Feb 2021

Department of Biochemistry and Molecular Biology

Central University of Kerala (CUK)

[SYLLABUS FOR MSC BIOCHEMISTRY (CUK)]

SYLLABUS (Feb - 2021)

M.Sc., (BIOCHEMISTRY) PROGRAM

Department of Biochemistry and Molecular Biology (BCMB)

Central University of Kerala

Periye, Kasaragod -671316

PROGRAM OUTCOMES
The program will help to,
1: Generate knowledgeable, trained and skilled post-graduates in the area of Biochemistry and molecular biology
2: Equip the postgraduates to embark on innovative research in the various branches of modern biology
3: Contribute in the area of Education, Biomedical science, Agriculture and Industry of the country

SPECIFIC OUTCOME

Equip the students for exploiting the biochemical and molecular Biology tools to contribute towards disease modeling and diagnosis

COURSE CODES & No	TITLE	CONTACT HOURS PER WEEK			
		L	T	P	C
CORE	**COURSES**				
BBM 5101	BIOMOLECULES	3	1	0	3
BBM 5102	BIOANALYTICAL TECHNIQUES	3	0	0	3
BBM 5103	CELL BIOLOGY	3	0	0	3
BBM 5104	MOLECULAR PHYSIOLOGY	3	1	0	3
BBM 5191	ANALYTICAL BIOCHEMISTRY LAB	0	0	6	2
BBM 5192	BIOMOLECULES AND CELL BIOLOGY LAB	0	0	6	2
BBM 5201	METABOLISM-I	3	0	0	3
BBM 5202	ENZYMOLOGY	3	1	0	3
BBM 5203	IMMUNOLOGY	4	1	0	4
BBM 5204	MOLECULAR BIOLOGY	3	1	0	3
BBM 5291	ENZYMOLOGY LAB	0	0	6	2
BBM 5292	IMMUNOLOGY & MOLECULAR BIOLOGY LAB	0	0	6	2
BBM 5301	METABOLISM-II	3	1	0	3
BBM 5302	MOLECULAR DIAGNOSTICS	2	1	1	3
BBM 5303	GENETIC ENGINEERING	4	1	0	4
BBM 5304	MOLECULAR CELL BIOLOGY	4	0	0	4
BBM 5305	MICROBIOLOGY	3	1	0	3
BBM 5391	MICROBIOLOGY AND GENETIC ENGINEERING LAB	0	0	6	2
BBM 5401	DISSERTATION	0	0	24	8
ELECTIVE	**COURSES**				
BBM 5001	CLASSICAL AND MOLECULAR GENETICS	2	0	0	2
BBM 5002	PLANT BIOCHEMISTRY	3	0	0	3
BBM 5003	COMPUTATIONAL BIOLOGY	3	0	0	3
BBM 5004	BIOSTATISTICS	3	0	0	3
BBM 5005	METABOLIC REGULATION AND FUNCTIONAL METABOLISM	3	0	0	3
BBM 5006	MOLECULAR VIROLOGY	3	0	0	3

BBM 5007	TISSUE ENGINEERING	3	0	0	3
BBM 5008	MOLECULAR NUTRITION AND NUTRIGENOMICS	3	0	0	3
BBM 5009	GLYCOBIOLOGY	2	0	0	2
BBM 5010	INTRODUCTION TO EPIGENETICS	2	0	0	2
BBM 5011	CLINICAL BIOCHEMISTRY	2	0	0	2
BBM 5012	GENOMICS AND PROTEOMICS	2	0	0	2
BBM 5013	VASCULAR BIOLOGY	2	0	0	2
BBM 5014	ADVANCES IN RNA BIOLOGY	2	0	0	2
BBM 5015	MOLECULAR ONCOLOGY	3	0	0	3
BBM 5016	INDUSTRIAL ENZYMES	2	0	0	2
BBM 5017	MOLECUALR ENDOCRINIOLOGY	3	0	0	3
BBM 5018	ANIMAL MODELS IN BIOMEDICAL RESEARCH	3	1	0	3

L-Lecture, T-Tutorial, P –Practical, C-Credits

Eligibility. BSc Degree with Biochemistry or Chemistry or any subject under life sciences as a main/core subject. Admission will be based on an admission test.

Minimum credit required for successful completion of the program is 72 credits including that of core courses, Elective Courses and Dissertation

Evaluation. Continuous evaluation based on specific components such as Tests, seminars, assignments/quiz carries 40% weightage and end semester examination carries 60% weightage. For laboratory courses, end semester examination carries 25% weightage and continuous assessment carries 75% weightage. Overall performance of the student will be indicated in Grades.

CORE COURSES

BBM 5101 BIOMOLECULES (3-1-0-3)

Course Outcomes:

The course will help to,

1: Understand the classification, structure and function of biomolecules, the building block of cells.

2: Visualize the biochemical process in terms molecular events

3: Design the experiments to characterize the novel biomolecules based on the chemical nature of the molecules

4: Develop the strategies to exploit the biomolecules for the benefit of the society

UNIT-I

Chemistry of Carbohydrates: Structure, Classification, physical and chemical properties and biological importance of sugars. Important derivatives of monosaccharides. Blood group polysaccharides, storage and structural polysaccharides, bacterial cell wall polysaccharides, proteoglycans and glycoproteins. Structural features of oligosaccharide side chains O- glycans and N- glycans.

UNIT-II

Chemistry of lipids: classification and properties. Essential fatty acids ω_3 and ω_6 fatty acids. Triacylglycerides- properties and biological significance. Storage and membrane lipids- biological significance. Phospholipids- properties and functions. Isoprenoids, sterols, cholesterol, prostaglandins and glycolipids.

UNIT-III

Amino acids: classification, structure, zwitter ions, reactions, properties. Separation of aminoacids, essential amino acids. Peptides:solid phase synthesis of peptides and biologically important oligo peptides. Proteins. Titration curve

Nitrogenous bases: nucleosides and nucleotides- structure, function and properties, isolation and separation of DNA.

UNIT-IV

Determination of protein structures –Peptide bond, Ramachandran Plot, protein sequencing methods, primary, secondary, tertiary and quaternary structural organization. Properties of protein, structure, motifs, fold. Protein folding. CD as a sensitive indicator in chain conformation of proteins. Chaperons- structure and function. Relationships in protein families. Protein- protein interaction, protein- ligand interaction. Protein denaturation. Prediction and engineering of protein structures.

UNIT-V

Levels of structure in different classes of nucleic acids. Structure of DNA- Watson Crick model. Different forms of DNA. Right handed and left handed helix. Supercoiling, chromatin-nucleosomes, structural polymorphism in nucleic acids. DNA and RNA sequencing- dideoxy method, oligonucleotide synthesis, classes of DNA sequence.

Types of RNA – structural features of tRNA, ribosome structure and assembly, nucleic acid denaturation, hybridization, macromolecular interaction, protein nucleic acid interaction.

Recommended books

1. Metzler, David E. Biochemistry (2 Volume Set): The Chemical Reactions of Living Cells. Elsevier, 2003.
2. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2011.
3. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
4. Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 2012.
5. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 2008.
6. Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. WM. C. Brown, 1995.
7. Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's illustrated Biochemistry (Harper's Biochemistry). McGraw-Hill Medical, 2006.
8. Devlin, Thomas M. *Textbook of biochemistry: with clinical correlations*. John Wiley & Sons, 2011.

BBM 5102 BIOANALYTICAL TECHNIQUES (3-0-0-3)

Course outcomes:

Students will be able to:

1: Acquire knowledge to prepare solutions of different concentrations and analyse them spectrophometrically

2: Understand the testing of analytes by chromatography

3: Understand the concepts of separation of biological samples by electrophoresis

4: Acquire knowledge of cell culture system and techniques associated with mass spectroscopy, X ray crystallography

UNIT-I

Acids, Bases and Buffers, Donnan membrane equilibrium,. Biochemical separation techniques: Principle and application of (a) Chromatographic techniques –affinity chromatography, ion exchange chromatography, gel filtration, TLC, GC, HPLC, Reverse Phase Chromatography. (b) Electrophoretic methods, isoelectric focusing and blotting (c) Ultracentrifugation (d) GC MS, LC MS .

UNIT-II

Methods of determination and analysis of biomolecular structures, optical spectroscopy, NMR, , mass spectrometry, X ray crystallography. ORD, CD, Fluorescence polarization, FRET. Spectrophotometry - Electronic absorption and emission spectroscopy of atoms and molecules, Light scattering, Ultraviolet and Visible Spectroscopy, Infrared Spectroscopy. Raman Spectroscopy

UNIT-III

Karyotyping, FISH. Cell culture techniques, growth of cells in culture, primary culture, cell lines, applications. Sub cellular fractionation, , flow cytometry. Single cell transcriptomics and single cell proteomics

UNIT IV:

Sequencing techniques:

Next-Generation sequencing – Introduction, Overview, history and development of sequencing techniques. Basic terms and principles. NGS technologies and platforms

Illumina, Pacific Biosciences and Oxford Nanopore – how they work. NGS applications and workflow.

Recommended books

1. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker, 2010.
2. Introduction to Instrumentation in Life Sciences. Prakash Singh Bisen and Anjana Sharma. 2012.
3. Crystallography Made Crystal Clear. Rhodes G. 2000.
4. U Satyanarayana, Biochemistry, Books And Allied (p) Limited, 2014
5. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2012.
6. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
7. Bancroft, J.D. and Stevens, A.: theory and practice of histological techniques ed.3, Churchill livingstone inc. 1990. Edinburgh. London, Melbourne and New York.
8. Next Generation Sequencing. Methods and Protocols. Editors: Head, Steven R., Ordoukhanian, Phillip, Salomon, Daniel R. (Eds.)-2018

BBM 5103 CELL BIOLOGY (3-0-0-3)

Course outcomes:

Students will be able to:

1: Acquire knowledge about basic cell structures and dynamics

2: Understand the transport system at cellular levels

3: Understand the concepts of cell division and functioning of different types of cells

4: Acquire knowledge of membrane dynamics

UNIT-I

Milestones in the development of Cell Biology, Cell theory, Cell as unit of life, basic properties of a cell. Prokaryotic and Eukaryotic cells, plant cell and Animal cell. Structure and integrity of cells, organelles of eukaryotic cell, sub cellular organization of activities.

UNIT-II

Plasma membrane: Structure and functions of plasma membrane, different models of plasma membrane, characteristics of fluid mosaic model, biochemical composition, lipid anchored membrane proteins, Role of plasma membrane in cell signaling.

Transport mechanism, passive and active transport, co-transport, symport, antiport, uniport, ion channels, bulk transport, endocytosis, exocytosis, phagocytosis, pinocytosis. Role of clathrin, COPI and COPII in transport. Ca^{2+} and Fe transport.

UNIT-III

Cytoskeleton and organization, microtubules, microfilaments and intermediary filaments. Structure and function of centrosomes. Structure and functions of cilia and flagella.

