , Virginitly, Pregnancy and Abortion- Battered Baby Syndrome- Sexual exploitation of girl children – age and criminal responsibility – Relevant sections or parts in Indian Penal Code- Drugs and psychotropic substances

Reference Text Books:

1. P. C. Dikshit., Text book of Forensic Medicine and Toxicology- PEEPEE Publishers
2. V.V. Pillay, Text book of Forensic Medicine and Toxicology- Paras medical Publishers
3. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's (2013) Techniques of Crime Scene Investigation, CRC Press, Boca Raton.
4. Lee and Gaenslen's, (2013) Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.),CRC Press, Boca Raton .
5. The Indian Penal code. 28th edition – Rattan lal and Dhirajlal
6. <https://nicfs.gov.in/nicfs/>
7. <https://ncrb.gov.in/en>

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand the History of Forensic science and its significant role in judicial system
- Understand some of the basic facts, concepts and principles relating to the physical and morphological identification
- Describe the principles and significance of crime scene protection and investigation.
- Demonstrate the procedure of superimposition
- Understand the role of crime scene reconstruction in crime investigation
- Understand the changes after death and its significant role in forensic science.
- Demonstrate an understanding of how forensic scientists operate and use scientific evidence in a legal context.
- Explain the classification of poison and its identification procedure in forensic toxicology.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

IV Year - VII Semester

Core Course -11: Clinical Biochemistry

Course Code: CC11/BM47C11

Credits: 5

Objectives:

- To provide knowledge on clinical samples, their collection procedure and diagnostic importance.
- To understand the process of blood cells formation and associated disorders such as anemia and leukemia and to know their diagnostic methods.
- To study various organ (Liver, Kidney etc.,) functional tests and their clinical implications in diagnosis and treatment of liver and kidney diseases.

Unit I:

Specimen collection and processing (Blood, Urine, Stool etc.). Anti-coagulants and urine preservatives. Composition of blood, cells (formed elements), plasma proteins, lipoproteins and their functions. Anemia-Definition, pathophysiology and types. Iron deficiency, Megaloblastic, Pernicious and Hemolytic anemia. Hemoglobinopathies: Thalassemia and Sickle cell anemia.

Unit II:

Liver Function Tests: Functions of liver. Test to assess the functions of the liver and its clinical importance. Routine laboratory tests (serum assays) for the diagnosis of various liver ailments. Metabolism of bilirubin, test for the detection of bile pigments – bilirubin, urobilinogen and bile acids in blood and urine. Jaundice - types, clinical features and differential diagnosis of jaundice. Hepatic cholestasis, cirrhosis, fatty liver and gallstones.

Unit III:

Renal Function Tests: Clearance tests-Inulin, Creatinine and Urea clearance test. Concentration and dilution tests. Phenol red (PSP) test. Urine analysis-Composition of urine, Chemical examination and tests for the detection of abnormal constituents.

Gastric Functional Tests: Gastric secretions and composition. Examination of duodenal contents. Fractional (FTM) gastric analysis and its importance. Hypo and hyper acidity. Steatorrhea.

Unit IV:

Clinical enzymology: Enzyme patterns in acute pancreatitis, liver diseases, bone disorders, myocardial infarction and muscle wasting. Clinically important enzymes: AST, ALT, LDH, creatine kinase, alkaline phosphatase and isoenzymes and their changes.

Endocrine Disorders: Hypo and hyper secretion of hormones. Laboratory tests to assess the function of pituitary, thyroid, adrenals and gonads.

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Unit V:

Metabolic disorders: Carbohydrate metabolism: Diabetes mellitus, types, clinical features, diabetic complications and its management. Diagnostic tests-Glucose tolerance test (GTT), Glycosylated hemoglobin (HbA_{1C}). Glycosuria, Fructosuria and Galactosemia. Glycogen storage diseases. Amino acid metabolism: Phenylketonuria, Tyrosinemia and Alkaptonuria. Nucleic acid metabolism: Lesch-Nyhan syndrome. Lipid metabolism: Tay-Sachs disease, Nieman-Pick disease and Fabry disease.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Recent comparative studies on the treatment of anemia. Iron metabolism. Case studies related to iron deficiency anemia. New diagnostic markers for liver diseases, kidney diseases, gastric and endocrine disorders. Pathophysiology of insulin resistance diabetes and associated factors.

Reference Text Books:

1. Devlin, T. M. (2011). Textbook of Biochemistry with Clinical Correlations. 7th Edn. Publisher: John Wiley & Sons, Inc. Hoboken, New Jersey.
2. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2014). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 5th Edn. Publisher: Saunders, Elsevier Inc. Philadelphia.
3. Marshall, W. J., Lapsley, M., Day, A. P., & Ayling, R. M. (2014). Clinical Biochemistry – Metabolic and Clinical Aspects. 3rd Edn. Publisher: Churchill Livingstone, Elsevier Ltd., UK.
4. Chatterjea, M. N., & Rana, S. (2013). Textbook of Medical Biochemistry. 8th Edn. Publisher: Jaypee Brothers Medical Publishers, New Delhi, India.
5. Godkar, P. B., & Godkur, D. P. (2014). Textbook of Medical Laboratory Technology – Clinical Laboratory Science and Molecular Diagnosis. 3rd Edn. Volume 1, Publisher: Bhalani Publishing House, Mumbai, India.
6. Sood, R. (2015). Concise Book of Medical Laboratory Technology - Methods and Interpretations. 2nd Edn. Publisher: Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand and study the changes in blood haemoglobin content related to anemia.
- Examine and observe the morphology of various blood cells and correlate clinically.
- Gain knowledge on routine biochemical assay followed in disease diagnosis.
- Comprehend the tests that are essential to study diseases chronicity.
- Execute enzymes assays focusing on heart, liver, bone and pancreatic diseases.
- Compare and correlate normal organ function with various clinical conditions.
- Know about the pathophysiology, laboratory tests and treatment methods of diabetes.
- Evaluate different disease markers and associate the changes with clinical relevance.

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IV Year - VII Semester

Core Course -12: Genomics

Course Code: CC12/BM47C12

Credits: 5

Objectives:

- This course explains Identification and isolation of disease genes and susceptibility
- Introduce various genomic tools for genomic analysis.
- Current approaches to diagnose, treat, and prevent diseases and disorders.

UNIT I:

Introduction to Genomics - Structure and organization of prokaryotic and eukaryotic genomes; Human genome organization; History and goals of genome project; Genetic variation polymorphism, deleterious mutation; Phylogenetics; Tools for genome analysis - PCR, RFLP, DNA fingerprinting, RAPD, Automated DNA sequencing.

UNIT II:

Applied Genomics - Genomics in personal identification – Mitochondrial DNA, Gender Identification. Evolutionary Genomics- Neanderthal genome, Ancient Population and migration. Metagenomics-Environmental sample screening.

UNIT III:

Identification and Isolation of disease genes - Candidate gene identification; Genetic polymorphism and disease susceptibility; Markers from candidate gene / pathways; Whole genome association of variation - Single nucleotide polymorphism, CNVs.

UNIT IV:

Genome Databases- data banks and genome browsers- DNA microarray technology; Human Microarray and Transcriptomics; Next-Generation Sequencing

UNIT V:

Pharmacogenomics and Personalized Medicine- Genetic variations on drug response; Testing for susceptibility to complex diseases; RNA and oligonucleotides therapeutics, Strategies and approaches in personalized medicine.

UNIT VI:

Numerical Problems in Pharmacogenomics and Case histories of personalized medicines .

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References:

1. Introduction to Genomics (2nd Edition) – Arthur M Lesk, Oxford University Press
2. Human Molecular Genetics (4th Edition)- Tom Strachan & Andrew Read, Garland Science
3. Genetics- Analysis of Genes and Genomes (7th Edition)- Daniel L Hartl & Elizabeth W Jones, Jones and Bartlett Publishers.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the importance of Genomics.
- Describe the methods for analyzing genome structures.
- Illustrate the genomics associated with diseases
- Describe various methods of evaluating genetic diseases.
- Know the therapeutic strategies for genetic disease
- Elucidate the mechanism underlying genomic changes
- Methods involving tailored medicine.
- Understanding various therapeutic methods.

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IV Year - VII Semester

Core Choices Course : Proteomics

Course Code: CO01/BM47C13 P

Credits: 5

Objectives:

- To acquaint the proteome and proteomics and to study cell disruption methods.
- To understand different methods of protein extraction and purification techniques.
- To provide knowledge on protein expressions, analyses, posttranslational modifications.

Unit I:

Introduction and scope of Proteome and Proteomics – Getting Started with Protein Purification – Making Cell Free Extract – Cellular Disruption, Extraction Buffer, Protease Inhibitors, Methods of Cell Disruption – Subcellular Markers – Fractional Centrifugation – Protein Quantitation – Bradford Method.

Unit II:

Manipulating proteins in solution – Stabilization and storage of proteins – Concentrating proteins from dilute solutions – Recovery of proteins by Ammonium sulfate Precipitation – Ultrafiltration – Lyophilization – Dialysis – Precipitating Agents – Ammonium sulfate, Acetone, PEG, TCA and Methanol-Chloroform precipitation.

Unit III:

Protein Separation techniques: Chromatography techniques – HPLC, FPLC, Ion exchange, Gel filtration and Affinity chromatography. Tags and Recombinant proteins – Overexpression and purification of recombinant proteins – GST, His-tag, MBP, IMPACT, TAP-tag, Green Fluorescent Protein (GFP) and their applications – Protein databases and its applications.

