

Amrita Center For Nanosciences and Molecular Medicine

**Program in the
Bachelor of Science (B.Sc.)
Biochemistry**

2020

Amrita VishwaVidyapeetham

B.Sc-Biochemistry

Curriculum

Course Code	Course Title	L T P	Cr	ES	Course Code	Course Title	L T P	Cr	ES
	SEMESTER 1					SEMESTER 2			
20ENG102	English I	3 0 0	3		20ENG112	English II	3 0 0	3	
20CHE101	Chemistry	3 0 0	3		20BIC111	Metabolism of Carbohydrates & Lipids	3 0 0	3	
20MAT102	Biostatistics	3 0 0	3		20MMD112	Immunology	3 0 0	3	
20BIC101	Bio organic Chemistry and metabolites	3 0 0	3		20MMD111	Cell Biology-2	2 0 0	2	
20BIC102	Biophysics and Bioenergetics	3 0 0	3		20BIC112	Nucleotides and Nucleic Acid	3 0 0	3	
20MMD102	Cell Biology 1	1 0 0	1		20MMD184	Cell Biology Practicals	0 0 6	2	
20BIC103	Biochemistry	3 0 0	3		20BIC183	Biochemistry Practicals	0 0 9	3	
20CSA103	Computational Skills	2 0 0	2		20MMD183	Immunology Practicals	0 0 6	2	
20BIC181	Biophysics Practicals	0 0 6	2			Total	21		
20BIC182	Chemistry Practicals	0 0 6	2						
20CSA185	Computational Skills Practicals	0 0 3	1						
	Total	26							
	SEMESTER 3					SEMESTER 4			
20BIC201	Protein structure and function	3 0 0	3		20BIC211	Bioinformatics	3 0 0	3	
20BIC202	Biochemical techniques	3 0 0	3		20MMD211	Molecular Biology and Genetic Engineering	3 0 0	3	
20MMD201	Microbiology	4 0 0	4		20MMD212	Genetics	3 0 0	3	
20MMD202	Developmental Biology	2 0 0	2		20BIC212	Biosafety and bioethics	2 0 0	2	
20BIC281	BiotechniquePracticals	0 0 6	2		20MMD213	Proteome and Proteomics	2 0 0	2	
20MMD281	Microbiology Practicals	0 0 9	3		20BIC282	Bioinformatics Practicals	0 0 6	2	
20IPR201	IPR	0 0 3	1		20MMD283	Molecular Biology Practicals	0 0 6	2	
	Total	18			20CUL201	Cultural education	1 0 0	1	
						Total	19		
	SEMESTER 5					SEMESTER 6			
20MMD301	Stem cell Biology	2 0 0	2		20BIC311	Antimicrobial agents	2 0 0	2	
20BIC301	Human Physiology and anatomy	3 0 0	3		20BIC312	Recombinant DNA Technology	2 0 0	2	
20BIC302	Biopolymers and its applications	3 0 0	3		20BIC313	Cancer Biology	3 0 0	3	
20BIC303	Metabolic pathways and its significance in disease	3 0 0	3		20BIC314	Hormone: Biochemistry and Function	3 0 0	3	
20BIC304	Enzymology	3 0 0	3		20RM301	Research Methodology	2 0 0	2	
20BIC381	Cell culture Lab	0 0 6	2		20BIC399	Projects	9	9	
20BIC382	Enzymology Lab	0 0 6	2			Total	21		
	Total	18							

Total Credits 123

Preamble

Living system consists of organic complexities that in various permutations and combinations make up the organism. Understanding the biochemical and physical principles behind is the key to deciphering the living complexity.