Structure and function of nucleus and nucleolus. Morphology of chromosomes.

Structure and functions of mitochondria, lysosome, endoplasmic reticulum, Golgi complex, and ribosomes. Transport from ER to Golgi complex, protein sorting in TGN, glycosylation in Golgi complex.

Connective tissue: Collagen, elastin, other fibrous proteins, proteoglycans, fibronectin, other proteins of extracellular matrix.

UNIT-IV

Cell division- mitosis and meiosis, similarities and differences, crossing over, cell cycle- different phases.

Types of cells, stem cells, quiescent cells, cellular differentiation, types of tissues- epithelium, microvilli, basement membrane, structural features and characteristics.

Recommended books

1. Lodish, Harvey. *Molecular cell biology*. Macmillan, 2008.
2. Cooper, G. M., and R. Hausman. "The Cell-A Molecular Approach, 2000."*Sunderland (MA): Sinauer Associates, Inc*, 2000.
3. Pollard, Thomas D., William C. Earnshaw, and Jennifer Lippincott-Schwartz.*Cell biology*. Elsevier Health Sciences, 2007.
4. Pelczar, M. J., E. C. S. Chan, and N. R. Krieg. *Microbiology. Fifth edition, Tata Mcgraw-hill Publishing Company Ltd., New Delhi* (2004).

BBM 5104 MOLECULAR PHYSIOLOGY (3-1-0-3)

Course Outcomes:

Students will be able to

1: Understand the role of various digestive secretions in course of digestion of food components and absorption mechanisms

2: Understand composition of blood, metabolism of hemoglobin and clotting mechanisms and also connective tissue components

3: Understand how oxygen and carbon dioxide interacts with hemoglobin, factors influencing interaction and their transport mechanisms. Water, electrolyte and acid –base balance mechanisms

4: Understand xenobiotics and detoxification mechanisms of liver. Nerve impulse generation and transmission across neuron and between neurons and role of neurotransmitters

5: Understand the mechanisms involved in muscle contraction and relaxation and photochemistry of Vision.

UNIT-I

Digestion and Absorption: Digestion, absorption, role of salivary gland, stomach, pancreas, intestine, liver, gall bladder, secretion of digestive enzymes and HCl, regulation of secretion by secretagogues.

(a)Digestion and absorption of carbohydrates: sodium dependent glucose transport

(b) Digestion and absorption of proteins: exopeptidases, endopeptidases, action of pepsin, action of trypsin, gastric, intestinal and pancreatic phases of protein digestion. Absorption of small peptides and free amino acids, specific transport systems.

(c) Digestion and absorption of lipids: role of bile acids, action of gastric and pancreatic lipases, micellar formation, absorption of lipids

UNIT-II

Blood: composition of blood, functions, physical characters, plasma proteins, separation of plasma proteins, functions of plasma proteins, formed elements. RBC, WBC, platelets and their functions, erythropoiesis, metabolism of erythrocytes, synthesis of hemoglobin, catabolism of hemoglobin, formation of bile pigments, blood coagulation-fibrinolysis and anti-clotting system, anti-clotting drugs.

UNIT-III

Chemistry of Respiration: respiratory gases, reactions of hemoglobin with oxygen, carbon di oxide, protons and 2,3 bisphsophoglycerate, mechanism of hemoglobin action, factors influencing combination of oxygen with hemoglobin, influence of 2,3 bisphsophoglycerate, oxygen transport, carbon dioxide transport, isohydric shift and chloride shift.

Water, electrolyte and Acid –base balance: water metabolism. Homeostatic controls, role of kidney in water and osmolality control. Structure and function of nephron, renal blood flow and

its importance, formation of urine, composition of urine, GFR, functions of tubules, acid –base balance

UNIT-IV

Detoxification mechanisms, liver and xenobiotics, liver- anatomical structure, hepatic function.
Nervous tissue: Structure of neurons, resting membrane potential, action potential, conduction of nerve impulse, transmission of nerve impulse, synapse, neurotransmitters.

UNIT-V

Muscle Chemistry: Contractile system, role of ATP in muscle contraction, mechanism of contraction, relaxation, sources of energy for muscular work.
Biochemistry of vision: Structure and functions of rods and cones, photochemistry of vision, rod vision, photochemical and biochemical reactions, cone vision, light adaptation and dark adaptation, defects in normal vision.

Recommended Books

1. Rodwell, Victor W., David Allen Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil. *Harpers illustrated biochemistry*. McGraw-Hill Medical Publishing Division, 2015.
2. Devlin, Thomas M. *Textbook of biochemistry: with clinical correlations*. John Wiley & Sons, 2011.
3. Hall, John E. *Guyton and Hall textbook of medical physiology*. Elsevier Health Sciences, 2010.
4. Ganong, W. H. Review of Medical Physiology. *Appleton and Lange* 1999.
5. White, A., P. Handler, and E. L. Smith. Principles of *Biochemistry. New York, McGraw-Hill* 1117 (1954).
6. Sherwood, Lauralee. *Human physiology: from cells to systems*. Cengage learning, 2015.
7. Biochemistry – U. Satyanarayana, U. Chakrapani , third edition, ISBN 81-87134-80-1

BBM 5191 ANALYTICAL BIOCHEMISTRY LAB (0-0-6-2)

Course outcomes:

Students will be able to:

1: Practically understand the concept of preparation of standards curves and perform quantitative estimations

2: Acquire skills in quantitating various biomolecules in biological samples using colorimetric and spectrophotometric methods

3: Practically understand the various separation techniques

4: Will learn to isolate biomolecules from biological samples and perform purity analysis by HPLC or TLC.

Quantitative analysis

1. Estimation of glucose
2. Estimation of Protein
3. Estimation of DNA
4. Estimation of Tyrosine,
5. Estimation of Cholesterol
6. Estimation of triglycerides

Bioanalytical Techniques

1. Ammonium sulphate fractionation of Proteins and gel electrophoresis.
2. Separation of Amino acids by Paper Chromatography. Separation of Amino acids by TLC.
3. Extraction of lipids from liver and separation by TLC or adsorption chromatography.
4. Purification and quantitation of cholesterol from Brain or egg yolk
5. Milk analysis-Estimation of lactose, calcium, phosphorous, Preparation of casein
6. Extraction of beta carotene from carrot and analysis by HPLC
7. Estimation of Vitamin C in orange

Recommended Books

1. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker, 2010.
2. Introduction to Instrumentation in Life Sciences. Prakash Singh Bisen and Anjana Sharma. 2012.
3. U Satyanarayana, Biochemistry, Books And Allied (p) Limited, 2014
4. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2012.

5. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
6. Biochemical methods by Sadasivam and Manikam, Wiley Eastern Limited.
7. An introduction to practical Biochemistry by D. T. Plummer, Mc Graw Hill.
8. Laboratory manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited.
9. Introductory Practical Biochemistry by S. K. Sawhney and Randhir Singh, Narosa.

BBM 5192 BIOMOLECULES AND CELL BIOLOGY LAB

Course outcomes:

Students will be able to:

1: Isolate the cells and count them

2: Analyse the viability and examine the division mechanisms of cells

3: Resolve the biological materials by electrophoresis

4: Do cell culture works

Qualitative analysis of the major Biomolecules and major classes of secondary plant compounds

1. Qualitative Detection of carbohydrates, proteins and lipids.
2. Qualitative analysis of Glycosides, Anthraquinones, Flavonoids, Coumarins, Saponins, Polyphenols and Alkaloids

Cell biology lab

1. Isolation and counting of cells-lymphocytes, liver cells.
2. Preparation of cell culture media and sub culturing of mammalian cells
3. Cell viability test- Trypan blue. MTT assay.
4. Mitosis experiment
5. Meiosis experiment
6. Nuclei staining by DAPI / PI
7. Apoptosis- DNA Ladder Pattern, Annexin V staining
8. Flow cytometric analysis

Recommended Books

1) Goldman, Emanuel, and Lorrence H. Green, eds. *Practical handbook of microbiology*. CRC Press, 2015.
2) Dubey, R. C., and D. K. Maheshwari. *Practical microbiology*. S. Chand, 2002.
3) Microbiology: A laboratory manual by Cappuccino and Sherman, Pearson Education, 6th Ed.

BBM 5201 METABOLISM-I (3-0-0-3)

Course outcomes:

The course will help to,

1: Imbibe the knowledge regarding the relevance of thermodynamic principles in the living system

2: Think about the energy transduction and the spontaneity of the living system

3: Understand the catabolic and anabolic process of carbohydrate and its reciprocal regulation

4: Care about the role of carbohydrate in the biological functions, beyond the production of ATP.

UNIT-I

Basic principles of thermodynamics on energy change in chemical reactions, Free energy and Standard Free energy changes in reaction, endergonic and exergonic reactions, high energy bond, high energy compounds. Energetics of metabolic pathways, energy coupling (ATP and NADH) and coupled reactions. Oxygen consumption, heat evolution. Redox potential and thermodynamics of oxidation reduction reactions.

UNIT-II

Introduction to metabolism: catabolism, anabolism, methods of study of metabolism, autophagy Metabolism of carbohydrates: Glycolysis, pentose phosphate pathway, gluconeogenesis, metabolism of glycogen and starch. TCA cycle, interconversion of sugars and related pathways, regulation of carbohydrate metabolism.

UNIT-III

Metabolism of Glycogen: Storage form of carbohydrate and significance. Overview of glycogenesis and gluconeogenesis- detailed study of hormonal regulation and role of secondary messengers. Mechanism of blood glucose maintenance. Mechanisms to avoid futile cycles.

UNIT-IV

Oligosaccharide Metabolism: Biosynthesis of mucopolysaccharides- hyaluronic acid, chondroitin sulfate, dermatan sulfate, heparin and keratin. Metabolism of mucopolysaccharides, glycoproteins and proteoglycans.

UNIT-V

Electron transport chain, ultrastructure of mitochondria, electron transferring enzymes-pyridoxine linked dehydrogenases, flavin linked dehydrogenases and oxidases, cytochromes,

iron- sulphur proteins and quinone. Pathway of mitochondrial electron transport in respiratory chain. Energetics of electron transport, inhibitors of electron transport chain, mitochondrial transporters and shuttle systems, Free radicals.

Functions of ATP, substrate level phosphorylation, oxidative phosphorylation. Mechanisms of oxidative phosphorylation- energy coupling, chemical and chemiosmotic, conformational coupling, ATP synthesis, inhibitors and uncouplers of oxidative phosphorylation, control of oxidative phosphorylation.

Recommended Books

1) Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry: a short course. Macmillan, 2011.
2) Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
3) Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 2012.
4) Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 2008.
5) Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. Wm. C. Brown, 1995.
6) White, Abraham, Philip Handler, and Emil L. Smith. “Principles of Biochemistry.”Academic Medicine 39.12 (1964).
7) Metzler, David E. Biochemistry (2 Volume Set): The Chemical Reactions of Living Cells. Elsevier, 2003.