Unit IV:

Identification and Analyses of Proteomes: Strategies for protein identification, Electrophoretic techniques Two dimensional Polyacrylamide gel electrophoresis (2D-Gel) for proteome analysis – Identification of proteins on SDS gel - Mass Spectrometry based analyses of protein expressions – MALDI-MS, Protein sequencing, Protein microarrays, Protein chips and functional proteomics. Protein-protein interactions, Clinical and Biomedical applications of proteome analysis.

Unit V:

Protein modifications and proteomics: Chemical modification – Active site directed modification, specific modifications – Glycosylation (N-glycosylation, O-glycosylation & Proteoglycans) Phosphorylation (Phosphoproteins) - Disulfides, Lipid modifications and applications.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Screening and identification of biomarkers by plasma proteomics. Proteomic analyses in the diagnosis of diseases. Proteomic profiling of tissue proteins by mass spectrometry. Understanding cancer biology through proteomics. Forensic proteomics. Developing areas of proteomics and its impact on clinical research.

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Reference Text Books:

1. Rosenberg, I. M. Protein Analysis and Purification. 2nd Edn.
2. Conn, P. M. (2003). Hand book of Proteomic Method. Publisher: Humana Press, Totowa, New Jersey, USA.
3. Wilkins, M. R., Appel, R. D., Williams, K. L., & Hochstrasser, D. F. Proteome Research – Concepts, Technology and Application. 2nd Edn.
4. Simpson, R. J. (2003). Proteins and Proteomics. Publisher: IK International 2003.
5. Twyman, R. M. (2004). Principles of Proteomics, Publisher: BIOS Scientific Publishers.
6. Lundblad, R. L. The Evolution from Protein Chemistry to Proteomics. Publisher: Taylor and Francis.
7. Stryer, L. (2007). Biochemistry. Publisher: W. H. Freeman and Co., New York.
8. Pennington, S.R., & Dunn, M. J. (2001). Proteomics - from protein sequence to function. Publisher: BIOS Scientific Publishers Ltd., UK.
9. Liebler. (2002). Introduction to Proteomics. Publisher: Humana Press.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Define proteome and proteomics and its uses in various research fields.
- Explain the cell disruption techniques and methods of isolation of cellular proteins.
- Describe on extraction and separation of protein based on their solubility and size.
- Apply protein purification techniques in proteome research.
- Understand the expression of proteins, analysis and identification of proteome, and its applications.
- Know the principle, procedure and uses of 2D-Gel electrophoresis in proteome analysis.
- Understand the principle and applications of Mass spectrophotometry and protein microarrays.
- Comprehend the pattern of posttranslational modifications and its biological significance.

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IV Year - VII Semester

Core Choice Course -1: Cardiovascular Biology

Course Code: CO01/BM47C13C

Credits: 5

Objectives:

- Identify and describe the interior and exterior parts of the human heart.
- Describe the path of blood through the cardiac circuits.
- Describe the size, shape, and location of the heart.
- Compare cardiac muscle to skeletal and smooth muscle.
- Describe the process and purpose of an electrocardiogram
- Explain the cardiac cycle
- Calculate cardiac output
- Describe the effects of exercise on cardiac output and heart rate
- Name the centers of the brain that control heart rate and describe their function
- Identify other factors affecting heart rate

UNIT-1

Heart as a pump, function of heart valves

Anatomy of heart, Cardiac muscle, Morphology, Electrical properties, Mechanical Properties Contractile response, Isoforms, Correlation Between Muscle fiber length and tension Cardiac Hypertrophy, Metabolism, Pacemaker Tissue. Origin and spread of cardiac excitation, Properties of cardiac muscle, Pacemaker potentials. Spread of cardiac excitation,

UNIT-2

Origin of Heartbeat and the electrical activity of the heart ECG, Bipolar leads Unipolar leads, Normal ECG, Bipolar limb leads and the cardiac vector, Vector cardiograph, His bundle electrogram, Monitoring. Normal cardiac rate, Cardiac Arrhythmias, Abnormal pacemakers, Ectopic foci of excitation, Atrial arrhythmias, Consequence of atrial arrhythmias, Ventricular arrhythmias, Cardiopulmonary resuscitation, Accelerated AV conduction, Antiarrhythmic Drugs, variation of reentrant pathways, Electrocardiographic finding in other cardiac and systemic diseases, Effects of changes in the ionic composition of blood

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Unit-3

Heart as a pump:

Mechanical events of cardiac cycle, Event in late diastole, Atrial systole, Ventricular systole, Early diastole, pericardium, Length of systole and diastole, Arterial pulse, Atrial pressure change and the jugular pulse, Heart sounds, Murmurs, Cardiac output, Methods of measurement, Cardiac output in various conditions, Factors controlling cardiac output, Relation of tension to length of cardiac muscle, Factors affecting end-diastolic volume, Myocardial contractility, Integrated control of cardiac output, Oxygen consumption by the heart

Unit-4

Cardiovascular regulatory mechanism

Local regulatory mechanism, Auto regulation, Vasodilator metabolites, Substance secreted by the endothelium, Endothelial derived relaxing factor, Other function of NO, Endothelins, Endothelin-1, Regulation of secretion, Cardiovascular function, Other function of endothelins, System regulation by Hormones, Natriuretic Hormone, Circulating Vasoconstrictors, System Regulation by the Nervous system, Neural Regulatory Mechanisms, Cardiac Innervation, Vasomotor control, Afferent to the vasomotor area, Somatosympathetic reflex, Baroreceptors
Carotid sinus aortic arch, Buffer nerve activity, Baroreceptor resetting, Effect of carotid clamping and buffer nerve section, Atrial stretch receptors, Role of Baroreceptors in Endocrine Defense of ECF volume, Bainbridge Reflex, Left Ventricular Receptors, Pulmonary Receptors
Clinical Testing and Stimulation, Effect of chemoreceptor stimulation of vasomotor area
Direct effects on the vasomotor area, Sympathetic vasodilator system, Control of Heart Rate

Unit-5.

Cardiovascular Homeostasis in Health and Disease

Compensation for Oxygen consumption, Postural Hypotension, Effects of Acceleration, Effects of Zero Gravity on the Cardiovascular system, Other effect of Zero Gravity, Arrhythmias, Aneurysms, Angina pectoris, Aortic dissection, Aortic valve disease, Arterial disease, Arteriovenous malformation, Atrial fibrillation, Atrial flutter, Ventricular fibrillation, Ventricular tachycardia, Atrioventricular block, AV reentrant tachycardia, Chronic venous insufficiency, Coarctation of the aorta, Congestive heart failure, Dilated cardiomyopathy, Hypertrophic cardiomyopathy, Endocarditis, Mitral valve disease, Myocardial infarction, Hypertension, Experimental Hypertension, Hypertension in Humans, Malignant Hypertension, Essential Hypertension, Other types of Hypertension, Renin-angiotensin aldosterone system, Tricuspid valve disease, Pericarditis and pericardial effusion, Pulmonary valve disease, Manifestations, Treatment, Atherosclerosis.

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Unit-6

Recent advances in HTN, valvular diseases, life saving techniques. Recent advance surgery in cardiovascular repair.

Ref.:

(1) Ganong's Review of Medical Physiology, Twenty-Sixth Edition by Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, n2019 Jason X.-J. Yuan 2019 by McGraw-Hill Education

2. Biology of Cardiovascular and Metabolic Diseases 2021 Book by Chaya Gopalan and Erik

Kirk3. Cardiac and Vascular Biology Johannes Backs, Marc Freichel, Manuel Mayr, Ulrich Pohl, Junjie Xiao, Daphne Merkus, Sarah Parker. Springer Link

Course outcomes:

A basic foundation in Cardiovascular biology

- 1 Can able to describe the major organs of the cardiovascular system and their functions.
- 1 Describe the anatomy of the heart and the flow of blood through the heart.
- 1 Explain how the electrical conduction system controls the heartbeat.
- 1 List and describe the characteristics of the three types of blood vessels.
- 1 Define *pulse* and *blood pressure*.
- 1 Identify and define cardiovascular system anatomical terms.
- 1 Identify and define selected cardiovascular system pathology terms.
8. Identify and define selected cardiovascular system diagnostic procedures.
9. Identify and define selected cardiovascular system therapeutic procedures.
10. Identify and define selected medications relating to the cardiovascular system.
11. Define selected abbreviations associated with the cardiovascular system.

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IV Year - VII Semester

Elective Course: Reproductive Biology

Course Code: EC01/BM47E1R

Credits: 4

Objectives:

- To ensure understanding of male and female reproductive physiology
- To ensure understanding about the disorders of reproductive system
- To ensure understanding on reproductive health care for better outcome of pregnancy.

Unit I:

Fundamentals of Human reproductive system: Introduction-Anatomical structures - Male and female, Sexual differentiation during development, Gonadal dysgenesis, Congenital Anomalies – in male (Cryptorchidism, Hypospadias Varicocele, Spermatocoel) and female (Mullerian duct anomalies, Undescended ovaries, ovarian agenesis and vaginal atresia) reproductive system, male/female pseudo hermaphroditism. Gametogenesis - Oogenesis & Spermatogenesis, Ovulation, Fertilization. Twin Conception – Formation and Development - Identical and Fraternal.