Unit 1**(Lectures 10)**

Overview of Biochemistry and elements, chemical reactions and biomolecules in living organisms. Concentration units: Avagadro's number, mole, mole fraction, molarity, equivalent weight, normality, molality, percentage. Properties of water: Molecular structure of water, physical properties of water. Its effect on biomolecules. Effect of non-polar compounds on water. Colligative properties: Osmotic pressure and its measurements by Berkely and Hartley's method. Laws of osmotic pressure. Hypo, hyper and isotonic solutions. Effects of osmotic pressure on living cells. Donnan membrane equilibrium. Physical properties of molecules: (1)

Unit 2**(Lectures 10)**

Adsorption -Definition, Freundlich and Langmuir's adsorption isotherm. Applications of adsorption.(2) Viscosity-Definition, Determination of viscosity of liquids and solutions by Ostwald's viscometer (solutions of gum and protein to be taken as example). (3) Distribution law -Distribution law, partition coefficient. Applications of distribution law. Ionic equilibria: Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson Hasselbalch equation, buffer capacity, preparation of acidic and basic buffer solutions. Theory of acid base indicators. Choice of indicators. pH titration curves and isoelectric pH of aminoacids. Electrodes (Hydrogen Electrode & Calomel electrode), glass electrode. Conductometric titrations [Strong acid against strong base, weak acid (amino acid) against NaOH]. Determination of pKa value of amino acid by using pH meter.

Unit 3**(Lectures 10)**

Photochemistry: Laws of photochemistry, quantum efficiency, light absorption, Beer Lambert's law, spectrophotometer, colorimeter, fluorescence, phosphorescence, chemiluminescence, bioluminescence (Elementary treatment). Applications of UV-visible and fluorescence spectra. Principle of IR spectra and its applications.

Co-ordination compounds: Transition metals, properties (Colour, oxidation states, magnetic properties). Co-ordinate bond, double and complex salts – differences with examples.

Postulates of Werner's theory. Types of ligands – uni, bi and polydentate with examples. Coordination number. Porphyrin nucleus and classification. Important metalloporphyrins occurring in nature-structure and their biological importance (Hb, cytochrome, chlorophyll, VitB12). Bile pigments – Types, structure and chemical nature. Nitrogen: Fixation of atmospheric nitrogen – symbiotic and non-symbiotic.

Unit 4

(Lectures 15)

Nitrogen cycle. Environmental pollution by nitrogen compounds. Phosphorous: Importance of phosphorus compounds in biological system, phosphorous cycle. Oxygen: Importance of oxygen in biological system. Formation and role of ozone in maintenance of life on earth. Effects of environmental pollutants on ozone layer.

Sulphur and selenium: Importance of compounds of sulphur and selenium in biological system. Effect of sulphur compounds on environmental pollution. Chemical bonding: Different types of bonds & bond characteristics. Ionic bonding, covalent bonding, co-ordinate bonding, Van der Waal's forces, ion- dipole, dipole –dipole interactions, London forces, hydrophobic interaction, hydrogen bonding. Effect of chemical forces on physical properties (Solubility, BP and MP). Biochemical toxicology: Source, entry in to biological system and toxicity of lead, mercury, cadmium and arsenic.

Text Books

Barrow, G. M. (2007) Physical Chemistry Tata McGraw-Hill, India.

ames E. Huheey, Ellen Keiter and Richard Keiter : Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Public, 4th Edition (2013).

Pattabhi.V. and Gautham.N.(2002) Biophysics.Narosa Publishing House, India.

20BIC102

Biophysics and Bioenergetics.

Preamble

Connecting Physics to biology is an essential factor which eventually determines quantifying primary factors in a physical process that occur at cell level. Physics serves as a nanoscopicvisualization tool to dissect such processes to reveal the information to students. This course introduces applications of Physics into Biology.

Unit 1

(5 lectures)

Physics: general overview, Does Physics treats disease? Why Physics for Biology and Molecular Medicine? Concepts in Physics to apply in Biology, Methods in Physics to elucidate Biology.

Unit 2

(10 lectures)

Bioenergetics: Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation

potential, and phosphoryl group transfers. Electron transport in membrane for oxidative phosphorylation, Chemical basis of hydrolysis of ATP and thioesters. Redox reactions, standard redox potentials and Nernst equation.

Unit 3 **(10 lectures)**

Biophysics in Medicine: Applications of physical principles in biology and its significance in the development of various biophysical methods for analysing the complexity of biological system. Principles of Medical-imaging, Image analysis, Instrumentation and Working principles, Medical applications of X-ray: Imaging, Introduction to Fluoroscopy.