BBM 5202 ENZYMOLOGY (3-0-0-3)

Course outcomes:

The course will help to,

1: Understand the concept of catalysis and Enzyme catalysis in particular.

2: Comprehend enzyme kinetics and derive the equations for various orders of enzyme catalysis.

3: Know the mechanism of enzyme catalysis

4: Understand the various levels of regulation of enzyme activity.

UNIT-1

Enzymes-Historical perspectives, general features of enzymes. Enzyme techniques- isolation and purification of enzymes, criteria of purity, Classification and nomenclature of enzymes, enzyme specificity. Coenzymes and Co factors: Structure and function of CoA, TPP, PLP, NAD/NADP, FAD, FMN, Biotin, folic acid, Vitamin B12 coenzymes.

UNIT-II

Enzyme kinetics: velocity of a reaction, order of a reaction, methods to study velocity of an enzyme reaction, progress curve, factors influencing velocity of an enzyme reaction-MichaelisMenten equation, Km, Vmax, effect of pH, temperature, enzyme concentration. Analysis of Kinetic data-Lineweaver-burk plot, catalytic efficiency, Halade relationship-Hills plot, Bisubstarate reactions sequential, random, Ping-Pong reactions rate equations with examples.

UNIT-III

Mechanism of enzyme action: Active site, mechanisms at the active site, covalent and acid-base catalysis, proximity and orientation effects, structure and mechanism of action of chymotrypsin and ribonuclease. Ribozymes, isozymes, multienzyme complexes.
Enzyme Inhibition- competitive, non-competitive, uncompetitive inhibition and mixed, anti metabolites, suicide substrates.

UNIT-IV

Regulation of enzyme activity- allosteric control- reversible covalent modification- proteolytic activation- sequential- concerted and cumulative feed- back control - importance of compartmentation- Allosteric enzymes- Jacob and Monod model of allosteric enzymes-Koshland model- subunit interaction and regulation of enzyme activity – ATCase.

Recommended Books

1) Dixon, M., and E. C. Webb. "Enzyme inhibition and activation." Enzymes 3 (1979): 126-136.
2) Palmer, T. Understanding Enzymes, 4th ed., Prentice Hall/Ellis Horwood, London (1995).
3) Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2001.
4) Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
5) Copeland, Robert A. Enzymes: a practical introduction to structure, mechanism, and data analysis. John Wiley & Sons, 2004.
6) Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. WM. C. Brown, 1995.
7) Devlin, Thomas M. *Textbook of biochemistry: with clinical correlations*. John Wiley & Sons, 2011.
8) Biological Chemistry Second edition by H. R Mahler and E. H Cordes Harper and Row, 1972.
9) Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding", 2nd ed. (1999), Alan Fersht, W.H. Freeman & Co. New York, NY

BBM 5203 IMMUNOLOGY (4-1-0-4)

Students will be able to

1: Understand the immune system, theories of immunity, kinds of immune responses, different cells involved immune system, innate immunity mechanisms

2: Understand the role of primary lymphoid organs and secondary lymphoid organs in immunity, development of B and T cells, role of MHC in antigen presentation

3: Understand humoral immunity, orchestration, antigens, epitopes, immunoglobulins, antibody classes, antibody diversity mechanisms, cytokines and monoclonal antibodies and techniques.

4: Understand cell mediated immunity, MHC and immune response. T cell maturation, activation and differentiation.

5: Understand hypersensitive reactions, kinds, immunodeficiency disorders, kinds, transplantation immunology

UNIT-I

Overview of Immune system: early theories of immunity, adaptive immunity. Innate basic immunity -physical, physiological defenses, acute phase proteins and interferon; Humoral and Cell mediated immunity. Cells of the immune system: myeloid lineage and lymphoid lineage - Lymphoid, mononuclear, granulocytic cells, mast cells, dendritic cells, Role of complement system in immunity.

UNIT-II

Organs of the immune system-primary lymphoid organs, lymphatic system and Secondary lymphoid organs. Thymus,Bone marrow; Lymph node, spleen and tonsils, MALT, GALT; cells of the adaptive Immunity - T lymphocytes B lymphocytes. MHC molecules-Antigen Presenting Cells-mechanism of antigen processing and presentation. Development of T cells and B cells in the Primary and Secondary Lymphoid organs-Positive and Negative selection.

UNIT-III

Humoral Immunity: Generation of B cell and T cell responses: Antigens- immunogenicity, factors that influence immunogenicity, epitopes, haptens, antigen- antibody interaction, complement activation and its biological consequences, clonal selection, immunoglobulins- structure and function, the immunoglobulin super family, Primary and secondary response of T and B cells. B cell generation, activation and differentiation, cytokines. Interaction, molecular basis of diversity, gene organization, Gene recombination, somatic hypermutation. N-and P-nucleotide addtion. Monoclonal antibodies, formation and selection of hybrid cells, precipitation,

agglutination, Complement fixation, immune-electrophoresis, ELISA, western blotting, and immunofluorescence techniques.

UNIT-IV

Cell mediated Immunity: Major Histocompatibility complex: general organization and inheritance of the MHC, MHC molecules and Genes, Antigen processing and presentation, T cell receptor, T cell maturation, activation and differentiation. Cytokines in immune regulation.

UNIT-V

Immuno-pathology: Hypersensitivity reactions types Immediate and delayed type reactions, causes and treatment. Immunodeficiency and autoimmunity: primary immune-deficiencies, treatment of immune-deficiencies, AIDS, organ specific – Graves disease, Myasthenia gravis, Systemic autoimmune diseases, Rheumatoid Arthritis. Transplantation immunity mechanism of graft rejection. Immunosuppressors-Physical, chemical and biological immune-suppressants. Vaccines and Vaccine Production strategies. Tumor immunology

Recommended Books

1. Essential Immunology by Roit, I. Blackwell Science, Oxford
2. Immunology by Kuby, J. W.H. Freeman and Company, New York
3. Immunology by Roit, brostoff and Male. Mosby Edinburgh
4. Text Book of Immunology by Barrett. The C.V. Masby Company, St. Louis
5. Immunology by Tizard. Saunders College Publishing, Philadelphia
6. The Experimental Foundations of Modern Immunology by W. Clark. John wiley and Sons, New York
7. Cellular and Molecular Immunology by Abbas, Lichtman and Pober, W.B. Saunders Company, Philadelphia

BBM 5204: MOLECULAR BIOLOGY (3-1-0-3)

Students will be able to:

1: Acquire knowledge about concepts of DNA replication and DNA repair

2: Understand the transcription and translation systems of various organisms

3: Understand the concepts of post transcriptional and post translational modifications

4: Acquire knowledge of gene regulation

UNIT-I

Classical experiments in molecular biology, genetic material, molecular structure of genes. Replication in prokaryotes and eukaryotes, details of events, enzymes and protein factors, cellular control, mechanisms of replication.

DNA repair mechanisms, SOS response, recombination repair, nucleotide excision repair (mammalian and E.Coli).

UNIT-II

Transcription (prokaryotes and eukaryotes), RNA polymerase, transcription factors. Differences between prokaryotic and eukaryotic transcription, post transcriptional modification of mRNA, tRNA, rRNA, RNA splicing, spliceosome machinery, alternative splicing, exon shuffling, catalytic RNAs , RNA editing.

UNIT-III

Genetic Code, triplet code, triplet binding assay, general features, incorporation of novel aminoacids, Translation – initiation, elongation, termination of protein synthesis, components required at each stage ,sequence of reaction, inhibitors of protein synthesis, post translational modifications of proteins.

UNIT-IV

Regulation of gene expression in prokaryotes, constitutive and inducible enzymes in bacteria, induction and repression – operon model- Lac operon- Tryptophan operon- arabinose operon. Regulatory RNA gene silencing, RNAi, microRNAs, regulation of gene expression in bacterial virus (bacteriophage). Mobile DNA elements, mechanism of transposition.

UNIT-V

Regulation of gene expression in eukaryotes, interaction with RNA, DNA binding proteins, gene dosage, gene amplification, regulatory transcription factors, Histones acetylation and deacetylation, epigenetic effects.

Recommended Books

1. Essentials of Molecular Biology by David Friedfelder
2. Biochemistry and Molecular Biology by Elliot and Elliot
3. Principles of Genetics by Gardner et al
4. Molecular Biology of Gene (V edition) by Watson et al

BBM 5291 ENZYMOLOGY LAB (0-0-6-2)

Course outcomes:

Students will acquire skilled to:

1: Assay enzymes catalysed reactions and find Vmax and km values

2: Differentially assay the isoenzymic forms of an enzyme

3: Understand enzyme kinetics in the presence and absence of inhibitors.

4: Partially purify enzyme in the nature form and assess its yield and purity

- Enzyme kinetics: Determination of velocity, Progress curve, Effect of substrate concentration, pH, temperature and concentration of enzyme, Determination of Km and Vmax. Inhibition of enzyme- determination of Ki. (Trypsin, Urease, salivary amylase)
- Determination of specific activity of enzymes: Spectrophotometric method (LDH), coupled enzyme assay
- Colorimetric methods (Trypsin, amylase arginase, SGOT),
- Zymography, Isoenzyme detection.
- Partial purification of enzyme (Ammonium sulfate precipitation, Column Chromatography)

Recommended Books

1) Bisswanger, Hans. *Practical enzymology*. John Wiley & Sons, 2013.
2) Wilchek, Meir, and Edward A. Bayer. "Methods in enzymology." (1990).
3) Sawhney, S. K., and Randhir Singh. *Introductory practical biochemistry*. Alpha Science International Ltd., 2000.
4) A textbook of practical biochemistry- Joshi A. Reshmi
5) Practical clinical biochemistry- Harold Varley.
6) Experimental Biochemistry: A student companion by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd., New Delhi.
7) Laboratory Manunal in Biochemistry by Jayaraman, New Age International Publishers, New Delhi.
8) Biochemical methods by S Sadasivan & A Manickam. New Age International Publishers

BBM-5292 MOLECULAR BIOLOGY & IMMUNOLOGY LAB (0-0-6-2)

Students will be skilled to:

1: Isolate various biological materials and amplify them using PCR techniques

2: Use restriction enzymes on an applicative level

3: Perform antibody-antigen reactions

4: Use ELISA as an antibody dependent diagnostic method

Molecular Biology

1. Isolation of chromosomal DNA from animal tissues and separation on agarose gel electrophoresis.
2. Isolation of plasmid DNA from bacterial culture and separation on agarose gel electrophoresis.
3. Isolation of total RNA from animal tissues and separation of RNA by formaldehyde/ agarose gel electrophoresis.
4. Restriction digestion of plasmids
5. PCR and Real Time PCR Assays.