Unit II:

Role of hormones in male reproductive physiology: Endocrine control of testicular function- GnRH and Pituitary Gonadotropins, inhibin and prolactin. Physiological roles of Androgens – Spermatogenesis, secondary sex characteristics, anabolic actions and ageing. Mechanism of Androgen action-Androgen receptors. Physiological roles of estrogens- fertility, male behavior, Epiphyseal fusion.

Unit III:

Role of hormones in female reproductive physiology: Ovarian steroid hormones (OSH)- Estrogen, Progesterone, Androgens and their mechanism of action -Estrogen receptors. Physiological roles of OSH, prostaglandins, oxytocin and vasopressin. Mammalian reproductive cycle –Primate menstrual cycle, induced and spontaneous ovulators, delayed implantation Menopause and hormone replacement therapy.

Unit IV:

Disorders of Reproductive system: Infertility: Causes - Male factors and female factors, Couple Dependent Factors, Toxic Exposures. Methods of IVF - ICSI, ZIFT, GIFT and PGD, disadvantages of IVF. Embryo cryopreservation and sperm bank. Recurrent pregnancy loss: Causes and treatment– Genetic, Hormonal, Metabolic and other factors; Rh incompatibility-overview. Pathophysiology - Dysmenorrhoea, Amenorrhoea, Polycystic Ovary Syndrome, premature ovarian failure, premenstrual syndrome, Infections in Pregnancy, High risk pregnancy-Causes, Diagnosis and prevention.

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Unit V:

Genetic defects and reproductive health: Principle of teratology and teratogenic agents, Pre-conception Counseling – Preconception care -reproductive history, preconception risk assessments, medical assessment, nutritional assessment, social assessment, family history-Carrier screening X-linked recessive and autosomal recessive disorders - other factors assessment. Brief introduction - Contraceptives - Antenatal Care and Risk assessment –Methods for prenatal diagnosis of genetic defects –Amniocentesis and chorionic villus sampling. Reproductive Health - WHO definitions and indicators of reproductive health.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Discuss few clinical reports on ART and its success rates in India and western countries. Collect information from published data in India regarding prenatal diagnosis adopted for genetic diseases.

Reference Text Books:

1. Textbook of Gynecology; D.C Dutta
2. Endocrinology (5th edition); Mac E. Hadley
3. Obstetrics and Gynaecology-2 –For postgraduates and Practitioners.
4. <https://www.studocu.com/en/document/australian-national-university/human-biology/lecture-notes/lecture-notes-lectures-1-9-reproduction/311871/view>
5. <https://www.studocu.com/en-au/document/university-of-manchester/human-reproductive-biology-e/lecture-notes/human-reproductive-biology-lec-1-6/1312030/view>
6. <https://www.studocu.com/en-au/document/the-university-of-edinburgh/reproductive-biology-3/lecture-notes/reproductive-biology-3-15/1087563/view>
7. https://www.studocu.com/en-au/search/Human+Reproductive+Biology?languages=language_en&type=document

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Gain knowledge on genetic counseling and prenatal diagnosis and their role in prevention of child being born with a genetic disease.
- Understand the concept of twin conception and risk associated with multiple pregnancies.
- Provide information to the needy regarding advanced techniques (Assisted reproductive techniques) availability for the treatment of infertility
- Understand the Importance of preconception care and antenatal care for the better outcome of pregnancy
- Understand the role of hormones in male and female reproductive physiology
- Understand the benefits of contraceptives in health care.

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IV Year - VII Semester

Elective Course -1: Cell Signaling

Course Code: EC01/BM47E1 C

Credits: 4

Objectives:

- To provide an overview on signal transduction, diverse forms of signaling molecules, various types of receptors and signaling pathways.
- To explain the concept of neuronal signaling pathway, neurotransmitters and mechanism of muscle contraction.
- To understand the role of signal proteins in cellular functions and their defects in disease.

Unit I:

Definition – Signal transduction, stimulus, effectors; Need for Signaling, Cell signaling in primitive organisms - *E.coli* and yeast; Effects of Cell Signaling – Cell differentiation, Cell proliferation, Cell survival, metabolism and other cellular functions.

Unit II:

Mechanisms of Paracrine Signaling, Synaptic Signaling, Endocrine Signaling, Autocrine Signaling; Sensory transduction: Nerve impulse transduction- Nerve cells, Synapses, Reflex arc, Voltage gated ion-channels, Impulse transmission.

Unit III:

Cell surface receptors – G protein coupled receptors – Structure, mechanism of signal transduction, Regulatory GTPases, Effector molecules of G proteins; Signaling Molecules – cAMP, cGMP, DAG and NO as signaling molecules, Ca²⁺ receptors and calcium channel.

Unit IV:

Receptor tyrosine kinases, Signal transmission via Ras and MAP kinase pathways; Nuclear Receptors – Functions, Hormones and Second messengers - Signaling by steroid hormones, Cytokine receptors – Activation of cytokine receptors, Jak-Stat pathway.

Unit V:

Errors of signal proteins and tumorigenesis, p53 signaling pathway and tumour suppression, APC and Wnt/ β Catenin Signaling.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Targeting G protein coupled receptor in cancer therapy, **Notch signaling**, Wnt/ β Catenin Signaling pathway and therapeutic opportunities. Endocrine signaling.

Reference Text Books:

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1. Gerhard, K. (2014). Biochemistry of Signal Transduction and Regulation. 4th Edn. Publisher: Wiley-VCH Publication.
2. Cooper, G. M., & Hausman, R. E. (2007). The Cell: A Molecular Approach. 4th Edn. Publisher: ASM Press, and Sinauer Associates, Inc., USA.
3. Lodish, H., Berk, A., Kaiser, C. A., Bretscher, A., Ploegh, H., Amon, A., & Scott, M. P. (2013). Molecular Cell Biology. 7th Edn. Publisher: W. H. Freeman and Company, USA.
4. Bruce, A., & Alexander, J. (2015). Molecular Biology of the Cell. Garland Science.
5. Hancock, J. T. Cell Signalling. 2nd Edn. Publisher: Oxford University Press.
6. Helmreich, E. J. M. The Biochemistry of Cell Signalling. Publisher: Oxford Press
7. Bastien, D., Gomperts, Kramer, I. M., & E. R. Tatham, P. E. R. (2015, Signal Transduction. Publisher: Academic Press.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the intracellular communication through diverse signaling pathways and networks.
- Discuss the basic molecular mechanisms of signal transduction pathways related to cell growth and stress systems.
- Describe the properties of sensory transduction, synapses and the role of neurotransmitters.
- Emphasis on specific categories of signaling components like extra cellular signals/ligands, receptors etc.
- Explain how signaling via different receptor types (e.g. GPCR, RTKs, RS/TKs) transduces intracellular signaling.
- Describe the role of secondary messengers (cAMP, cGMP, DAG and NO) in signal transduction.
- Gain knowledge on important signaling pathways and their regulatory roles in cellular development process, homeostasis and in cancer (i.e. Ras and MAP kinase pathway, Jak/STAT - nuclear receptors, Wnt/ β Catenin pathway).
- Understand the errors of signal proteins and tumourigenesis, p53 signaling pathway and tumour suppression.

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IV Year - VII Semester

Laboratory Course: Clinical Biochemistry

Course Code: LC06/BM47CP6

Credits: 3

Objectives:

- To gain basic knowledge on specimen collection, processing and separation of sample.
 - To perform biochemical measurements in clinical samples (Blood and Urine).
 - To analyse normal and abnormal constituents in blood and urine samples.
1. Collection of Blood and Urine, Types of preservative and anticoagulants.
 2. Quantitative Estimation in Blood:
 - ✓ Fasting and Post prandial (PP) Glucose
 - ✓ Cholesterol.
 - ✓ Urea
 - ✓ Creatinine
 - ✓ Uric acid
 - ✓ Total Proteins and A/G ratio
 - ✓ Bilirubin
 3. Quantitative Estimations in Urine:
 - ✓ Urea
 - ✓ Uric acid
 - ✓ Creatinine
 4. Qualitative tests in Urine: Tests for abnormal constituents (sugar, protein (albumin), ketonebodies, bile pigments and bile salts).
 5. Enzyme Assays in serum:
 - a. Measurement of transaminases (SGOT and SGPT) activity.
 - b. Measurement of lactate dehydrogenase (LDH) activity.
 - c. Measurement of alkaline phosphatase (ALP) activity.

Reference Text Books:

1. Varley, H. (2006). Practical Clinical Biochemistry. 6th Edn. Publisher: CBS Publishers & Distributors Pvt. Ltd., India.
2. Talib, V. H. (1999). A Handbook of Medical Laboratory Technology. 2nd Edn. Publisher: CBS Publishers & Distributors Pvt. Ltd., India.
3. Talib, V. H. (2020). Practical textbook of Laboratory Medicine. 2nd Edn. Publisher: CBS Publishers & Distributors Pvt. Ltd., India.
4. Plummer, D. T. (2004). An Introduction to Practical Biochemistry. 3rd Edn. Published by TataMcGraw-Hill Education Pvt. Ltd., New Delhi.
5. Jayaraman, J. (2011). Laboratory Manual in Biochemistry. 2nd Edn. Published by New Age International Publishers, Bangalore.

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Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Separate plasma and serum from the blood sample.
- Skilled in biochemical estimation in serum and urine.
- Examine and analyse the pathological urine sample.
- Measure the activity of the marker enzymes in the serum sample.