Unit 4 **(10 lectures)**

Nuclear medicine and Radiotherapy: Pros and cons, Nano-bioelectronics: Monitoring and recording bioelectric signals, Transducers in physiology, Diagnostic and Therapeutic Techniques: Cardiac pace makers, Blood flow monitors, Pulmonary function analyzers, Hemodialysis machines, Defibrillators, Short/ wave diathermy, Electrically stimulated pain management, Laser: operating principles, types, Biomedical applications in surgery.

Unit 5 **(10 lectures)**

Nanophotonics for Biology and Nanomedicine: Near-Field Bioimaging, Semiconductor Quantum Dots for Bioimaging, Up-Converting Nanophores for Bioimaging, Biosensing, Nanoclinics for Optical Diagnostics and Targeted Therapy, Nanoclinics for Photodynamic Therapy

Text books:

(1) Biophysics: An Introduction by Rodney M. J. Cotterill, Published by John Wiley & Sons Ltd, 2002.

(2) Biological Physics: Energy, Information, Life by Philip Nelson, www.physics.upenn.edu/~pcn/.

20BIC103

Biochemistry

Preamble

Amino acids are building blocks of proteins. The 20 different amino acids at various permutations and combinations give rise to different proteins with different functions. These different protein interaction and function is responsible for keeping the cellular complexities intact and live.

Unit-1 **(15 lectures)**

Composition, different types of amino acids, Synthesis of different types of amino acids, Contribution of amino acids to biochemistry, Amino acids as source for energy production, Amino acids are derivatives for various metabolites.

Unit-1

(15 lectures)

Protein as a biopolymer, synthesis of proteins, primary sequence of proteins and its significance in folding and structure. Role of proteins in different biochemical contexts, Proteins as enzymes, receptors, different types of signalling molecules, carriers of different cargos and elements.

Text Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:14641-0962-1.
2. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
3. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

20BIC111

Metabolism of Carbohydrates & Lipids

Preamble

Existence of a cell requires energy and nutrients for cell maintenance and homeostasis. Thus production of energy is vital for every function a cell execute. The question is how effective the cell is able to achieve this and what are the mechanisms involved in this process and the role of various enzymes in this process. Enzymes are the key components responsible for are vital in the chemical rearrangements and modifications of various biological molecules carried out at 37°C with utmost specificity. These changes are responsible for various communications and modifications that happens as a result of environmental and internal cues a cell receives essential for the production of energy and various other metabolites essential maintaining the cell structure function.

Unit-1

(2 Lectures)

Significance of six carbon sugar glucose in cellular homeostasis.

Unit 2

(13 lectures)

Breakdown of glucose in energy production. Glycolysis, Tricarboxylic acid cycle, pentose phosphate pathway and how they are connected together with energy production and growth. Mitochondrial structure and its significance in the oxidative phosphorylation leading to energy production.

Unit 3

(5 lectures)

What are Lipids, How they are made, Lipid metabolism: lipid synthesis and degradation

Unit 4

(10 lectures)

Oligosaccharides, different types of oligosaccharides, their synthesis and significance in biology.

Unit 5

(15 lectures)

Gluconeogenesis and its connection with the pentose phosphate pathway, metabolism of other important sugars (fructose metabolism and glycogen metabolism), glycogenesis, glycogenolysis, regulation of glycogen metabolism.

Text book:

- (1) Lehninger Principles of Biochemistry by David L. Nelson; Michael M. Cox, Freeman publications; Seventh Edition 2017.

20BIC112

Nucleotides and Nucleic Acid metabolism

Preamble

Nucleotides are essential for wide variety of processes and are under constant synthesis denovo in all cells. Synthesis of the nucleotide precursor is an energy intensive process that uses multiple metabolic pathways across different cell compartments and several sources of carbon and nitrogen and is regulated at multiple levels.