Immunology:

1. Antigen-antibody reaction- Radial Immunodiffusion (RID), Ouchterlony method, agglutination, Quantitative precipitation assay-test,
2. Hemagglutination assay for ABO blood group typing determination of and Rh factor
3. Isolation of lymphocytes from peripheral blood by ficoll method and check the viability of isolated lymphocytes.
4. Lysis of red blood cells (hypotonic lysis with H_2O and ammonium chloride)
5. Immunoelectrophoresis, ELISA
6. Immunocytochemistry

Recommended books

1. Practical clinical biochemistry- Harold Varley.
2. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker, 2010.
3. Practical Biochemistry by David Plumber
4. Practical Immunology by Frank and Westwood

BBM 5301 METABOLISM-II (3-1-0-3)

Course Outcomes:

1: Recognize how fundamental chemical principles and reactions are utilized in biochemical processes.

2: Judge whether a proposed or hypothetical reaction is consistent with the general framework of catabolic and anabolic metabolism.

3: Understand how nutrient sources are turned into metabolic energy and the associated metabolic flux

4: Understand how defects in metabolic pathways can lead to various diseases

5: Reconstruct the anabolism of the essential building blocks of life.

8: Use their factual background knowledge in biochemistry to understand and to duplicate the reasoning that led to key advancements in biochemistry.

UNIT-I

Lipid Metabolism: Biosynthesis of fatty acids – fatty acid synthase and regulation of fatty acid synthesis. Oxidation of fatty acids – alpha, beta and omega oxidation. Biological regulation and significance of fatty acid metabolism. Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Metabolism of triglycerides, phospholipids and sphingolipids. Fatty acid derivatives: eicosanoids, their function and metabolism. Metabolism of lipoproteins, prostaglandins.

UNIT-II

Steroid metabolism: Cholesterol – Biosynthesis and regulation- HMG-CoA reductase and transcriptional regulation mechanisms. Biosynthesis of cholesterol derivatives, bile acids, vitamin D and steroid hormones. Metabolism of lipoproteins. Regulation of steroid metabolism.

UNIT-III

Amino Acid Metabolism: Overview of biosynthesis of nonessential amino acids. Metabolic fate of amino groups- transamination and deamination. Nitrogen excretion- ammonia formation and the urea cycle. Catabolism of amino acid carbon skeleton- glucogenic and ketogenic amino acids.

UNIT-IV

Amino Acid Derivatives: Conversion of amino acids to specialized products (bioactive amines): Histamine, Serotonin, epinephrine and nor-epinephrine. Nitric oxide synthesis and function.

UNIT-V

Nucleic Acid Metabolism: Nucleotide biosynthesis- de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanisms of feedback regulation. Biosynthesis of dNTPs. Mechanism of purine and pyrimidine catabolism.

Recommended Books

1. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of biochemistry." New York: John Wiley & Sons 2008.
2. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
3. Zubay, Geoffrey L., William W. Parson, and Dennis E. Vance. Principles of biochemistry: student study art notebook. Wm. C. Brown, 1995.
4. Metzler, David E. Biochemistry (2 Volume Set): The Chemical Reactions of Living Cells. Elsevier, 2003.
5. Hall, John E. *Guyton and Hall textbook of medical physiology*. Elsevier Health Sciences, 2010.
6. Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's illustrated Biochemistry (Harper's Biochemistry). McGraw-Hill Medical, 2006.
7. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin.
8. White, Abraham, Philip Handler, and Emil L. Smith. "Principles of Biochemistry."Academic Medicine 39.12 (1964).
9. Lawrence A.K. Amedeo J. P. and Steven C.K. Clinical Chemistry
10. Bahr, Manson, and D. R. Bell. "Manson's Tropical Diseases." The English Languages Book Society, Billiere, Tindall and Cassell, Ltd (1996).
11. Medical Biochemistry by Bhagvan
12. Genetic Biochemical Disorders by Benson and Fenson
13. Endocrinology by S.A. Binkley

BBM 5302 MOLECULAR DIAGNOSTICS (2-1-1- 3)

Course Outcomes:
Students will be able to:

1: Acquire knowledge about chromosomal based disease identification methods

2: Understand the various genetic diseases and the techniques discretely used for their diagnosis

3: Acquire knowledge on use of antibodies in cancer therapeutics

4: Acquire laboratory skill in the molecular diagnosis of cancer and viral infections

UNIT-I

Connecting genes with diseases. Detection of genetic defects- tracking disease genes using linked markers, direct tests for disease genes, expression screening, oligonucleotide screening, cloning of chromosome breakpoints, identification of candidate genes. Cloning disease genes. Karyotyping.

UNIT-II

Nucleic acid analysis for diagnosis of diseases. PCR/OLA, analysis of mutations. DNA fingerprinting. Molecular diagnosis of genetic diseases – mutation scanning, gene dosage analysis. Molecular profiling in cancer. Mamaprint, Coloprint. Pharmacogenomics and personalized medicine,

UNIT-III

Genetic disease probes: Analysis of human disease genes. DNA analysis in Duchene muscular dystrophy. X linked chromosomal probes for prenatal diagnosis of X linked retinitis pigmentosa.

UNIT-IV

Monoclonal antibodies for tumor diagnostics, myeloid leukemia, thyroid carcinoma, ELISA, western blotting and PCR for diagnosis of infectious diseases. Enzymes in clinical analysis and marker enzymes.

Molecular Diagnostics Lab Exercise

1. PCR based detection of BCR-ABL-1 fusion in B Cell lymphoma
2. RT-PCR mediated detection of PSA and PSMA for diagnosis of prostate cancer
3. RT-PCT multiplexing analysis of Ck20, CEA and EGFR genes for stagging cancer
4. RT- PCR based detection of Dengue viral infection
5. RT- PCR based detection of Chikungunya viral infection

6. RT- PCR based detection of Adeno viral infection
7. ELISA based detection of NS-1 for detection of Dengue viral infection
8. ELISA of PSA for detection of prostate cancer/ CA-125 for ovarian cancer.

Suggested Readings

1.PCR based diagnostics in infectious diseases. ;Gath DD et al., Blackwell Scientific .1994.
2.Molecular Basis of inherited diseases.;Davies and Read, IRL Press.
3.Molecular diagnostics; Rapley and Walker. Blackwell Scientific.
1997. 4.Molecular Biotechnology; Glick and Pasternak. PanimaPub.
2002.
5.Molecular Diagnosis of genetic diseases. EllestMountford, Humana Press. 2004.
6.Molecular Diagnosis of infectious diseases..Decker and Reischl, Humana Press. 2004.
7.Molecular Diagnostics. ; Patrinos and Ansorge,Elsevier/Academic Press.2005.
8.Molecular Medicine ;R.J.Trent, Elsevier/Academic Press.2005.

BBM-5303- GENETIC ENGINEERING (4-0-0-4)

Course outcomes:

Successful completion of the course will enable students to:

1: Understand recombinant DNA technology and the stepwise methodology to achieve it

2: Learn the concept of generating DNA libraries and various DNA transfer methods.

3: Get an idea of generating transgenic mice. Especially whole body and conditional knockouts

4: Understand the mechanism and details of CRISPR based gene editing

UNIT-I

Recombinant DNA Technology: Basic principles of recombinant DNA technology, restriction endonuclease; Cloning vectors: plasmid vectors, phage vectors, cosmids, high capacity cloning vectors- BACs, PACs, YACs and human artificial chromosomes; Gene transfer methods: Physical, Chemical and Biological. Screening of recombinants: Marker inactivation, nucleic acid hybridization and immunological screening for expressed genes.

UNIT-II

Cloning strategies: Directional Cloning, Blunt ended cloning; Cloning of fusion proteins; Introducing of tags to cloned proteins.

Library Construction: cDNA and genomic DNA libraries, cDNA cloning and cloning from genomic DNA.

UNIT-III

Expression systems: Expression vectors for optimum protein synthesis, solubilization of expressed proteins. Tet-on and Tet- Off systems

Prokaryotic expression systems; Eukaryotic expression systems; Insect cell expression systems-baculovirus transfer vector.

UNIT-IV

Techniques in gene manipulation: Site directed mutagenesis; Random mutagenesis using PCR; protein engineering to improve enzymes, DNA shuffling.

UNIT-V

Transgenic Animals/ Cells: Transgenic animal, Retroviral DNA microinjection and engineered stem cells methods for producing transgenic mice. Whole body Knock outs and conditional knock outs. Use of TALEN, ZFN and CRISPR-CAS in genome editing.

Applications of recombinant DNA technology: production of therapeutic proteins, GMO.

Recommended Books

1) Rapley, Ralph, and David Whitehouse, eds. Molecular biology and biotechnology.Royal Society of Chemistry, 2014.
2) U Satyanarayana, Biotechnology, BooksAnd Allied (p) Limited, 2013.
3) James D. Watson, Recombinant DNA, W. H. Freeman,1992
4) John E. Smith, Biotechnology, Cambridge University Press, 2009.
5) B. D. Singh, "Biotechnology expanding horizons." Kalyani, India (2009).
6) S. B. Primrose, Molecular Biotechnology, Blackwell Scientific Publications,1991
7) Sandhya Mitra, Genetic Engineering: Principles and Practice, McGraw-Hill Education, 2015
8) Pamela Peters, Biotechnology: a guide to genetic engineering, Wm. C. Brown Publishers, 1993

BBM 5304 MOLECULAR CELL BIOLOGY (4-1-0-4)

Course Outcomes:

The course will help to,

1: Acquire knowledge in the fundamental molecular events involved in the cell cycle and its regulation mediated by cyclins and growth factors

2: Visualize the cellular interactions at molecular level

3: Understand the functioning of receptors and orchestration of signalling

4: Imbibe knowledge in the areas of relevance of protein sorting and vesicular trafficking

5: Think about the need for understanding molecular mechanisms to solve the complexities involved in the apoptosis and cancer

UNIT-I

Cell cycle regulation: Phases of eukaryotic cell cycle , regulation of cell cycle, cyclins and cyclin dependent kinases, growth factors, nuclear lamins, inhibition of cell cycle progression. Checkpoints in cell cycle regulation, Cytokinesis.

UNIT-II

Cell signaling: Introduction to cell- cell signaling- overview of signal transduction, Signaling molecules. Nitric oxide, neurotransmitters, peptide hormones, growth factors, eicosanoids. Cell surface receptors and their functions. G protein coupled receptors, receptor protein tyrosine kinases, cytokine receptors. Non receptor protein tyrosine kinases. Receptors linked to other enzymatic activity. Intracellular signaling pathways- cyclic AMP pathways, cyclic GMP pathway, phospholipids and ca^{2+}, Ras and Raf, MAP kinase pathway, JAK/STAT pathway, signal transduction and cytoskeleton, integrins and signal transduction regulation, Wnt signaling, Notch pathway, Hedgehog signaling, RO signaling.

UNIT-III

Cellular Interactions: Cell adhesion, cell-cell and cell- matrix interaction, extra cellular matrix components, multi adhesion proteins and cell –matrix interactions, Fibronectin, Laminin, Integrin receptors. Cell-cell adhesion and adhesion proteins- Cadherin, Ig supergene family, selectin. Adhesion receptors and leukocyte extravasation, connecins, gap junction assembly and cellular communication, receptor biology.