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IV Year - VIII Semester

Core Course -13: Genetic Engineering

Course Code: CC13/BM48 C14

Credits: 5

Objectives:

- Explains the basic principles of gene cloning and DNA analysis.
- Explains visualization of the DNA by means of gel electrophoresis and Southern blotting.
- Describes the production of proteins from cloned genes and the probing occurring during cloning.

Unit-I: Basic Principles of Gene cloning and DNA analysis. Advent of gene cloning and PCR, Vectors for gene cloning: Basic features for plasmids, Cloning vectors for, Bacteria pBR322, Yeast, and other fungi, 2 μ m Plasmid, , Eukaryotes: mammals, animals, Plant-Ti plasmid, P-element (drosophila), vectors based on ϕ bacteriophage, M13 bacteriophage, BAC. Lac selection In-vitro transcription of cloned DNA. Different strategies of cloning, Restriction enzyme, Sticky ends, Blunt ends, Homopolymeric tailing, Use of adaptor and linkers, DNA polymerase, Klenow polymerase, Terminal transference, T4 PNK, Alkaline phosphatases, Reverse transcriptase, DNA ligase, Nuclease Bal31-S1 nuclease DNase: Mung bean nuclease, ExoIII

Unit-II: Studying Gene location and structure: Locating the position of a gene on a small and large DNA molecule. In situ hybridization to visualizing the position of a gene on a eukaryotic chromosome. Separating chromosomes by gel electrophoresis. Sanger-Coulson Method, Chain terminating nucleotide. The primer synthesis of complementary strand, Four separate reaction result in four families of terminated strands Reading the DNA sequence from the autoradiograph, DNA polymerase that can be used for sequencing, Automated DNA sequencing, Sequencing PCR products, Maxam-Gilbert methods, Chemical degradation of DNA, Building up a long DNA sequence.

Unit-III: Studying transcript of cloned gene: Electron microscopy of a nucleic acid molecule Analysis of DNA-RNA hybrid by nuclease treatment, Transcript analysis by primer extension, Other technique for studying RNA transcript such as Northern blot, RACE, RNA sequencing Studying the regulation of gene expression, Identifying protein binding sites on a DNA molecules, Gel retardation of DNA protein complex. Foot printing with DNase I, Modifying with interference assays, Identifying control sequences by deletion analysis, Reporter gene and carrying out a deletion analysis.

Unit-IV: Analysis of protein by in vitro mutagenesis, Different types of in vitro mutagenesis techniques, Using oligonucleotide and other methods to create a point mutation in a cloned gene, Potential of in vitro mutagenesis,

Unit-V: Production of protein from cloned genes, Special vectors for expression of foreign genes in E.coli, Promoters is the critical component of an expression vectors, Example of promoters

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used in expression vectors, Cassettes and gene function, General problem with production of recombinant protein in E.coli, Problem resulting from sequence of the foreign gene. Problems caused by E.coli, Recombinant protein production from yeast and filamentous fungi- *S.Cervisiae* as host for recombinant protein synthesis., Production of recombinant insulin synthesis and expression of artificial insulin gene. Syntheses of hGH in E.coli. Recombinant factors VIII and other human proteins

Unit-5. Recent update on Ti plasmid cloning and genetically modified crops and animal in biotechnology

Ref:

1. Gene cloning and DNA analysis – An introduction By TA Brown 5th edition Wiley publishers.
2. Desmond ST Nicholl 2002-An introduction of genetic engineering 2nd edition Cambridge university press
3. Watson JD Recombinant DNA **W.H.Freeman & Co Ltd**
4. Benjamin Lewin Gene VII, **Oxford University Press**
5. From Genes to Clones: Introduction to Gene Technology by Ernst–Ludwig Winnacker. **Oxford University Press**

Student Learning Outcome: (Should have a minimum of 8 points)

Upon successful completion of the course student will be able to:

- research branch where virtual genetic models are created using computer software.
- explore all of the understanding of gene cloning in an approachable way
- advanced the understanding of many theoretical and practical aspects of gene function and organization.
- One can use non-virtual genetic engineering tools to manipulate the genes of living organisms for cloning, introducing new characteristics to an organism or anything else to do with physical tools.
- Can deal with separating, classifying and preparing genes for *applied* genetic engineering experiments and activities.
- plan on achieving the goal of de-extinction using genetic modification, which is the process of bringing back extinct animals.
- genetically modify crops to allow them to grow in certain conditions that otherwise couldn't be possible
- study gene functions and come up with vaccines, life-saving drugs and many other things like the reduced need for pesticides.

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IV Year - VIII Semester

Core Course -14: Immune and Molecular Diagnostics

Course Code: CC14 /BM48C15

Credits: 5

Objectives:

- To ensure understanding about the immunological techniques in the diagnosis of diseases.
- To impart knowledge on DNA/RNA/protein based molecular techniques in the diagnosis.
- To ensure awareness and knowledge about the importance of quality assessment program in clinical laboratory set up.

Unit I:

Basic Immunological Methods – Preparation of antigens, rising of antisera, routes of administration, doses for administration, purification of antibodies- methodology – IgG & IgA. Monoclonal antisera raising & Hybridoma technology. Types of conjugated antibodies, types of substrates and color detectors used in immunoassays. Immunofluorescence, Flow cytometry - clinical focus – Leukemia typing (immunophenotyping), ELISA and its variants- Principle and application, Surface Plasmon Resonance- principle and application- western blotting- principle and application

Unit II:

Serodiagnostics – Define Acute & Convalescent sera, collection of serum specimen, storage, preparation of dilutions. Serodiagnosis of various infectious diseases - Detection of antibodies to microbial antigen – Syphilis, typhoid, streptococci infections, HIV, Hepatitis B and C - Comments on respective clinically specific antigens, Overview of clinical significance of various autoantibodies and diagnostic methods involved in the detection. Overview of diagnosis of complement disorders and clinical significance of C3nephritic factor and complement deficiencies.

Unit III:

Clinical significance of measurements of specific proteins in serum, CSF & Urine - Immunoglobulins (Igs), paraproteins & cryoglobulins, Functional assays for immune complexes. Clinical significance of C-Reactive proteins - cryoglobulins in patient specimens- test methods for detection. Tests for allergy—Total serum IgE, Allergen specific IgE – serology based methods -in vivo -skin test, in-vitro – RAST (1st, 2nd & 3rd generation methods) – cell based methods - Allergen induced mediator release assay – Histamine release, LTC₄ release (Cellular antigen Stimulation Test-CAST), Flow cytometric basophil activation assay (Flow assay Stimulation Test-FAST) - CD63 CD203c.

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Unit IV:

Basic Molecular Methods: Types of mutations- PCR based mutation detection methods – for known & unknown mutations – ASP, ASOP, TTGE, DGGE, Heteroduplexing method, SSCP & sequencing. Micro (STRs) and minisatellites (VNTRs) Analysis- principle and applications. Discuss: Primer designing for PCR. Collection, processing and storage of sample –RNA extraction- cDNA preparation, RT-PCR –Principle, methods & Applications - Real time PCR – Principle, methods & Applications. Types of dyes (SYBR Green) and probes (Taq-Man). FISH- Principle and Application

Unit V:

Molecular Diagnostics –Diagnosis of Mycobacterium tuberculosis, HCV & HIV; Conventional vs. Molecular Diagnostics –Merits & Demerits. Molecular diagnosis of single gene disorder - sickle cell anemia- Molecular HLA typing – Sequence specific PCR (SSP), Sequence specific oligonucleotide probe (SSOP), Sequence Based Typing (SBT) - Advantages of molecular HLA typing over serological methods-HLA typing (Microlymphocytotoxicity Assay) and clinical significance-Comment on Sensitivity and Specificity of clinical laboratory techniques – Quality assessment Programs (external & internal assessment Programs).

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Recent advances in clinical application of Next generation sequencing

Reference Text Books:

12. Immunology 2nd edition, Janis Kuby.
13. Roitt's Essential Immunology 11th Edition, Peter J.Delves, Seamus J.Martin, Dennis R.Burton and Ivan M.Roitt.
14. Essentials of Clinical Immunology 5th Edition, Helen Chapel, Mansel Haeney, Siraj Misbah and Neil Snowden.
15. Mutation Detection, A Practical Approach, R.G.H.Cotton, E.Edkins and S.Forrest.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Know about the applications of various immunological techniques in the disease diagnosis.
- Know about the applications of various molecular based techniques in the disease diagnosis.
- Understand the importance and advantages of molecular technique over the conventional methods of disease diagnosis.
- Understand the role of serodiagnostic tools for diagnosis of various infectious diseases.
- Understand the clinical significance of measurement of specific proteins in the body fluids.
- Understand the importance and methods of DNA based molecular techniques in the prenatal screening, forensic investigations, HLA typing and genetic disease diagnosis.

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- Understand the principle and methodology of various molecular techniques used in expression studies.
- Understand about the importance of quality assessment program in clinical laboratories.

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IV Year - VIII Semester

Core Choices Course : Neurobiology

Course Code: CO02 /BM48C16N

Credits: 5

Objectives:

- 1) Define the molecular, cellular, and tissue-level organization of the central and peripheral nervous system
- 2) Understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication
- 3) Relate the properties of individual cells to their function in organized neural circuits and systems
- 4) Understand how the interaction of cells and neural circuits leads to higher level activities.