Unit-1

(10 lectures)

Metabolism of purines and pyrimidines. Structure and properties of nucleotides and nucleic acids. Nucleotides Made from Very Simple Molecules. de novo Purine Metabolism. Building a Purine Ring. Paths to Guanine and Adenine Nucleotides. Purine de novo Metabolism Regulation.

Unit-2

(13 lectures)

Pyrimidine de novo Metabolism. de novo Pyrimidine Biosynthesis. Pyrimidine de novo Metabolism. Catabolism of Guanine Nucleotides. Catabolism of Adenine Nucleotides. Catabolism of Guanine and Hypoxanthine. Purine Nucleotide Salvage. Pyrimidine Catabolism and Salvage Reactions.

Unit-3

(12 lectures)

Catabolism of Uracil and Thymine. Deoxyribonucleotide Synthesis. Ribonucleotide Reductase. RNR Reaction Mechanism. Thymidine Metabolism. Thymidylate Synthase. Recycling of Foliates. Nucleoside Analogs. Deoxyadenosine Analogs. Adenosine Analogs. Deoxycytidine Analogs.

Unit-4

(10 lectures)

Regulation of nucleic acid metabolism and its significance. Abnormalities in nucleic acid metabolism xeroderma pigmentations and skin cancer.

Text Books

1. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. 2003. Harper's Illustrated Biochemistry. 26th Edition. McGraw-Hill.
2. Garrett, R.H. and Grisham, C.M. 2005. Biochemistry. 3rd Edition. Thomson.
3. Lehninger Principles of Biochemistry by David L. Nelson; Michael M. Cox, Freeman publications; Seventh Edition 2017.

20BIC181

Biophysics Practicals

1. study the principle of spectrophotometer. To verify the Lambert Beer's law.
2. Determine the beer's limit and measurement of molar and percent extinction coefficient.
3. Estimate the percent purities of dyes and inorganic compounds.
4. Establish the absorption spectrum and determine the absorption maxima of pNitro phenol.
5. Plot absorption spectrum of DNA and protein(BSA/Egg Albumin) and find λ_{max}
6. Obtain relation between concentration & Refractive Index for solutions of proteins and sugars and estimation of specific refraction increment for proteins
7. Determine refractive index of a given liquid as a criterion for its purity (Benzene i.e. commercial benzene + A.R. acetone)
8. Study the principle of colorimeter and spectrophotometer and determine suitable filter for light absorption studies of inorganic salts. Verify Beer-Lambert law. Determine molar Extinction coefficient
9. Plot absorption spectrum of DNA and protein and find λ_{max} .
10. study the effect of different solvents on UV absorption spectra of proteins
11. Study of spectral changes of proteins at different pH using Spectrophotometry
12. Study of structural changes of proteins at different temperature using UV spectrophotometry

Text Books:

Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education, ISBN : 0716738619, 9780716738619.

20BIC182

Chemistry Practicals

- (1) Preliminary identification and detection of functional groups (Heating on a crucible lid; Identification of elements present;
- (2) Heating with soda-lime;
- (3) Treatment with sodium hydroxide solution;

- (4) Treatment with sodium carbonate solution;
- (5) Treatment with concentrated sulphuric acid;
- (6) Reactions and colorations with ferric chloride solution;
- (7) Treatment with 2,4-dinitrophenylhydrazine;
- (8) Treatment with hydroxylamine and ferric chloride; Identifications of unknown organic compound.

Text Books:

- 1 Practical organic chemistry by F. G. Mann and B. C. Saunders.
- 2 A text-book of practical organic chemistry including qualitative organic analysis by A. I. Vogel.

20BIC183

Biochemistry Practicals

- (1) Preparation of buffers;
- (2) Determination of pKa value;
- (3) Estimation of proteins by Biuret method;
- (4) Estimation of proteins by Lowry's method;
- (5) Separation of sugars by Thin Layer chromatography,
- (6) Effect of pH and temperature on the activity of an enzyme,
- (7) Progress curve of an enzyme.

Text Book:

- (1) Biochemistry in the Lab A Manual for Undergraduates by Benjamin F. Lasseter.