UNIT-IV

Protein sorting and targeting: Overall pathway of synthesis of nuclear coded, secretory, lysosomal and membrane proteins. Import across ER signal hypothesis, post translational modifications of secretory/ membrane proteins in ER, sorting of lysosomal proteins, mannose-6- phosphate receptors, synthesis, trafficking and localization of mitochondrial proteins. Protein traffic into and out of nucleus; peroxisome assembly. Membrane biogenesis; cytoskeleton assembly and vesicular transport.

UNIT-V

Apoptosis and cancer: Programmed cell death, caspases, cell death receptor and apoptosis, pro and anti apoptotic pathways and cell survival , proteosomes, Cancer – development and causes of cancer, Role of oncogenes and tumor suppressor genes in tumor development. Transformation of cells in culture, tumor viruses, tumor suppressor genes.

Recommended Books

1) Pollard, Thomas D., William C. Earnshaw, and Jennifer Lippincott-Schwartz.*Cell biology*. Elsevier Health Sciences, 2007.
2) Lodish, Harvey. *Molecular cell biology*. Macmillan, 2008.
3) Karp, Gerald, and Nancy L. Pruitt. *Cell and molecular biology: concepts and experiments*. J. Wiley, 2002.
4) Cooper, G. M., and R. Hausman. "The Cell-A Molecular Approach, 2000."*Sunderland (MA): Sinauer Associates, Inc*, 2000.

BBM 5305 MICROBIOLOGY (3-0-0-3)

Course outcomes:

1: An understanding of the history of Microbiology, types of microbes and classification.

2: Learn microscopic examination of microbes, growth of microbes, nutritional requirements and growth curve.

3: Learn procedures to isolate pure cultures, types of plating techniques and enumeration of microorganisms using microscopes

4: Students understand the reproduction of viruses, bacteria and fungi and get acquainted with the genetics of viruses and bacteria.

Unit -I

Overview of microbial world, Bacterial taxonomy, Morphological and structural organization of microbes. Ultrastructure of Archaea, Eubacteria, Unicellular eukaryotes (Yeast) and Viruses (Bacterial, animal and tumour viruses)

Unit -II

Cultural characteristics of microorganisms, Microbial growth and nutrition, media formulation, Techniques for enumeration of microorganisms in soil and water, Pure culture and enrichment culture techniques for isolation of heterotrophs and autotrophs, Reproduction and growth, Growth kinetics, factors affecting growth, synchronous growth continuous culture, Strain development-mutation and selection of mutants

Unit -III

Microbial interactions and infection, host-pathogen interactions, microbes infecting humans, veterinary animals and plants, pathogenicity islands and their role in bacterial virulence, quorum sensing

Unit -IV

Industrial applications: Ethanol production, Antibiotics (penicillin and streptomycin), Enzymes (amylase and lipase) and organic acids (citric acid and acetic acid). Food and Dairy Microbiology, Single Cell Protein and Probiotics, Environmental microbiology, Water treatment, Bacteriological analysis of water, Bioleaching, Bioremediation.

References

Darnell J, Lodish H and Baltimore D (1999) Molecular Cell Biology. W.H.Freeman & Co.

Pelczar MJ, Chan ECS and Krein NR (1997) Microbiology, Tata McGraw Publication

Prescott LM, Harley JP and Klein DA (1996) Microbiology. W. C. Brown Publications

BBM 5391: MICROBIOLOGY & GENETIC ENGINEERING LAB (0-0-6-2)

MICROBIOLOGY LAB

Course Outcomes

1: Students are given practice on the Sterilization techniques, Preparation of culture media (liquid and solid). They are taught, culturing, storage and preservation of microbial strains.

2: Learn how to isolate microbes from soil, mouth flora and water samples and prepare pure cultures using streak plate and pour plate methods

3: Taught growth curve measurement of bacterial population by turbidometry/Colony Forming Unit methods.

4: Learn procedures to enumerate microorganisms using microscopes and characterization of microbes by biochemical tests.

1. Preparation of solid and liquid media for growth of microorganisms
2. Isolation and maintenance of microorganism
3. Isolation of pure cultures from soil and water.
4. Microscopic examination of bacteria- staining of bacteria
5. Growth kinetics- turbidometry.

GENETIC ENGINEERING

Course Outcomes

Successful completion of this practical session will provide students the skills for

CO1: designing of the primers and amplifying the gene of interest from the source

CO2: purify vector and carry out restriction digestion of both vector and the inseart

CO3: Purify the restricted products from gel and set up ligation reactions.

CO4: Identify positive clones by PCR and restriction diagnosis.

1. PCR amplification of insert
2. Restriction digestion of the vector and the insert
3. Ligation of restricted DNA fragments
4. Preparation of competent *E.coli* cells, transformation and expression of cloned gene
5. PCR and restriction diagnosis based identification of positive clones
6. Gene knockdown using Si/ShRNA based approach

BBM 5401: DISSERTATION (0-0-24-8)

Course Outcomes

1: The students will be exposed to the various areas of research works which are being conducted by the faculty members

2: Laboratory based **experimental skill** will be provided in the emerging areas of cancer biology, molecular virology, plant innate immune response, secondary metabolites and immunology

3: Students will be trained in the research methodology along with the dissertation thesis and research article writing

4: The course will skill students to conduct doctoral studies

ELECTIVE COURSES

BBM 5001 Classical and Molecular genetics (2-0-0-2)

Students will be able to:

1: Acquire knowledge about Mendelian and non-mendelian inheritance

2: Understand the concepts of chromosomal abberationas and mechanisms of recombination

3: Understand the concepts gene mapping , pedigree drawing

4: Acquire knowledge of gene silencing mechanisms

UNIT-I

Principles of Heredity, Mendelian laws, Genotype to phenotype, Chromosomal theory of inheritance. Non Mendelian pattern of inheritance, autosomal inheritance (dominant and recessive), sex linked inheritance (X and Y linked), extranuclear inheritance, mitochondrial inheritance, polygenic inheritance.

UNIT-II

Linkage, crossing over, Recombination and mapping of genes to chromosomes.

UNIT-III

Eukaryotic chromosomes, Chromosomal rearrangements and changes in chromosome number.

UNIT-IV

Genetic mapping of Mendelian traits: Identification of recombinants in pedigrees, Genetic and physical map distances, genetic markers, two point, multipoint and homozygosity mapping.

UNIT-V

Physical mapping methods and identification of human disease genes. Regulation of gene expression in eukaryotes- Gene silencing and Genome imprinting, RNA interference.

Suggested Readings

1)The Science of Genetics. Atherly,Girton,McDonald(Saunders College Publishing)

2)Genetics. D L Hartl (Jones &Bartlet Publishers)

3)Analysing Chromosomes B Czepulkowski (BIOS)

4) Principles of Genetics M.J. Simmons, D.P. Snustad, E.J. Gardner

5) Human Molecular Genetics T. Strachan, Andrew P. Read

6) An Introduction to Molecular Human Genetics Pasternak

7) Human Molecular Genetics Sudbery

BBM 5002 PLANT BIOCHEMISTRY (3- 1- 0-3)

Course Outcomes:

Students will be able to:

1: Understand the biosynthetic pathways leading to synthesis of diverse metabolites in plants and classification of metabolites

2: Various analytical procedures for determining metabolite composition

3: Strategies towards modulating biosynthesis of plant based metabolites and processes adopted for their large-scale industrial production

4: To motivate them to take up innovative projects in plant biotechnology

5: The importance of germplasm and biodiversity conservation for sustainable utilization of resources

UNIT-I

Photosynthesis and carbon assimilation, Hill reaction, Photosystem I and photosystem II, Photophosphorylation, Light harvesting complexes, Nonphotochemical quenching, Photosynthesis inhibitors, Carboxylation, Sturcture and kinetics of RUBISCO, CO_2 concentrating mechanisms, Storage and utilization of fixed carbon.

UNIT-II

Plant hormones- Structure and function of plant hormones- auxin, cytokinin, ethylene, abscisic acid, florigin, gibberellins, brassinosteroids, jasmonates, salicylic acid, nitric oxide, Steroid and peptide hormones

UNIT-III

Nitrogen Metabolism and Secondary metabolites- Nitrogen cycle, nitrogen fixation, assimilation of nitrate and ammonium ions. Secondary metabolite classes, Biosynthetic pathways and Regulatory enzymes - Shikimic acid pathway, Phenylpropanoid pathway, Polyketide synthesis, Alkaloids and cyanogenic glycosides, Acetate-mevalonate pathway, Methyl-erythritol Phosphate pathway, Prenyl transfer. Antimicrobial peptides.

UNIT-IV

Metabolic engineering, Metabolite profiling-analytical and preparative chromatography, Brief descriptions on metabolite structure elucidation by NMR (one-dimensional and two-dimensional methods), UV-vis and IR spectroscopy, GC-MS, LC-MS, Biotechnological approaches for secondary metabolite production- strategies to increase productivity, Cell, Organ culture and hairy root culture, Optimization of conditions, Precursors, Elicitors, Growth and production kinetics in

bioreactors

UNIT-V

Innate immune responses in plants- Mechanism of pathogenesis, effectors, gene-for-gene resistance, Pathogen recognition and signal transduction, Systemic and induced defense mechanisms, Non-host resistance to pathogens

Suggested Textbooks:

1. Plant Biochemistry - PM Dey and JB Harborne
2. Plant Biochemistry - Gleason FK
3. Introduction to Plant Biochemistry - Goodwin
4. Plant Physiology - Salisbry
5. Plant Biochemistry and Molecular Biology - PJ Lea and RG Heagood

BBM 5003 Computational Biology (2-0-3-3)

Course Outcomes:

Students will be able to:

1: Understand how to retrieve DNA, RNA sequences and protein structures

2: Will be able to develop skills to perform BLAST and phylogenetic analysis

3: Will be able to do 3D modelling of biological molecules and docking studies

UNIT-I

Nature and Scope of Bioinformatics, historic evolution from tools to discipline, systemic approach, the emergence of "-omics', various omics and their scope, Bio- sequence file formats, Bio- databases- primary and secondary- PDB, Swissprot, DDBJ, KEGG, OMIM, NCBI prosite, Pfarm.

UNIT-II

Data base searches- text based and sequence based, sequence alignment- local/ global, pairwise/multiple. Scoring methods, BLAST, using and interpreting its output – e-value and bitscore. Dot Plots- dotlet. Multiple sequence alignment using Muscle and Mafft.

UNIT-III

Analyzing Bio sequences: Basic sequence analysis tools for DNA, RNA. Introduction to molecular phylogenetic, Phylip.

UNIT-IV

Protein databases (Primary, Composite, and Secondary), Protein sequence databases: Genpept, Uniprot, Swissprot, PIR, Specialized Genome databases: (SGD, TIGR), Structure databases (CATH, SCOP, and PDBsum). Structural Bioinformatics: Protein structure data bases and visualization tools- structural alignment. Protein structure prediction methods- Comparative modeling, threading.