UNIT-I

Introduction to Neurobiology. Brain Anatomy and function. Energy sources (oxygen and glucose delivery) and metabolism of Brain. CNS: Forebrain, Brainstem and spinal cord, Meninges, CSF, Blood brain barrier, cellular components of the BBB. PNS, and their function. Meninges and Diabetic neuropathy. Embryonic development of Neural tube and neural crest. Neurulation and its failure. Autonomic ganglion neurons, Enteric nervous system. Derivatives of the neural crest, placodes. 5 major division of CNS from Neural tube. Development of ventricular system. Normal sensation, Movement, and homeostasis depend on long distance connection with in CNS. Maintenance of homeostasis, Motor hierarchy controls, control by the lowest level of hierarchy. Cortex control center to voluntary movement. Function of cerebellum, basal ganglia the ultimate arbiter. Glial cells.

UNIT-II

Excitable Tissue: Nerve, Morphology, Axoplasmic Transport, Excitation and Conduction, Resting membrane potential, latent period, action potential, compound action potentials, all-or-none law, Electrogenesis of the action potential, salutatory conduction, orthodromic and antidromic conduction, Biphasic action potentials,. Ionic basis of Resting membrane potential, ionic fluxes during the action potential, distribution of ions channels in myelinated neurons. Synaptic transmission - Properties of Chemical and Electrical synapses – A model synapse: The Neuromuscular junction, Motor Unit, combination of muscles in muscle fiber, innervation ratio, tension, muscle spindles- orderly recruitment, EMG, stretch reflex, activation of motor neurons, Presynaptic exocytosis is Ca²⁺ dependent — the Interplay of Excitation and Inhibition - Synapses are Heterogenous and can be Specialized Short term and long-term Synaptic Plasticity.

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UNIT-III

Pre-and Post Synaptic Receptors - Receptor structure and function – Receptor classification schemes: Anatomical, Pharmacological and Structural/mechanistic-Neurotransmitters and their receptors - Catecholamine receptors. Neurotransmitter, Neurohormones, Neuromodulators - Definitions and functions - Acetylcholine is the prototypical neurotransmitter - Biogenic Amines are transmits one decarboxylated amino acids such as Catecholamines, Serotonin and Histamine- GABA, Glutamate and Glycine are major transmitter systems in the mammalian brain - Nitric oxide - Neuroactive peptides - Hypothalamic neurohormones - Opiate peptides - Brain gut peptides - other peptide.

UNIT-IV

Nervous system and pain. Nerve fiber-, spinal cord, Brain somato sensory cortex ascending and descending pain pathways, Neurochemical of pain, gate control theory, opening and closing of gate. Conditions act on gate system. Categories of pain. Nociceptor, thermoreceptor, mechanoreceptors, processing of sensory information, receptor level, receptor, adaptation, processing at circuit level, somatic sensory pathway. 2 point discrimination, neuro pathway: somato sensory system, general sensory pathway, classification of sensory receptors.

Unit-V

Paraneoplastic diseases, encephalomyelitis, cerebellar degeneration, opsoclonus-myoclonus, Neurodegeneration diseases. CNS, PNS, Demyelination disease, Charcot-Marie-Tooth disease, Multiple sclerosis, Acute disseminated encephalomyelitis, Central pontine myelinolysis. parkinson's disease, Huntington's disease, Alzheimer's disease, Intracerebral hemorrhage, hemorrhage stroke, Polio,

Unit-VI (not for Exam) Recent Advances in the Cellular and Molecular Mechanisms of Neurons. Recent advances and current views of pain and its managements. **Recent advances in neural electrode–tissue interfaces. Recent Advances in Recurrent Neural Networks. Recent advances in algorithmic learning theory of the Kanban cell neuron network**

REFERENCE:

1. Neuroscience in Medicine - Ed. Michael Conn P. Second Edition.
2. Ganong's Review of Medical physiology. Kim Barrett, Heddwen Brooks, Scott Bitano, Susan Barman. 23rd or 24th Edition

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- 3.Principle of Internal Medicine by Harrison. 19th Edition.
- 4.Human Physiology, An Integrated approach. By Dee Unglaub Silverthorn. 7th edition
- 5.Chemosensory Sensors and System by Maximilian Brandt.
- 6.Principle of Neurology by Adams & Victor 8th edition
- 7.Larsen's Human Embryology by Schoenwolf, Bleyl, Brauer and Frnscis-West.

Course outcomes:

A basic foundation in neurobiology

- 1. Competency in quantitative reasoning and research methodology in neuroscience**
2. Able to read, review, and evaluate and discuss primary research literature in neurobiology and evaluate the validity of hypotheses generated by others
3. Work on research projects independently and in small group settings
4. Communicate effectively orally and in writing
5. Generate methods to test a research question in neurobiology
6. Actively discuss contemporary issues in neurobiology with critical thinking and methods generation in mind.
- 7. Generate testable scientific hypotheses and develop research plans to test these hypotheses**
8. Neurobiology is the scientific study of the brain and nervous system, whose ultimate goal is to understand higher brain function at a variety of levels
9. Provide students with current knowledge about brain structure and function from both a basic research and a clinical perspective, and to allow them to use this knowledge in competing higher education or research projects.
10. Students into an exploration of the nervous system on many different levels, from "Biomolecules to Brain."
11. Introductory courses provide a broad survey of nervous system construction and activity,

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IV Year - VIII Semester

Core Choice Course: Molecular Medicine

Course Code: CO02/ BM48C16 M

Credits: 5

Objectives:

- The course emphasise the Molecular basis of diseases and the advancements of Molecular Diagnostic Technologies.
- It gives brief understanding about Signal transduction and its role in human diseases and Therapeutic Strategies.
- The course will also emphasize molecular mechanism of various diseases such as HIV, HCC, Tuberculosis, Dengue, SARS and the challenges in antimicrobial resistance.

Unit I:

Molecular basis of diseases: Human genetics relevant to diseases, DNA polymorphism, Single (Cystic fibrosis, Huntington's disease, Familial hypercholesterolemia, Dunchenne muscular dystrophy, red-green colour blindness, Tay-Sachs diseases, pearson syndrome & Xeroderma pigmentosum) and polygenic diseases (Asthma & Diabetic mellitus), Omics, Gene-environment: Interactions in disease manifestation and inheritance, genetic and physical mapping of human genome and identification of genes in diseases.

Unit 2:

Molecular Diagnostic Technologies: PCR-Based Methods, Next generation sequencing techniques, Microarray Approaches to Gene Expression Analysis. Comparative genomic hybridization (CGH), ELISA, Prenatal and postnatal genetic tests.

Unit 3:

Signal transduction and its role in human diseases: Cellular and tissue microenvironment in diseases, Defects in G protein-coupled signal transduction in human disease, TGF- β , MAPK, PI3K/Akt, Notch & JAK-STAT signaling pathways in human diseases, Inhibiting signaling pathways through rational drug design

Unit 4:

Therapeutics Strategies: Translational research (bench to bedside), Mechanism of action and clinical application of Antisense Oligonucleotides, Gene therapy, Personalized Medicine, Stem cell therapies, RNAi & microRNA in human diseases, Monoclonal Antibodies, CRISPR/Cas technology-AYUSH, Plants and microbes as sources of natural metabolites, Healing herbs in Traditional medicinal system (*Curcuma longa* and *Yukyung Karne*). TKDL

Unit-5:

Molecular Mechanisms and Challenges: RNA and DNA viruses of humans causing diseases; Corona virus SARS-CoV-2, HBV related HCC, HIV, Dengue fever- Parasitic disease; Leishmaniasis, African trypanosomiasis and Malaria- Bacterial diseases: Tuberculosis (TB), Pneumonia & Cholera- Superbugs and Antimicrobial resistance (*Staphylococcus aureus*)- Multi drug resistance issues & future challenges.

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Unit-VI: Current Contours: (Not for Final Exam only for Discussion):

Marburg virus & Ebola virus- De novo synthesis of small molecular inhibitors for target based treatment- Immunotherapy -Recent advancements and technology in translational research,

Reference Text Books:

1. Littwack, G. (2008). *Human Biochemistry and Disease*. Academic Press.
2. Trent, R. J. (2012). *Molecular Medicine*, Fourth Edition: Genomics to Personalized Healthcare. Academic Press.
3. Trent, R. J. (2005). *Molecular Medicine: An Introductory Text*. Academic Press.
4. Elles, R., Mountfield, R. (2011). *Molecular Diagnosis of Genetic Diseases*. Springer Publication.
5. Licinio, J., Wong, M. L. (2003). *Pharmacogenomics: The Search for Individualized Therapies*. Wiley-VCH Verlag GmbH & Co. KGaA.
6. Audet, J., Stanford, W. and Stanford, W. L. (2009) *Stem cells in regenerative medicine*. New York, Humana press.
7. Buckingham and Flav's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007.
8. Toren Finkle & J. Silvio Gutkind, Signal transduction and human diseases, (Wiley online library)

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Describe human genetics relevant to diseases and identification of genes in diseases
- Understand the impact of Gene-environment interaction on disease
- Analyze the signal transduction pathways and its role in human diseases
- Explain the basic concepts of AYUSH and its range of natural products usage for treating various human ailments.
- Clarify the importance of translational research
- Understand the importance of diagnostic tools and analyse various therapeutic strategies.
- Think and formulate new hypothesis & concepts in the field relevant area after studying the molecular mechanism of various human diseases.
- Decide the area of research work for their master dissertation project work.

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IV YEAR - VIII SEMESTER

Elective Course - Drug Discovery and Assay Development

Course Code: EC02/BM48E2D

Credits: 4

Objectives:

- This course is mainly emphasized on the drug development process from bench to bedside.
- Drug discovery process is to deliver one or more clinical candidate molecules, each of which has sufficient evidence of biologic activity at a target relevant to a disease.
- Sufficient safety and drug-like properties so that it can be entered into human testing.