20BIC201

Protein structure and function

Preamble:

Protein structure and function is a sub-discipline that integrates structural bioinformatics and molecular medicine. This course aims at understanding the biomolecular sequence, structure and function which form the fundamental concepts in structural bioinformatics. This course is divided into different units: Molecular structure of biomolecules; physico-chemical properties of amino acids; Biomolecular structure and function, Pattern identification and recognition.

Unit 1

(24 Lectures)

Classification of proteins on the basis of composition, conformation of proteins. Software involved in judging conformation generation and optimization. The amino acid building blocks-classification, structure and physical properties of the standard amino acids. chemistry of peptide bond, non-ribosomal peptide bond formation, Proteinaceous and non-proteinaceous, essential and non-essential amino acids. amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Lambert-Beer Law.

Unit 2

(28 Lectures)

Primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structure of biomolecules. Ramachandran Plot, Errat plot, Different normal databases and integrated databases in molecular biology. Biomolecular structure and function of myoglobin and hemoglobin. Molecular physiology of myoglobin and hemoglobin, Bohr effect, Hill's coefficient. Concept of lock and key and induced fit theory, concept of activation, energy and binding energy. Enzyme kinetics and its physiological significances, Enzyme Inhibition, types of inhibitors of enzyme with examples.

Unit 3

(8 Lectures)

Symmetry, Identification of three dimensional structural pattern, Pattern recognition and function of biomolecules.

Text Books:

(1) Introduction to protein structure, by Carl Branden and John Tooze. 2nd Edition, New York: Garland Publishing Company, 410, (1999). ISBN 9780815323051.

20BIC202

Biochemical techniques

Preamble

Based on the biochemistry of the molecules, different methods have been developed to study, analyse and improve the existing strategies for identifying different molecules that are essential for various cellular functions.

Unit 1

(25 Lectures)

Purification methods, Affinity chromatography, Metal ion binding Immobilized metal ion affinity chromatography, Charge Ion exchange chromatography, Size Gel filtration, Hydrophobicity, Hydrophobic interaction chromatography, Reversed phase chromatography, Isoelectric point, Chromato focusing, chromatography media, buffers for chromatography, Poly-acrylamide gel electrophoresis, Blotting techniques.

Unit 2

(20 Lectures)

FPLC and HPLC, Mass spectrometry.

Text Book:

(1) Paul Cutler; Protein Purification Protocols, Humana Press.

20BIC211

Bioinformatics

Preamble

Bioinformatics is a discipline that integrates different sub-disciplines of informatics, chemistry, physics, molecular biology, biochemistry and molecular medicine. This course aims at understanding the molecular basis of life by looking into genes, proteins and small molecules on the basis of different biological databases, sequence algorithms, computational biology and its related software. Latest trend in introduction of machine learning and its applications addressed.

Unit 1**(10 Lectures)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Searching Databases: Integrated databases.

Unit 2**(15 Lectures)**

Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Consensus sequence, Sequence Pattern and repeat finding, Gene identification tools; Protein Information Sources, SWISSPROT, TREMBL, protein data bank, Understanding the structure of each source and using it on the web.

Unit 3**(15 Lectures)**

Protein Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results.

Unit 4**(5 Lectures)**

Data mining, Introduction of machine learning and its applications.

Text Books:

(1) Bioinformatics: Genes, Proteins and Computers By Christine Orengo, David Jones, Janet Thornton, 2002 by Taylor & Francis, 320 Pages.

(2) Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985.

20BIC212**Biosafety and bioethics****Preamble**

The recent advances in the field of biotechnology/biomedical technologies have brought into focus several safety and ethical issues. The inventions in the field of genetic engineering, molecular medicine and related fields of molecular biology not only affect us but also the plants, microorganisms, animals and the entire environment and the way we practice agriculture, medicine and food processing. An increase in our ability to change life forms in recent years has given rise to the new science of bioethics. The present course focus on the biosafety and bioethical issues the modern society confronts. Topics such as biosafety levels, biosafety guidelines, Biomedical technologies its health and human rights perspectives, Clinical ethics, emerging trends in biomedical and genetic technologies and regulatory frame works, legal and ethical implications of cryonics, cloning and its ethical legal and scientific aspects, regulation of biobanks and responsible conduct of biomedical research will be discussed in the curriculum.