UNIT-V

Molecular visualization and analysis: Mol Visualization softwares, Pymol/JMol, Molecular view of diseases, drug discovery pipeline, structure based drug design, structure prediction softwares, molecular docking softwares, overview of pharmaco- genomics, toxico- informatics, immunoinformatics and clinical informatics.Microarrays- 2D- (basics).

Experiments

1. One experiment each in
    * Basic sequence handling
    * Pattern recognition
    * Trans membrane protein prediction
    * Bio-Perl functions(2)
2. Study of Biodata bases(3)
3. BLAST
4. Pymol/JMolSequence alignment, Dotlet
5. MSA with Muscle, Mafft
6. Phylip(2)
7. ORF & Gene finding
8. Protein Struuctre Prediction
9. SwissPDB Viewer
10. Molecular Docking
11. ADME Studies

Suggested Readings

1. Bioinformatics concepts, skills and applications- S.C.Rastogi, N,Mendirattar and Y.Rastogi, CBS Publishers, New Delhi.
2. Bioinformatics- Westhead, Parish and Twynan, Bio Scientific Publishers, Oxford.
3. Introduction to bioinformatics: A theoretical and practical approaches- S.A. Krawetzt, D.D. Womble, Human Press.
4. Bioinformatics: sequence and genome analysis- D.W.Mount, CSH lab press.
5. Internet for the molecular biologist- S.R. Swindell, R.R.Miller, G.S.A.Meyers, Horizon Scientific Press.

BBM 5004 BIOSTATISTICS (3-0-0-3)

Course Outcomes:
Students will be able to:

1: develop skills to perform statistical analysis of population studies

2: understand how to design sample analysis

3: perform chi square, Fischer exact and multivariant analysis

UNIT-I
Definition, scope and role of statistical methods in biological research. Basic principles of experimental design- principles of replication, randomization and local control. Informal and formal experimental designs- completely randomized design, randomized block design, Latin square design and factorial designs.

UNIT-II
Statistical population, sampling from population- simple random sampling and complex random sampling, Parameters and statistics, data collection- types of biological data, data processing, classification and categorization- simple and complex tables, pictorial presentation, graphic presentation of data.

UNIT-III
Basic statistics: measures of central tendencies: mean (arithmetic, harmonic, geometric) median and mode, frequency distribution, measures of dispersion- range, quartiles, standard deviation, coefficient of variation and standard error. Concept of probability- probability distributions- binomial, Poisson and normal distribution.

UNIT-IV
Tests of statistical significance: Hypothesis testing student 't' test, one tailed and two tailed, one sample and two sample, multi sample One way analysis of variance, two – way analysis of variance and multivariate analysis of variance. Multiple comparisons- the Tukey test, The Newman – Keuls test and Duncans multiple range test.

UNIT-V
Regression and correlation- scatter diagram, simple linear regression, correlation and correlation coefficient, Karl Pearson's correlation coefficient, Spearman's rank correlation. Chi-square test. Use of computer resources (Excel, SPSS and available

statistical softwares and other web resources) in data processing, statistical analysis and presentation.

Suggested Readings

1. Biostatistical Analysis, 5ht edition- Zar JK, Prentice Hall International, INC, Englewoods Cliffs, New Jersy, 2005.
2. Biostatistics, 8th edition- Daniel WW, John Wiley & Sons Publishers, 2005.Research methodology: methods and techniques, 2nd edition- Kothari CR, New Age International (P) Ltd Publishers, New Delhi, 2004.
3. Text Book of Biostatistics I- Sharma, Discovery Pub, New Delhi, 2005.
4. Fundamentals of Biostatistics- Raastogi VB, Ane's Books, New Delhi,2006

BBM 5005

METABOLIC REGULATION AND FUNCTIONAL METABOLISM (3-0-0-3)

UNIT-I

Important concepts and mechanisms involved in metabolic regulation. Enzyme activity – molecular basis for compartmentation, regulation of activities and metabolite distribution, control structures in metabolism.

UNIT-II

Signal transduction pathways- control of cellular responses to external stimuli, intracellular signaling, Receptor Tyrosine Kinases (RTKs), G protein coupled receptors (GPCRs).Hormones in human metabolism and disease; Mechanism of hormone action with examples- hormone and neurotransmitters receptors. Protein phosphorylation/dephosphorylation and regulation of enzyme activity.

UNIT-III

Integration and regulation of carbohydrate, lipid and protein metabolism in humans. Gene –metabolic control analysis-regulatory networks-operons.Transcriptional and Translational controls Human Energy Metabolism, Metabolic disorders- disorders of carbohydrate, lipid, protein and nucleotide metabolism.

UIT-IV

Role of free radicals and signaling mechanisms- Free Radicals and oxidizing agents, in Biology,Reactive oxygen and Nitrogen species. Antioxidant defense system. Oxidative stress ain biology and disease- lipid peroxidation, protein oxidation, DNA oxidation and disease conditions.

UNIT-V

Biochemical adaptation.Environmental Stress (Oxygen,Temperature,water) Mechanisms of metabolic regulation- Enzyme adaptation, Biochemical adaptation and macromolecular protectants,Adaptive control of transcription and translation.Oxygen limitation and metabolic rate depression , control of glycolysis. Anoxia survival ,Anoxia responsive gene expression hypoxia and neovascularisation Mammalian hibernation- Biochemical adaptation and gene expression Hypothermia and hibernation, Metabolic regulation in hibernation .Cold hardiness and freeze tolerance.

Suggested Readings

1. Biochemistry (2004) 3rd Edition -Voet and Voet
2. Biochemistry (2000) - Mathews, VanHolde, Ahem

3. Biochemistry - StryerPrinciples of Biochemistry - Nelson, Cox
4. Understanding the control of Metabolism(1996), Fill D, Portland Press
5. Functional Metabolism. Regulation and adaptation –K B Storey, Wiley-Liss

BBM 5006 MOLECULAR VIROLOGY (3-0-0-3)

Students will be able to:

1: Acquire knowledge about structure and classification of RNA and DNA viruses

2: Understand the complex molecular events involved in the virus life cycle such as infection, uncoating, replication, packaging and exit

3: Understand the SARSCoV2 infection and vaccine strategies at molecular level

4: Create scientific awareness about the emerging and re-emerging viral diseases and its preventive measures

5: Think innovative strategies to prevent the viral infectious diseases

UNIT-I

Science of virology: historical perspective, classification of virus-DNA, RNA viruses, Morphology, cataloging viruses, virus cultivation, detection and genetic analysis.

UNIT-II

Molecular Biology of emerging and re-emerging virus: Viral entry, replication, Assembly, maturation and exit of virus; SARSCoV, MERS, SARSCoV2, DENV, HCV, WNV, YFV, TBE, Chandipura Virus, KFDV, H1N1, NIPAH and CHIKV

UNIT-III

RNA virus genome replication and mRNA production- reverse transcription and integration. Transcription strategies. Genome replication strategies of Adenovirus and Herpes virus

UNIT-V

Viral immunology, antiviral therapy and vaccination: vaccines-historical aspects, vaccine production strategies against COVID19. New vaccines technology- Adenoviral vector, DNA vaccines, mRNA vaccine and Antiviral drugs.

Suggested Readings

1. Principles of Virology 2nd Edition (2004) - Flint, Enquist, Racaniello and Skalka. ASM Press.
2. Microbiology - Prescott, Harley and Klein, Mc Graw Hill Publishers.
3. Foundations of Microbiology - Alcamo, Jones and Bartlett Publishers

4. Fields B, Knipe D, Howley P. Fields Virology. 5th ed. Lippincott Williams and Wilkins, 2007.
5. White DO, Fenner FJ. Medical Virology. 4th ed. Academic Press, 1994.
6. MacLachlan NJ, Dubovi EJ. Fenner's Veterinary Virology. 4th ed. Academic Press, 2011.

BBM 5007 TISSSUE ENGINEERING (3-0-0-3)

UNIT-I

History and scope of tissue engineering- Scientific challenges, tissue engineering in perspectives- origin, acelluar prosthesis, stem cells, vascularisation in vitro and in vivo. Construct technology.

UNIT-II

Organization of cells into higher ordered structures –dynamics of cell –ECM interaction, composition and diversity of ECM, receptors of ECM molecules, relevance for tissue engineering, matrix molecules and their ligands.

UNIT-III

Inductive phenomena- epithelial to mesenchymal signaling in endoderm development. Morphogenesis. Cell determination, mechanical and chemical determinants of tissue development.

UNIT-IV

Bioreactor modulation- cultivation of functional tissues, tissue assembly in microgravity, in vitro embryology kinetics.

UNIT-V

Transport in tissue engineering- molecular interaction with cells, molecular and cell transport through tissue.

Suggested Readings

1. Principles of Biochemistry, 4th edition- Lehninger, Nelson and Cox. W.H. Freeman and Co. ISBN 0-7167-4339-6.
2. Cell and Molecular Biology - G.Karp
3. Biotechnology - B.D.Singh

BBM 5008 MOLECULAR NUTRITION AND NUTRIGENOMICS (3-0-0-3)

Students will be able to:

1: Acquire knowledge about nutritional aspects of diet

2: Understand the importance of signalling in the context of diet

3: Understand the concepts of micronutrients in the context of physiology

UNIT-I

Perspective on human nutrition, food groups and nutritive and energy value of foods, BMR. Nutritional aspects of carbohydrates, lipids, proteins, vitamins and minerals. Essential amino acids, essential fatty acids, visible and invisible fat, Dietary fiber.

UNIT-II.

Nutritional disorders. Protein- energy malnutrition- Kwashiorkor, marasmus. Diet related diseases- obesity. Eating disorders, . Regulation of food intake- psychological and physiological aspects. Neuroendocrine control of hunger and satiety. Dietary fat, cancer and atherosclerosis. Nutrition, inflammation and chronic disorders.

UNIT-III

Molecular mechanisms of genetic variation linked to diet-: micronutrients and evolution of skin pigments., Evolution of taste as a survival mechanism. Natural food toxins in diet and evolution of xenobiotics metabolism in humans.

UNIT-IV

Nutrigenomics and Epigenetics: Gene polymorphism and dietary nutrients and cellular homeostasis. Micronutrient- gene interaction- Vitamin A and Vitamin D responsive genes, steroid responsive element binding protein, PPAR, Nuclear hormone receptor super family- Regulation of gene expression by nutrient regulated transcription factors. Genetic buffering mechanisms- gene duplication, phenotypic stability and health, phenotypic instability and disease- roe of nutrients example- folate, carrier protein.

UNIT-V

Importance of micronutrients, effect of gene interaction with reference to vitamins and minerals on genomic machinery and gene products, retinoic acid, vitamin C, vitamin B, vitamin D, vitamin K, calcium, selenium, zinc (calcium signaling, zinc finger protein,seleno proteins and superoxide dismutase), epigenetics.