Unit I:

Introduction To The Drug Discovery- Early History of Medicine, Drug Discovery and Development in the Middle Ages, Foundation of Current Drug Discovery and Development, Beginnings of Modern Pharmaceutical Industry, Evolution of Drug Products.

Unit II:

Drug Designing- Introduction, Rational drug design, Computer based drug design, and target based drug design. Target identification, Target Validation, Screening of Hits, Lead Optimization, Molecular Modeling and virtual screening techniques: Drug likeness screening, Concept of pharmacophore mapping and pharmacophore based Screening, Molecular docking, De novo drug design

Unit III:

Drug Discovery: Small Molecule Drugs- Irrational Approach, Rational Approach, Antisense Approach, RNA Interference Approach, Chiral Drugs, High -Throughput Screening. "Omics"- Guided Approach – Genomics, Proteomics, Metabolomics. Large Molecule Drugs- Vaccines, Antibodies, Cytokines, Hormones

Unit IV:

Bioassay - In Vivo-Based Bioassay- Brine Shrimp Model, Zebrafish Model, Drosophila Model, Animal Models - The Wistar Rat, Immunocompromised Mice, The Nude Mouse, The SCID Mouse, Transgenic Animal Models, Knockout Animal Models. Bioassay in Isolated Organs, Cell-Based Bioassay, Reporter Gene Assay, Enzyme-Based Bioassay, Receptor- Based Bioassay, Immunoassay- Assessment of Immune Function

Unit V:

Clinical Trials – Clinical Trials- Types and Design, Investigational New Drug Application, New Drug Application (NDA) Requirements, Ethical Considerations, Regulatory Requirements for Clinical Trials, Role of Regulatory Authorities, Food, Drug, and Cosmetic Act of 1938, Continuing Challenges and Refinements.

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Unit VI: Current Contours (Not for Final Exam only for Discussion)

Combinatorial Chemistry: Introduction: Concepts and Terms, Solid-phase Strategies, Solution Phase Strategies, Computer-Aided Drug Design, Docking and virtual screening, Molecular Dynamics and binding free energy methods

Reference Text Books:

1. Robert GCK, ed., "Drug Action at the Molecular Level" University Park Press Baltimore.
2. Martin YC. "Quantitative Drug Design" Dekker, New York.
3. Delgado JN, Remers WA eds "Wilson & Gisvolds's Text Book of Organic Medicinal & Pharmaceutical Chemistry" Lippincott, New York.
4. Foye WO "Principles of Medicinal chemistry 'Lea & Febiger.
5. Smith HJ, Williams H, eds, "Introduction to the principles of Drug Design" Wright Boston.
6. Molecular Modelling for Beginners by Hinchliffe, Alan John, Wiley-VCH
7. Computer-Aided Drug Design by Perun, Thomas J. ,B. I. Waverly, Taylor & Francis
8. Benjamin Blass. (2015) Basic Principles of Drug Discovery and Development, Academic Press.
9. Rick Ng (2008). Drugs From Discovery to Approval, 2nd edition

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- To understand different stages of drug discovery.
- Design and Discovery of Lead molecules.
- The role of drug design in drug discovery process.
- The concept of QSAR and docking.
- Various strategies to develop new drug like molecules.
- The design of new drug molecules using molecular modeling software.
- Different techniques for drug discovery like in silico virtual screening protocols.
- Working with molecular modeling software to design new drug molecules.

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V YEAR - IX SEMESTER

Core Course 15 – Stem Cell Biology and Regenerative Medicine

Course Code: CC15/BM59C17

Credits: 5

Objectives:

- To understand the basics and principles of stem cell technologies
- To generate healthy cells to replace diseased cells
- To educate on various types of stem cells and their properties

UNIT I:

Introduction to the concept of Stem Cell Biology - definition, classification, sources of stem cells, properties, potency, plasticity, self-renewal and expansion. Maintenance of stem cell culture, sub cloning, spontaneous and controlled division of embryonic stem cells. Stem cell Niches. Stem Cells - Molecular Mechanism - Pathway of Proliferation, Migration and Differentiation

UNIT II:

Embryonic (ES) and hematopoietic stem cell (HSC): definition, isolation and clinical application-transgenic and bone marrow transplantation (BMT); BMT for autoimmune diseases. Trophoblast stem cell; Epidermal stem cells.

UNIT III:

Regenerative medicine and Stem cells: Role of stem cells in regeneration, Stem cell lineage tracing, early development and embryonic stem cells. Stem cells in neurodegenerative and cardiovascular diseases.

UNIT IV:

Cancer stem cells - Role in solid tumors, Control of CSC migration and Invasion, Implication of cancer stem cells for therapy. Cytokines as a survival factor in cancer stem cells; exploiting cancer stem cell differentiation for tumor therapy; Targeting autocrine survival signals in CSCs.

Unit V:

Introduction to tissue Engineering - Cells as therapeutic agents, Tissue Organization, Tissue Components, Tissue types, tissue dynamics, Homeostasis in highly proliferic tissues and tissue repair. Cell and extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell- Cell contact- Cell junctions in tissues.

UNIT V:

Ethical implications and National policies governing ES cell research for science and the scientist. Ethical issues associated with stem cell biology.

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References:

1. Stem cells (Bench to Bedside) Ariff Bongso, Eng Hin Lee (Editors)- 2005- scientific publishing Co.
2. Stem cells : Scientific facts and fiction - By Christine L. Mummery, Anja Van de Stolpe, Bernard Roelen, Hans Clevers.
3. Tissue Engineering- Bernhard O, Palsson.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the basics of stem cell biology.
- Describe the methods for isolation.
- Illustrate the properties of stem cells
- Describe various applications of stem cells.
- Know the therapeutic strategies using stem cells
- Elucidate the mechanism underlying stemness
- Methods involving isolation of different stem cells.
- Understanding various limitations and challenges.

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V Year - IX Semester

Core Course -16: Cancer Biology

Course Code: CC16/BM59C18

Credits: 5

Objectives:

- This paper highlights hall marks of cancer and importance of cell-cycle checkpoints and its deregulation in cancer.
- Topics such as molecular mechanisms of cancer, Oncogene, Tumor suppressor gene, metastasis and apoptotic signaling pathway would help students to understand the overall biology about cancer.
- To understand advanced diagnostic tools, current therapeutic options and challenges in cancer.

Unit I:

Introduction: cancer cell and its properties, Classification of cancer (carcinoma, sarcoma, leukemia, lymphoma), Multistep nature of cancer- Epidemiology of cancer -WHO classification- Tumor staging and grading-Overview of Hallmarks of cancer

Unit-II

Cell growth and cell cycle regulation: Cell cycle (Four discrete phases of cell cycle)- Cell cycle and growth regulation- Major cell cycle regulatory check points(G1& G2/M checkpoint)- Cyclins and Cdks in cell cycle regulation- Mutation causing loss of cell cycle control and induction of cancer- Protein phosphorylation and de phosphorylation control cell cycle regulation

Unit-III

Mechanism: Chemical Carcinogens (initiation, promotion and progression), Radiation and cancer- Free radicals, antioxidants in cancer- Oncogenes (Bcr-Abl1 and ErbB2), Viral oncogene and non viral (cellular) oncogene, Activation of proto oncogenes (c-myc, Ras superfamily) - Tumor suppressor genes (RB, PTEN, BRCA1, BRCA2 and p53 in cancer) –Familial cancer and Knudson's two hit hypothesis-LOH-NF-kB & Wnt- β signalling pathway in human cancer.

Unit-IV

Apoptosis& Metastasis: Bcl2 family proteins, Caspases, Apoptotic signaling pathway (Intrinsic and extrinsic pathway- Telomeres and immortality-Molecular mechanism of tumor metastasis &EMT markers - VEGF &Tumor angiogenesis.

Unit-V

Diagnosis and Treatment: NGS based Diagnostic Approaches, Tumor markers & Tumor suppressor genes as diagnostic tool- **Strategies for cancer therapy:** Chemotherapy & classification of cytotoxic drugs (Alkylating agents, Platinum drugs, Topoisomerase inhibitors, Mitotic inhibitors), Radiotherapy, Gene therapy, Immunotherapy, Monoclonal antibody (dostarlimab) & Stem Cell therapy -Precision cancer medicine.

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UNIT VI Current Contours: (Not for Final Exam only for Discussion)

India Cancer Research Consortium (ICMR-ICRC), Global Cancer Consortium and its activities-
Milestones in cancer research-Artificial intelligence based therapy design.