Unit I**(3 Lectures)**

Introduction Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

Unit 2 (3 lectures)

General laboratory practice: Familiarise students with Code of Practice for Safe Working in the biological sciences laboratories, waste disposal, handling of biological hazards, equipment and apparatus, reporting of accidents, first aids, fire instructions and other emergencies

Unit 3 (8 Lectures)

Biosafety guidelines Government of India definition of genetic modified organism (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMOs. The GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Unit 4 (2 Lectures)

Foundation of Bioethics: Definition, historic evolution, codes and guidelines, universal principles.

Unit 5 (2 Lectures)

Clinical ethics Describe the sanctity of human life and the need to preserve human life, what makes research involving human subjects ethical, explain about issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies. Biomedical ethics.

Unit 6 (2 lectures)

Legal and ethical implications of cryonics: Introduction, origin of cryonic preservation in humans, procedure, meaning of death, its suspension and legal implications, its position in india.

Unit 7 (2 lectures)

CRISPER Revolution, its future and legal issues: Introduction, advances in genomic research and its legal aspects, ethical and human rights issues in human DNA editing, genome editing technology its legal and regulatory challenges

Unit 8 (2 lectures)

Ethical use of animals in the laboratory: Introduction to animal ethics, bioethics and animals, animal rights, animal use in biological research,

Unit 9 (2 lectures)

Ethics and regulation of biobanks: Introduction, types of biobanks, barriers of biobanking, biobanking framework in india, ethical issues of biobanks

Unit 10

(4 lectures)

Conduct in Research: Introduction to responsible conduct of research, advising and mentoring, treatment of data, research misconduct, competing interests, commitments and values.

Text books:

(1) Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.

(2) The Cambridge Textbook of Bioethics, 1st edition (2008), Peter A. Singer and A. M. Viens; Cambridge University Press, ISBN-13: 978-0511545566.

(3) Foundation of Bioethics, 2nd edition (1996), E. H Tristram; Oxford University Press, ISBN-13: 9780195057362.

20BIC281

BiotechniquePracticals

1. Protein purification
2. Chromatography
3. SDS_PAGE
4. Measurement of Molecular weight
5. Protein estimation
6. Western blotting
7. Chemiluminiscence reaction
8. Image capturing following chemiluminiscece reaction

Text Books:

1. Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15 2.
2. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGRAW Hill Publishing Company LTD, New Delhi, p 10- 15.

20BIC282

Bioinformatics Practicals

- (1) Sequence information database resource;
- (2) Understanding and use of various web resources: EMBL, Genbank, Unigene, Protein information resource (PIR);

Unit 5: (7 lectures) Muscular system:
Muscular functional anatomy of muscular system, types of muscles, neuromuscular transmission, general and molecular mechanism of skeletal muscle excitation and contraction, energetics of muscle contraction and characteristics of whole muscle contraction. An overview of concepts of muscle fatigue, oxygen debt, shivering/tremor, muscle degeneration, tetany, muscular dystrophy.

Unit 6: (6 lectures) Skeletal system:
Cartilage, structure, function and types. Bones: structure, function, location and types. Joints: structure, function and types.

Unit 7: (5 lectures) Fundamentals
of the endocrine system. Glands, their secretions, function and regulation

Text book:

Guyton and Hall Textbook of Medical Physiology, 2nd edition (2016), J. E. Hall; Elsevier.

20BIC302

Biopolymers and its applications

Preamble

Biopolymers in nature are produced by a range of microorganisms and plants. Biopolymers produced by microorganisms require specific nutrients and controlled environmental conditions. This course deals with the recent developments and trends of biopolymers especially in the field of nanotechnology, a basic introduction, a detailed discussion on various characterization techniques used for characterizing biopolymers, applications of biopolymers in various fields, especially in the field related to nanoscience and nanotechnology for medical application.