Suggested Readings

1. Nutritional Biochemistry(2nd Edition)- Tom Broddy(Elsevier)
2. Molecular Nutrition and Genomics - M.Lucock, 2007, Wiley.
3. Advanced Nutrition - Berdanier and Lempleni,2009, CRC Press.
4. Molecular basis of Human Nutrition- T.Sanders and P. Emery
5. Natural therapeutic Nutrition - C.H. Robinson and M. R. Lawler

BBM 5009 GLYCOBIOLOGY (2-0-0-2)

Students will be able to:

1: Acquire knowledge about basic carbohydrate structures and their metabolism

2: Understand the importance of lectins in glycobiology

3: Understand the concepts of carbohydrate signalling in the context of physiology

4: Acquire knowledge of elucidation of carbohydrate structures and their applications in the field of medicine

UNIT-I

General Principles: Review of carbohydrate chemistry. Saccharide structure and nomenclature, protein-glycan interaction.

UNIT-II

Biosynthesis and metabolism and functions: N glycans, O-glycans, glycospingolipids, proteoglycans and glycoprotein, sialic acids. Structures common to different types of glycans, glycosyl transferases, degradation and turnover of glycans.

UNIT-III

Protein that recognize glycans and their biological role. Discovery of animal lectins- P type lectins, I type lectins, C- type lectins, Selectin, galectins. Plant lectins.

UNIT-IV

Structure- Function relation: glycans in genetic disorders and disease, genetic disorders of glycosylation, glycosylation changes in ontogeny and cell activation, glycosylation changes in cancer, acquired glycosylation changes in human disorders.

UNIT-V

Methods and application: structural analysis and sequencing of glycans, chemical and enzymatic synthesis of glycans, inhibitors of glycosylation, Glycobiology in medicine. Functional glycomics. Glycan array analysis.

Suggested Readings

1. Essentials of Glycobiology- Varki, Cummings, Esko, Freeze, Hanlx, Marth, 1999,

CSH.Lab Press.
2. Principles of Biochemistry, 4th edition- Lehninger, Nelson and Cox. W.H. Freeman and Co. ISBN 0-7167-4339-6.
3. Cell and Molecular Biology - G.Karp
4. Biochemistry (2004) 3rd Edition -Voet and Voet
5. Molecular Biology of the Cell Bruce Alberts, Johnson, Lewis et al.

BBM 5010 INTRODUCTION TO EPIGENETICS (2-0-0-2)

Students will be able to:

1: Acquire knowledge about basic mechanisms of epigenetics

2: Understand the proteins involved in epigenetics

3: Understand the concepts of techniques used for epigenetic analysis

4: Acquire knowledge of environmental induced epigenetic concepts

UNIT-I

Epigenetics: Epigenetics Introduction, components of epigenetics. DNA methylation, DNMTs types and functions. Histone modifying enzymes, different types of histone modifications HMTs, HAT, HDAC The Histone Code hypothesis, Demethylases, microRNA and epigenetics

UNIT-II

Chromatin Organization: Polycomb and Trithorax genes, DNA Methylation/Hydroxymethylation, Histone Variants, Chromatin assembly and Nucleosome positioning, Reprogramming of histone marks Long Non-coding RNAs Small RNAs and RNA interference. Epigenetic regulatory proteins

UNIT-III

Techniques: Different methods for chromatin cross-linking, analysis of co-immunoprecipitated chromatin (PCR, Southern, ChIP-on-Seq), applications of ChIP & MeDIP. PAR-CLIP, Imaging the Nucleus and its functions,

UNIT-IV

Quantitative approaches and theoretical models and maintenance of Epi(genome) integrity, Epigenetics and cancers. Cross-talks between epigenetic markings.

UNIT-V

Environmental Epigenetics: Impact of environmental factors on epigenetic mechanismfactors. Effect of manmade and natural chemical of epigenetics, toxins,

endorcine disruptors

Suggested Readings

1.Fundamentals of Epigenetics By Moshe Szyf
2.Epigenetics: The Death of the Genetic Theory of Disease Transmission By Joel D. 3.WallachEpigenetics: How Environment Shapes Our Genes by Richard C. Francis 4.Epigenetic Principles of Evolution by Nelson R. Cabej

BBM 5011: CLINICAL BIOCHEMISTRY (3-1-0-1)

Students will be able to:

1: Acquire knowledge about diseases related to digestive system

2: Understand the diseases related to carbohydrate, protein and lipid metabolisms

3: Understand the concepts of liver function tests and haematological analyses.

Unit 1

Diseases related to digestion and absorption of foods:

Gastritis and gastric atrophy (hyperacidity), Achlorhydria (hypochlorhydria), ulcers (peptic ulcer, Zollinger –Ellison syndrome) Pancreatitis, lactose intolerance, sucrose deficiency, disaccharidurıa, monosaccharide malabsorption, steatorrhea, chyluria and deficiency of bile salt – cholelithiasis, Sprue.

Unit II

Diseases related to carbohydrate metabolism:

hypo and hyperglycemia, diabetes mellitus- classification, complications and biochemical tests, diabetes insipidus, glucose tolerance test, oral hypoglycemic agents, pentosuria, fructosuria, galactosuria, glycogen storage diseases, hereditary fructose intolerance, fructose 1, 6 diphosphatase deficiency, mucopolysaccharidosis.

Unit III

Diseases related to lipid metabolism:

Spingolipidosis, hyper and hypo lipoproteinemia, hypercholesterolemia, atherosclerosis-pathogenesis, and clinical features, lipid and other risk factors for atherosclerosis, hypolipidemic drugs.

Unit IV

Diseases related to amino acid metabolism and liver:

Defect of γ- glutamyl cycle transport of amino acids, phenyl ketonuria and alkaptonuria, histidinemia, Maples syrup disease, Albinism, methyl malonic acidemia, glutathionuria, homocystinuria. Jaundice.

Unit V

Diseases related to Nucleic acid and Hemoglobin Metabolism and brain:

Gout, Lesch-Nyhan syndrome, Abnormal Hemoglobin and their deficiencies - Macrocytic and microcytic anemia, Sickle cell anemia, Thalassemia, Hereditary methemoglobinemia. Porphyria. Neurodegenerative diseases and their biochemical basis.

Recommended Books

1. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008.
2. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin.
3. Bishop, Michael L., Edward P. Fody, and Larry E. Schoeff, eds. Clinical Chemistry: Principles, Techniques, and Correlations. Lippincott Williams & Wilkins, 2013.
4. Bahr, Manson, and D. R. Bell. "Manson's Tropical Diseases." The English Languages Book Society, Billiere, Tindall and Cassell, Ltd (1996).
5. Lawrence A.K. Amedeo J. P. and Steven C.K. Clinical Chemistry

BBM 5012 GENOMICS AND PROTEOMICS (2-0-0-2)

Students will be able to:

1: Acquire knowledge about databases of various genomes

2: Understand the techniques used for the identification of disease genes, location and arrangement of genes

3: Understand the concepts of gene map construction

4: Acquire knowledge of proteomic techniques for clinical applications

UNIT-I

Genome sequence ;Acquisition and analysis- genomic variation, human genome variation- SNPs. Integrated genomic circuits- Modeling whole genome circuit. Functional genomics, structural genomics, comparative genomics, pharmacogenomics, Genome projects- EColi, D.melanogaster, C.elegans, HGP.

UNIT-II

Mapping Strategies: types of gene map- genetic, cytogenetic and physical. Genetic analysis- basic strategy- linkage mapping, internal mapping, genetic mapping- molecular markers for mapping, gene mapping and identification- positional cloning, DNA microarray, SAGE and cluster analysis. Physical mapping, strategies for large scale DNA sequencing.

UNIT-III

Genomics Protocols: Construction of microsatellite based, high resolution genetic map in mouse, Genetic analysis of complex traits. Detection of chromosomal abnormalities by comparative genomic hybridization, MAP integration –from genetic map to a physical gene map to sequence map, construction of transcript MAP- human gene map.

UNIT-IV

Finding genes in genomic nucleotide sequence by bioinformatics tools. Expression profiling – identification of differentially expressed genes. Expression monitoring through cDNA microarray.

UNIT-V

Proteomics: Protein biochemistry, Functional diversity of protein, structure – function relationship, protein isolation, Protein- 2D gel, Mass Spectroscopy of proteins and peptides- MALDI. Protein chips, micro sequencing, Protein data based structural studies, Proteomics based diagnosis, Clinical proteomics, biomarkers.

Suggested Readings

1. Genomics- Cantor and Smith, Wiley Inter Science, 1999.
2. Discovering genomics, proteomics and Bioinformatics-Campbell and Heyer, 2003. Pearson Education
3. Genomics Protocols- Starkey and ElaswarapaPrinciples of Genome Analysis- Humana Press,2001.

   Primrose, Blackwell Sci.,2003.
4. Genomes 2nd Ed.- Bown .T.A, JohnWiley& Sons, 2002.
5. Introduction to Proteomics- Liebler.D.C, Humana Press, 2002.
6. http://www.ncbi.nlm.nih.gov/genbank
7. http://www.ensembl.org
8. http://www.proteinstructure.com

BBM-5013 Vascular Biology (2-0-0-2)

Course Outcomes:

The students will

1: get an overview of the process of formation of the vasculature in the body

2: understand the process of angiogenesis with its physiological and pathological implications.

3: learn the molecular events associated with maintenance of vascular tone

4: will have understanding of the endothelial cell biology and pathologies associated with vascular/ EC dysfunction

UNIT-I

Introduction to Human vascular system: Blood vessels: their composition and physiology; Blood Vessel Formation: the molecular mechanism of Vasculogenesis and Angiogenesis.

UNIT-II

Endothelial cell biology: Role of eNOS and various signaling pathways, in maintaining endothelial cell function and vascular tone.

UNIT-III

Smooth muscle Cells: Smooth muscle cell; contraction; Smooth muscle cell; signaling; Neuronal control of vasculature; Neuronal control of immune response in vasculature; Purinergic signaling in the vasculature.

UNIT-IV

Vascular Diseases: Vascular inflammation, Endothelial dysfunction: molecular mechanism, Atherosclerosis: plaque formation, plaque angiogenesis, plaque destabilization and rupture. Peripheral artery disease, Renal hypertension.

UNIT-V

Pathological angiogenesis: role in tumor growth and metastasis, arthritis, diabetic retinopathy and ischemic diseases.

<u>Suggested reading</u>:

1. An introduction to vascular biology from basic Science to clinical practice.Beverly J Hunt et al
2. Handbook of vascular biology techniques-Mark Selvin.
3. The ESC Textbook of Vascular Biology- Robert Krams and Magnus Bäck
4. Vascular Medicine: A Textbook of Vascular Biology and Diseases- Little, Brown Publishers, Joseph Loscalzo, Mark A. Creager, Victor J. Dzau.

BBM- 5014- Advances in RNA Biology (2-0-0-2)

Course Outcomes:

The students will

1: have a thorough understanding of the various transcripts on the cell

2: understand the various levels of RNA structure.