Reference Text Books:

1. Bruce Alberts, Molecular Biology of the Cell, Garland Science Publications, Newyork, USA.
2. Ed. Stella Pelengaries and Michael Khan (2006), The molecular biology of Cancer, Blackwell publishing.
3. Hanahan, Douglas et al.,(2011), Hallmarks of Cancer: The Next Generation,Cell , Volume144 , Issue 5 , 646 – 674, 2011
4. R. A. Weinberg (2006), The Biology of Cancer:. Garland Science.
5. R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G.Barry Pierce, I. Damjanov (2006), The Biological Basis of Cancer, 2nd Edition, Cambridge University Press.
6. Liciniio, J., Wong, M. L. (2003). Pharmacogenomics: The Search for Individualized Therapies.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand the basic properties of cancer cells and hallmarks of cancer.
- Analyze that how tumor staging and grading are performed
- Describe the cell cycle regulatory mechanism and its significance & impact in cancer therapeutics
- Order the steps involved in molecular mechanism of cancer progression & metastasis
- Describe an Oncogene, proto oncogenes and function of tumor suppressor genes
- Explain how the Intrinsic and extrinsic stimuli can lead apoptosis through signalling pathway.
- Analyze and critique in recent advancement of cancer diagnostics and treatment options such as precision cancer medicine & stem cell therapy
- Read and understand the research papers in cancer biology and formulate hypotheses for their student research projects

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V YEAR - IX SEMESTER

Core Choices Course - Nutraceuticals

Course Code: CO03/BM59C19N

Credits: 5

Objectives:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.
- To expose the learner to the health benefits of various classes of phytochemicals along with their salient chemical features, pharmacokinetics, doses and marketed preparations

Unit I:

Introduction and Significance: Introduction to Nutraceuticals and functional foods; classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario.

Unit II:

Phytochemicals As Nutraceuticals: Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals stability, analytical and labelling issues.

Unit III:

Assessment Of Antioxidant Activity: in vitro and in vivo methods for the assessment of antioxidant activity, comparison of different In Vitro methods to evaluate the antioxidant, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress.

Unit IV:

Nutrition Related Diseases And Disorders : Malnutrition and factors responsible for nutritional disorders and anti-nutritional factors (cyanogens, lectins, enzyme inhibitors, phytoalexins and phytates); Metabolic disorders - types, nutritional factors, prevention and treatment using nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia and immune competence.

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Unit V:

Role In Health: The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Importance and function of probiotic, prebiotic and synbiotic and their applications. Safety Issues: Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues- International and national.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Food as remedies- Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina etc.

Reference Text Books:

1. Bisset, Normal Grainger and Max Wich H (2001).“Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC,.
2. Handbook of Nutraceuticals and Functional Foods (2006). Robert Wildman, CRC , Publications.
3. WEBB, PP, (2006) Dietary Supplements and Functional Foods Blackwell Publishing Ltd United Kingdom.
4. Ikan, Raphael (2005) “Natural Products : A Laboratory Guide”, 2nd Edition, Academic Press /Elsevier,
5. Tipnis, H.P. “Bioavailability and Bioequivalence : An Update” New Age International.
6. Handbook of nutraceuticals and functional foods by Robert E C. Wildman, CRC/Taylor & Francis
7. Yahwant Vishnupant Pathak, (2009). Handbook of nutraceuticals Vol I &II by, CRC press.
8. Glenn R. Gibson, Marcel Roberfroid,(2008). Handbook of Prebiotics, CRC press, 2008.
9. Swaminathan M., (1985), Essentials of Food and Nutrition, 2nd Ed, Ganesh and Co.
10. Whitney, E.N. & Rolfes, S.R.. (1999): WesV Wadsworth, Understanding Nutrition, 8th Edition An International Thomson Publishing Co.
11. Anderson, Dibble, Turkki, Mitchell, Rynbergen J.B. (1982). Nutrition in Health and Disease 17th Edition; Lippincott Company.
12. John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), (2007) Asian Functional Foods (Nutraceutical Science and Technology) by CRC Publications, Taylor & Francis.
13. Ronald Ross Watson (Author), (2007), Functional Foods and Nutraceuticals in Cancer Prevention by Blackwell Publishing.

Student Learning Outcome: (Should have a minimum of 8 points)

Upon successful completion of the course student will be able to:

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- Explain concept of nutraceuticals and dietary supplements, classify these based on chemical nature, health benefits and mechanism of action
- Discuss the chemistry of phytochemicals, their health benefits, pharmacokinetics, interactions with food and recommended doses along with the marketed preparations
- Explain the challenges in formulating nutraceuticals
- Understand the significance of safety and stability studies of nutraceuticals
- Describe the labeling and regulatory aspects for manufacture and sale of nutraceutical products.
- To familiarize the students with the field of functional foods and nutraceuticals.
- To evaluate examples of scientific evidence supporting value-added functional foods
- Nutraceuticals supplementation for chronic disease prevention.

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V YEAR - IX SEMESTER

Core Choices Course – Biomaterials and Biosystems

Course Code: CO03/BM59C19B

Credits: 5

OBJECTIVES

- It is to acquire knowledge on the basic concepts of biomaterials and tissue interactions.
- Understand the desirable and undesirable reactions of the body with implanted materials.
- It intended to perceive the knowledge on various biomaterials and soft biomaterials helps to balance the health issues like orthopedic, cardiovascular, ophthalmologic and dental issues.

UNIT I :

Introduction to biomaterials, requirements for biomaterials, Classification of biomaterials: metallic, ceramic, synthetic and natural polymers. Properties of biomaterial; Effects of physiological fluid on the properties of biomaterials;

UNIT II:

Metallic and Ceramic implant materials: Biological response of implanted materials, desirable and undesirable reactions of the body with implanted materials, Materials used for orthopaedic implants, Materials used for dental, modes of dental implant failure, materials used for cartilage and vascular, bladder, modes of cartilage implant, vascular implant, implant failure study, modes of bladder implant failure.

UNIT III:

Polymeric implant materials: Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

UNIT IV:

Protein interactions with implanted materials, cellular recognition of proteins adsorbed on material surfaces, adhesion, migration, differentiation, cellular extra cellular matrix deposition leading to tissue regeneration, foreign-body response, inflammatory response.

UNIT V:

Biocompatibility & Toxicological screening of biomaterials: Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

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REFERENCES;

1. Biomaterial Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et.al. Academic Press, San Diego,1996
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House , 2002.
3. J B Park, Biomaterials-Science and Engineering, Plenum Press, 1984.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend various biomaterials.
- Describe the methods for fabricating biomaterials.
- Illustrate the properties of biomaterials
- Describe various applications of biomaterials.
- Know the therapeutic strategies using biomaterials
- Elucidate the biocompatibility of the biomaterials
- Methods involving analysis of biomaterials.
- Understanding various limitations and challenges in usage of biomaterials.

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V YEAR - IX SEMESTER

Elective Course: Biopharmaceutics and Pharmacokinetics

Course Code: EC03/BM59E3

Credits: 4

Objectives:

- Define the basic concepts in biopharmaceutics and pharmacokinetics
- Determine the effect of Pharmacokinetic (ADME) parameters on the biological effects of the drug
- Carry out biopharmaceutical studies and use data so obtained in the development of new drugs or dosage forms

Unit I:

Absorption; Mechanisms of drug absorption through GIT, factors influencing drug absorption through GIT, absorption of drug from Non per oral extra-vascular routes. Dissolution; Factors affecting dissolution. Distribution; Tissue permeability of drugs, organ/tissue binding of drugs and perfusion, apparent, volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding.

Unit II:

Metabolism; Drug metabolizing organs and Enzymes, chemical pathways of Drug Biotransformation Phase I and Phase II Reactions, Factors affecting Biotransformation. Elimination; Renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non renal routes of drug excretion of drugs.

Unit III:

Bioavailability and Bioequivalence; Definition and Objectives of bioavailability studies, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs

Unit IV:

Pharmacokinetics; Definition and introduction to Pharmacokinetics, Compartment models, Non compartment models, physiological models, Plasma Drug Concentration, Determination of pharmacokinetics parameters and their significance - Absorption Rate Constant (k_a), Elimination Rate Constant (K) & Elimination Half-life ($t_{1/2}$), AUC, C_{max} , and t_{max} . Apparent Volume of Distribution (V_d) & Renal Clearance (Q).

Unit V:

Compartment Modeling: One compartment open model (IV bolus), Nonlinear Pharmacokinetics: Causes of Non-linearity, Michaelis-menton method of estimating parameters, Estimation of K_m

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and Vmax Applications of Pharmacokinetic Principles: Design of Dosage Regimens, Individualization, Monitoring of Drugs Therapy.

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Chronopharmacokinetics, drug toxicity and forensic pharmacokinetics, kinetics of maternal-fetal drug transfer, pharmacokinetics v/s pharmacological/clinical response, metabolic kinetics

Reference Text Books:

1. Rosenbaum, S. E (2016) “Basic Pharmacokinetics and Pharmacodynamics: An Integrated
2. Text
book and Computer Simulations”, 2nd Edition, John Wiley & Sons,.
3. Brahmkar, D.M. and Jaiswal, S.B. (2015) “Biopharmaceutics and Pharmacokinetics: a
Treatise”, 3rd Edition, Vallabh Prakashan.
4. Chatwal, G.R. (2014) “Biopharmaceutics and Pharmacokinetics”, 2nd Edition, Himalaya
Publishing House.
5. Shargel, L and Andrew, B.C. Yu. (2016). “Applied Biopharmaceutics &
Pharmacokinetics”, 7th Edition, The McGraw-Hill Companies, Inc,
6. Gibaldi, M. (2016). “Biopharmaceutics & Clinical Pharmacokinetics”, 4th Edition, Pharma
Book Syndicate.
7. Jambhekar, S.S. and Philip, J. B. (2012). “Basic Pharmacokinetics” 2nd Edition,
Pharmaceutical Press.