Unit-1 (5 lectures)

Introduction and Basic Concepts: Definition of Terminology and Basic Concepts, Nomenclature of Polymers, Polymer Architectures

Unit-2 (8 lectures)

Polymers in Solution, Molecular Weight, Physical State Nano Polymers and related Materials: Fracture Behavior, Tailor-Made Plastics, Cross-Linked Materials, Polymer Additives, Nanopolymers and their applications.

Unit-3 (8 lectures)

Polymeric nanoparticles: the future of nanomedicin, Biopolymers indroduction and classification, Biopolymers: Bioplastics, biofibers, biopolymeric composites, Bio-inorganic

polymeric composites, Biopolymers for Specific Applications, Biomedical, Drug delivery, Environmental, Pharmaceutical Technology.

Unit-4

(12 lectures)

Bio-polymeric nanomaterials and its applications: Polysaccharides, Polysaccharide Graft Copolymers – Synthesis, Properties and Applications, Chitosan bio-polymers- Basic sources, characteristics, polymer isolation process, derivatives and their various bio medical applications.

Unit-5

(12 lectures)

Future research trends of biopolymers. Biopolymer Blends and Biocomposites, Biopolymers as wound healing materials, Biopolymers as biofilters and biobarriers. Stimuli responsive polymers: Classifications, preparation and their various applications.

Text Books:

(1) Text book of Polymer Science....by Fred W. Billmeyer;

(2) Biopolymers: Biomedical and Environmental Applications by SusheelKalia and Luc Avérous, Wiley 2011.

20BIC303

Metabolic pathways and its significance in diseases

Preamble.

How current research has given an understanding of the molecular aspects of the metabolic control.

Unit 1

(lectures 15)

The role of specific anabolic and catabolic pathways and how they are interrelated and controlled and the molecular basis of this control. Control of homeostasis in the body by regulation of this pathways.

Unit 2

(lectures 15)

Role of glycolysis pathways and TCA cycles in growth pathways. EGFR pathways, cytoskeletal regulation pathways. Coupling of catabolic and anabolic pathways through adenyly nucleotides (ATP/ADP/AMP) and pyridine nucleotides (NAD(P)⁺ / NAD(P)H). How metabolism is coupled with cellular architecture. Principles of metabolic regulation. ATP synthesis: substrate-level phosphorylation and oxidative phosphorylation.

Unit 3

(lectures 15)

Relationship between metabolic pathways, between liver and peripheral tissues. Biochemistry related to fasting and its influence on metabolic pathways and diseases.

Text Book

- (1) Lehninger Principles of Biochemistry by David L. Nelson; Michael M. Cox, Freeman publications; Seventh Edition 2017.

20BIC304

Enzymology

Preamble

Enzymes themselves are proteins act on other proteins or molecules to modify those proteins or molecules to carry out a specific function. The process involves bringing down the energy barrier to execute the above mentioned changes leading to structural changes that are required to carry out the function of those proteins or molecules.

Unit-1

(7 lectures)

Biochemical Reactions, Energy, and Enzymes: Endergonic and exergonic reactions reflect changes in Gibbs free energy (δG). Enzymes lower activation energy to speed up reaction. Activation Energy and Enzymes: Effect of activation energy on reaction rate, and function of catalysts.

Unit-2

(14 lectures)

Introduction to Enzymes: Discussion of the structure and function of macromolecules, with a particular focus on enzymes/catalysts. Reaction Energetics and Enzymes: Energetics of reactants and products, and activation energy. Enzymes as biological catalysts and transition state complex. Nomenclature used in enzymatic reactions involving S (substrate/reactant), E (enzyme), ES (transition state), and P (product). Enzymes-Free Energy and Kinetics: Definition of enzyme, catalyst, substrate, and active site. Free energy diagram and enzyme mechanism. Michaelis-Menten enzyme kinetics, K_m and V_{max} .

Unit-3

(12 lectures)

Enzyme Function and Specificity: Enzyme-substrate interaction due to physical (shape) and chemical (amino acid properties) complementarity between the active site and the substrate. Three ways activation energy can be lowered: Proximity/orientation, induced-fit, and donation of charges to substrates. Example: Sucrase, phenylalanine hydroxylase.