3: learn the mechanism of RNA transport and decay

4: know the molecular mechanism of RNA mediated silencing events

UNIT-I

Introduction to RNA Biology: Properties of ribonucleic acids; Types of RNAs found in cells; RNA world hypothesis; RNA structure and folding; RNA as an enzyme; Riboswitches as RNA regulators; An introduction to analytical techniques for studying RNA biology

UNIT-II

Messenger RNA Biology Post Synthesis: mRNA splicing – general mechanisms and networking; Alternative mRNA splicing – regulation and expansion of genomic complexity; Nuclear – cytoplasmic export of mRNA – mechanisms and regulation; RNA editing – co-transcriptional, substitution and deamination editing mechanisms.

UNIT-III

mRNA localization mechanisms – Zip codes and RNA sorting; mRNA methylation and its impact on gene expression. General mechanisms and pathways of mRNA degradation; Regulation of mRNA degradation –AREs, CREs etc. Quality control mechanisms – Nonsense mediated decay, Non-stop decay, no-go decay etc.

UNIT-IV

RNA Interference and Small RNAs: Introduction to RNAi; miRNAs – biogenesis and functions; other small RNAs and regulation; Co-transcriptional gene silencing; Long non-coding RNAs.

Suggested reading:

1. Molecular Cell biology- Lodish and Baltimore
2. Molecular Biology of RNA; OUP Oxford; 2 edition- David Elliott and Michael Ladomery
3. RNA Biology; Wiley VCH (6 April 2011)- Gunter Meister
4. The RNA World, Third Edition- John Atkins, Raymond Gesteland, and Tom Cech
5. RNA: Life's Indispensable Molecule, Cold Spring Harbor Laboratory Press- Jim Darnell
6. Review articles available at PubMed.

BBM5015 Molecular Oncology (3-0-0-3)

Students will be able to:

1: Acquire knowledge about basic cancer biology

2: Understand the mechanisms of generation of oncogenes and tumor suppressor genes

3: Understand the concepts of cancer signalling

4: Acquire knowledge of non coding RNAs in cancer and its therapeutics

UNIT-I

Introduction to cancer: Definition, Properties of a cancer cell, Normal cell versus Cancer cell, immortalization and transformation, cancer as a multifactorial and genetic disease, influential factors of carcinogenesis, brief overview of cancer treatment.Special emphasis on few important cancers which are prevalent in India- Breast cancer, Oral cancer, cervix cancer, prostate cancer, leukemia, GBM.

UNIT-II

Genome integrity and development of cancer: Mutations, DNA damaging agents, DNA repair and association of defective DNA repair pathways to development of cancer (6 hr). Oncogenes and tumor suppressor genes: Definitions of proto-oncogenes, oncogenes and tumor suppressor genes. Characteristics of oncogenes and tumor suppressors. Gain of function and loss of function mutations. Knudson's two hit hypothesis, haploinsufficiency, LOH.

UNIT-III

Epigenetics of cancer- Role of promoter methylation and histone modifications in the development of cancer.
Molecular signaling in cancer: Relevance of apoptosis, senescence and autophagy in cancer biology. p53, EGFR, RB1, TGF, mTOR and Wnt pathways in cancer.

UNIT-IV

Association of viral infections and cancer: Introduction to tumor viruses, viral oncogenes. Molecular mechanisms of viral transformation. Role of HPV, EBV and HTLV.
Invasion and metastasis: Epithelial to mesenchymal transition. Circulating tumor cells. Molecular modulators of EMT.

UNIT-V

Non coding RNAs in cancer: Brief account of miRNAs, piRNAs, lncRNAs and tRNA derived ncRNAs. Role of miR-122, HOTAIR, MALAT1 and piR-651 in cancer. Cross-kingdom miRNAs. Data bases of non coding RNAs.

Rationale treatment of cancer: A brief account of molecular targets in cancer. Mechanism of action of few anti-cancer drugs such as Gleevec, gefitinib and imatinib. Brief overview on clinical trials. Gene therapy in cancer.

Suggested Reading:

1. Molecular biology of cancer: Mechanisms, Targets and therapeutics. Pecorino L
2. The biology of cancer. Weinberg RA

BBM 5016: INDUSTRIAL ENZYMES (2-0-0-2)

Students will be able to:

1: Acquire knowledge about basic enzyme biology

2: Understand the mechanisms to enhance enzyme production

3: Understand the concepts of enzyme reactors and their applications

4: Acquire knowledge on applications of enzyme productions

UNIT-I

Prospects of enzyme technology, Industrial enzymes- carbohydrases, peptidases, nucleases and other technical enzymes, therapeutic enzymes.

UNIT-II

Novel enzymes from natural sources, Strain improvement for enzymes from microbial source, Physiological optimization.

UNIT-III

Enzyme stabilization- immobilization- carriers, adsorption, covalent coupling, cross-linking and entrapment, Micro-environmental effects, Enzyme reactors- batch, membrane, solid-bed.

UNIT-IV

Modified enzymes, Synzymes, Protein engineering of industrial enzymes. Biocatalytic applications- enzyme based biotransformations.

UNIT-V

Enzyme inhibitors: types of inhibitors, global market, commercial enzyme inhibitors, Sources of enzyme inhibitors, Applications of enzyme inhibitors- food, biomedical and agriculture. Regulatory requirements and Economic considerations for industrial enzymes

Suggested Textbooks:

Enzymes Biotechnology - Gray N, Calvin M and
Bhatia SC Fundamentals of Enzyme kinetics - Cornish-Bowden A
Enzymes in industry -
Aehle W

Industrial Enzymes: Structure, Function and Applications - Uhlig H

Industrial Enzymes: Structure, Function and Applications - Polaina J and MacCabe AP

BBM 5017 MOLECULAR ENDOCRINOLOGY (3-1-0-3)

Students will be able to:

1: Understand the overview of endocrine system at molecular level

2: Learn about the hypothalamic regulation of pituitary gland

3: Visualize the molecular events involved in the PTA axis and hormonal signaling

4: Gain knowledge in the area of diseases caused by hormonal imbalance

5: Know the pancreatic hormone and steroid hormone function and its implications

UNIT-I

Overview of mammalian endocrine system, classification and chemical nature of hormones, molecular mechanism of hormone action- general aspects, hormone receptors, signal transduction. Plasma membrane receptors, second messengers, steroid hormone receptors.

UNIT-II

Biochemistry and mechanism of action of hypothalamus and pituitary hormones, hypothalamic releasing factors, anterior pituitary hormones, vasopressin, oxytocin. Regulation of synthesis. Lactogenic hormones. Glycoprotein hormones, endorphins, hypo and hyper activities of pituitary hormones.

UNIT-III

Thyroid hormones- synthesis, secretion, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid diseases, thyroid function tests. Parathyroid hormones- biological actions, regulation of calcium and phosphorus metabolism. Calcitonin. Pathophysiology.

UNIT-IV

Pancreatic hormones: Islets of Langerhans. Insulin biosynthesis, regulation of secretion, biological actions and mechanism of action. Insulin receptor- intracellular mediators. Insulin signaling pathways. Glucagon, somatostatin, pancreatic polypeptide, Insulin like growth factors, gastrointestinal hormones.

UNIT-V

Adrenal hormones- glucocorticoids, mineralocorticoids- synthesis, secretion, transport, metabolic fate, biological actions and mechanism of action. Adrenal androgens- metabolic effects and functions. Hormones of adrenal medulla- catecholamines- biosynthesis, metabolism, mechanism of action. Abnormal secretion of adrenal hormones- Addison's

disease, Cushing's syndrome, phaeochromocytoma. Gonadal hormones- Androgens, estrogens. Biological actions and molecular mechanisms. Ovarian cycle, Steroid hormone receptor.

Recommended Books

1. C.R. Austin, R.V. Short, Mechanisms of Hormone Action, Cambridge University Press, 1979.
2. Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's illustrated Biochemistry (Harper's Biochemistry). McGraw-Hill Medical, 2006.
3. White, Abraham, Philip Handler, and Emil L. Smith. "Principles of Biochemistry."Academic Medicine 39.12 (1964).
4. Mac E. Hadley, Endocrinology, Prentice Hall, 2012.
5. Melmed, Shlomo, Kenneth S. Polonsky, P. Reed Larsen, and Henry M. Kronenberg. Williams textbook of endocrinology. Elsevier Health Sciences, 2011.

BBM 5018 ANIMAL MODELS IN BIOMEDICAL RESEARCH (3-1-0-3)

The course will help to:

1. Understand and inspire students to pursue career in biomedical research
2. Develop internationally competent manpower in biomedical research
3. Inspire students to develop novel drugs for the treatment and prevention of human diseases.

Unit I

Animal models in biomedical research-a brief history; Brief idea of laboratory animals including mice, rats, guinea pigs, rabbits, dogs and monkeys; Anatomy and histology of laboratory mouse; different strains of laboratory animals and their characteristics

Unit II

Theoretical knowledge of handling and housing laboratory animals; animal ethics guidelines; theoretical knowledge of animal surgery, anesthesia and euthanasia; production of transgenic and chimeric mouse; production of gene knockout, gene knock-in and conditional knockout animal models

Unit III

Animal models for different diseases of humans: homologous, isomorphic and predictive animal models; animal models for inflammatory diseases, diabetes, ulcer, epilepsy, cardiovascular diseases, liver diseases, kidney diseases and hereditary disorders in humans; animal models for cancer research: carcinogenesis models, xenograft models, orthotopic models, and transgenic, gene knockout and conditional knockout models;

Unit IV

Animal models in biodefense research, eg: anthrax, botulism, plague, small pox and cholera; Recent advances in laboratory animal model research.

Recommended Books and References

1. Min T, Chang K. Animal models of human disease, Academic Press, 2011.

2. Hau J, Van Hoosier GL. Handbook of Laboratory Animal Science, Second Edition: Animal Models, CRC Press, 2004.

3. Pierce K. H. Chow, Robert T. H. Ng, Bryan E. Ogden. Using Animal Models in Biomedical Research: A Primer for the Investigator, World Scientific; 2008.

4. Nagy A, Gertsenstein, Vintersten K, Behringer R. Manipulating the mouse embryo: A laboratory manual, Cold Spring Harbor, 2003.

2. Gross DR. Animal Models in Cardiovascular Research, 3rdEdition, Springer, 2009.

3. Shafrir E. Animal Models of Diabetes, 2nd Edition: Frontiers in Research, CRC Press, 2007.

COURSES THROUGH UGC MOOC PLATFORM

NAME
1) Biomass characterisation **2) Food microbiology and food safety** **3) Research methodology** **4) Biostatistics and mathematical biology** **5) Analytical techniques** **6) Functional foods and nutraceuticals** **7) Academic writing** **8) Social Research ethics** **9) Basic research** **10) Human growth and development** **11) Biochemistry** **12) Envt.chemistry & microbiology** ****

**The MOOC courses will be added as per requirement based on faculty council resolution.