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand various pharmacokinetic parameters, their significance & applications
- To critically evaluate Biopharmaceutics studies involving drug product equivalency.
- To design and evaluate dosage regimens of the drugs using pharmacokinetic and biopharmaceutical parameters
- Determine the effect of Pharmacokinetic (ADME) parameters on the biological effects of the drug
- Carry out biopharmaceutical studies and use data so obtained in the development of new drugs or dosage forms
- Design dosage regimens for patients based on calculated pharmacokinetic parameters
- Design Bioavailability and Bioequivalence studies of new drugs or dosage forms
- Evaluate drug-protein binding as a tool to predict pharmacokinetics of drugs.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

V Year - IX Semester

Elective Course: Research Methodology and Biostatistics

Course Code: EC03/BM59E3

Credits: 4

Objectives:

- To understand the rationale and logic of conducting a research work.
- To understand research design approaches to be adopted principles of sampling, methods and methodologies to be employed.
- To understand the methods of data collection, analyses, presentation methods and preparation of reports.

Unit I:

Meaning of research – Objectives of research – Types of research – Pure, applied, historical, analytical, descriptive and experimental – Significance of research – Research methods versus methodology – Scientific and research methods – Induction and Deduction – Research process.

Unit II:

Planning Research – Defining research problem – Identification, selection and Formulation of research problem – Review of literature – Hypothesis – Meaning, sources of hypotheses – Types of hypothesis – Formulation and testing – Research design – Meaning, need, features of a good design – Basic principles of experimental design – Factors affecting research design – Evaluation of research design.

Unit III:

Sampling Design – Census method and sampling method for investigation – advantages and disadvantages of sampling – Principle of sampling – Essentials of good sampling – Methods of sampling – Probability and Non-probability sampling methods – Random sample – Factors affecting sample size – Sampling and non sampling errors.

Unit IV:

Methods of Data collection – Primary and Secondary data – Modes of data collection – Analytical method – case study – observation method – interview method – Questionnaires in data collection – Collection of data through schedules – Advantages and limitations – Pre-testing and its importance.

Unit V:

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

Processing and analysis of data – Types of analysis – Statistics in research – Editing, Coding, Tabulation and Diagrams – Process of interpretation – Guidelines for making valid interpretations – Report writing – Roles and types of reports – Contents of research reports – Steps involved in drafting reports – Referencing.

Unit VI: Current Contours (Not for Final Exam only for Discussion):

Understanding market research before launching of any consumer products, understanding success stories of clinical trials before launching of drugs in market.

Reference Text Books:

1. C.R. Kothari (2004) - Research Methodology – Methods and Techniques (2nd Edition.)
2. Ranjit Kumar (2011) – Research Methodology (Third Edition).

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Definition of " research" and understanding the various steps to do research.
- Explains about different types of research based on objectives.
- Explain the differences between research methodology and research methods.
- Describes the research problem and types of hypothesis and their needs.
- Explains about sample designs and types of sampling.
- Explains about various methods for data acquisition and development of questionnaire and interview methods.
- Explains the statistical methods or data analyses.
- Explains the method of writing report and summation.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

V YEAR - X SEMESTER

Core Course 17- Nanomedicine

Course Code: CC17/BM510C20

Credits: 5

Objectives:

- To acquire knowledge about nanomaterials and its applications in the field of nanomedicine.
- Understanding treatment strategies for human diseases, through nanotherapeutics.
- Understanding methods of drug delivery to the targets using nanoparticles.

UNIT I:

Introduction to Nanotechnology, Nano-scaling, Various Structures and synthesis of Nanomaterials: Top-down (Nanolithography, CVD), Bottom-up (Sol-gel processing, chemical synthesis). Wet deposition techniques. Properties of nanoscale materials (optical, electronic and magnetic). Rationale for designing of nanomedicines.

UNIT II:

Materials for preparation of nanomedicines. Metallic and Semiconductor Nanomaterials, Quantum Dots, Nano wires, Nano-clusters, Bucky balls and Carbon Nanotubes. Nanosystems- Liposomes and Polymeric micelles, Dendrimers, Vesicles.

UNIT III:

Characterization of Nanomaterials, Spectroscopic techniques – UV visible and infrared spectroscopy, Raman spectroscopy, X-ray diffraction, Microscopy - SEM, TEM, AFM, etc. Characteristics and Biocompatibility of nanoparticles,

UNIT IV:

Basics of drug delivery, Types - polymer, lipid, metal-based drug delivery system and miscellaneous. Targeted delivery- Active and passive targeting - Enhanced permeability and retention effect, multifunctional property of nanoparticles. Nanocarriers for gene delivery applications. Nanorobots

UNIT V:

Nanoparticle applications in imaging and diagnostics. Dendrimers as a Multi-functional carrier. Role of Nanomedicine in cell repair and tissue engineering. Nanomedicine against infectious organism, Nanotechnology in drug resistance. Future applications of Nanomedicine. Limitations of nanotechnology. Social and ethical issues, environmental concerns and potential toxicity.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

UNIT VI-Clinical translation of nanomedicines: Preclinical and clinical considerations of nanomedicines, Overview of current clinical nanomedicines, Regulations of nanomedicines for human health.

References:

1. Nanomedicine – P.K.Sharma.
2. Medical Nanotechnology and Nanomedicine (Perspectives in Nanotechnology)by Harry F.Tibbals and H.F. Tibbals (2010)
3. The Handbook of NanomedicinebyK. K. Jain (2010)

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Comprehend the importance of Nanostructures.
- Describe the principle Nano-scale structures.
- Illustrate the chemical, physical and biological properties of nanomaterials.
- Describe various methods of synthesizing nanomaterials.
- Know the characterization methods of nanoparticles.
- Elucidate the mechanism of transporting nanomaterials across living cells.
- Explain various applications of Nanomaterials.
- Knowledge pertaining to challenges, toxicity and future of nanotechnology.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

V Year - X Semester

Core Course -18: Biosafety, Bioethics & IPR

Course Code: CC18/ BM510C21

Credits:5

Objectives:

- To introduce the various aspects of biosafety and levels of biosafety in laboratory.
- To study principles of bioethics and its guidelines.
- To understand Good manufacturing Practice (GMP) and Good lab practices (GLP)
- enable students to understand Biosafety assessment of pharmaceutical products such as drugs/vaccines
- To learn about Intellectual Property Rights and its importance.

Unit-I

Biosafety: Introduction - Laboratory associated infections and other hazards, Introduction to Biological Safety Cabinets-Assessment of biological hazards and Biological Containment- Good manufacturing Practice and Good lab practices (GMP and GLP)

Unit-II

Bioethics: Principles of bioethics- Social and cultural issues of Bioethics--Animal ethics; Guidelines for use of lab animals - Licensing of animal house -IAEC & CPCSEA- Ethical concerns of gene cloning- Ethical clearance norms for conducting studies on human subjects, NECRBHR, ICMR- Ethical implications of human genome project-Ethical issues in Human Cloning and stem cell research -Biopiracy

Unit-III

Regulatory framework of Biosafety: Biosafety guidelines and regulations (National and International) for rDNA and other biological researches -RCGM, RDAC, GEAC, IBSC, SBCC& DLC, IBSC- Definition of GMOs & LMOs - GM Labeling-Ecological safety assessment of GMO's (Eg. Bt cotton) and mixing up with the gene-pool- Bioterrorism and convention on biological weapons- Cartagena protocol

Unit-IV

Pharma and Medical Sector: Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials. Ethical concerns related to prenatal diagnosis, Gene therapy, Organ transplantation, Xenotransplantation, Ethics in patient care, Informed consent

Unit-V

Intellectual Property Right (IPR): Introduction- Different forms of IPR - Overview of WTO, WIPO, GATT & TRIPs- **Patents:** Basis of Patentable and non patentables- Patent Application Procedure in India, PCT- Other Forms of IPR: Trade Mark - Designs-Copyrights, Geographical Indications, Trade secrets, Non-disclosure agreements- Patent Life and Geographical Boundaries - Country-wise patent searches (USPTO, EPO, India etc.)-Traditional Medicine & IP Protection- Treaties and Conventions of Patents.

M.SC BIOMEDICAL SCIENCE (5 YEAR INTEGRATED) PROGRAMME

Unit VI: Current Contours (Not for Final Exam only for Discussion)

Advances in Synthetic Biology and Biosafety Governance-Indian Patent Act 1970 and Patent (Amendments) Act (2002), Protocols in exchanging Biological material across borders, Food Safety and Standards Authority of India (FSSAI), IP as a factor in R&D-Protection of environment and biodiversity-OECD consensus documents and Codex Alimentarius.

Reference Text Books:

1. Singh K. Intellectual Property Rights on Biotechnology, BCII, New Delhi.
2. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
3. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
4. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
5. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub
6. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed).ASM Press, Washington.
7. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from <http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf>
8. GOI's Patents Website: patinfo.nic.in
9. Intellectual property India: www.ipindia.nic.in
10. USPTO Web Patent Databases at: www.uspto.gov/patft

Student Learning Outcome:

Upon successful completion of the course student will be able to:

- Understand the basic concepts in the laboratory biosafety.
- Analyze the basic principles of bioethics and its importance in biological, biomedical, health care research.
- Gain knowledge about biosafety regulations and bioethics in the context of modern biotechnology
- Imply the Good manufacturing Practice and Good lab practices (GMP and GLP)- Standard Operating Procedures (SOP) for biotechnology & biomedical research
- Analyze the basic principles of bioethics and its importance in animal experiments.
- Understand different types of intellectual property rights and Create awareness about biosafety in biotechnological processes and products.
- Apply the biosafety issues in clinical trials and medical research
- Follow the guidelines of biosafety & practices in biosafety labs