Unit-4

(12 lectures)

Regulation of Enzyme Function: Multiple ways to regulate enzymes. pH regulation through side chain protonation; temperature regulation through protein structure; covalent modification through phosphorylation; cofactors and coenzymes. Enzyme-Activators and Inhibitors: Function and mechanism of enzyme activators and inhibitors. Positive and negative feedback loops in a metabolic pathway. Definition: Reversible, irreversible, competitive, non-competitive, allosteric regulation. Example: Cancer drug Gleevec (competitive kinase inhibitor).

Text Books

1. Enzymes by Malcolm Dixon, Edwin C. Webb, Elsevier Publishers. 2nd Edition, 2014.

20BIC311

Antimicrobial agents

Preamble

These are chemical entities that prevent the growth of microorganisms specifically. They are non-toxic to other organisms and are largely safe for the environment. There are different types of anti-microbial agents,

Unit 1

(2 Lectures)

Antiseptics: Commonly used antiseptics.

Unit 2

(8 Lectures)

Antibiotics: Bacterial cell wall synthesis, DNA replication, transcription, folate synthesis, protein synthesis inhibitors etc.

Unit 3

(5 Lectures)

Antibiotic resistance mechanisms: modification/destruction of antibiotics, efflux pumps, target modification, biofilm, quorum sensing; MDR bacteria, ESKAPE pathogens, MRSA, VRSA etc; modes of transmission of antimicrobial resistance genes.

Unit 4

(5 Lectures)

Antifungal, antiviral and anti-parasitic agents and their resistance mechanisms.

Unit 5

(5 Lectures)

Problems associated with antimicrobial resistance across healthcare.

Unit 6

(5 Lectures)

Other antimicrobial agents (Fatty acids, phytochemicals, antimicrobial peptides etc).

Text Books:

(1) Antimicrobial Agents: Antibacterials and Antifungals by André Bryskier (Editor); ASM Press.

(2) Antimicrobial Chemotherapy by David Greenwood (Editor); Oxford University Press; 4 edition.

Preamble

Recombinant DNA technology is the combining of DNA molecules from two different or the same species to produce desired outcome in general. The recombined DNA molecule is inserted into a host DNA to generate new combinations of genes or nucleotide stretches that are of value academia understanding of genetic manipulations and can be tailored to be of value in medicine for the production of recombinant proteins, in agriculture for generation of better yielding crops or pest resistant crops and in industry for bulk production of proteins.

Unit - 1**(7 Lectures)**

Introduction to recombinant DNA technology – tools for rDNA technology – DNA manipulative enzymes: restriction enzymes, ligases, polynucleotide kinase, phosphatase, cutting of DNA molecules – joining of DNA molecules – homopolymer tails, linkers, adapters.

Unit – 2**(5 Lectures)**

Gene cloning vectors: salient features, plasmids – properties, types, pBR322 and pUC18, bacteriophage vectors – λ, λZAP, λgt11, cosmids, artificial chromosomes – BAC, YAC, MAC.

Unit - 3**(7 Lectures)**

Gene transfer techniques: calcium chloride mediated gene transfer, electroporation, microinjection, liposome fusion, etc. Screening and selection of recombinant host cells: blue/white screening.

Unit - 4**(6 Lectures)**

Construction of gene libraries: genomic and cDNA libraries. Blotting techniques, polymerase chain reaction (PCR) and its applications.

Unit - 5**(5 Lectures)**

Applications of rDNA technology in industry, medicine, and pharmacy.

Text Books

1. siRNA and miRNA Gene Silencing, from bench to bedside, series methods in Molecular biology vol 487, Sioud, Mouldy (Ed). Springer, 2009, XIV, 474p.
2. Joseph Sambrook, David William Russell, Molecular Cloning: A Laboratory Manual, Volume 1-2-3 CSHL Press, 2001.
3. Terence A. Brown, Essential Molecular Biology: A Practical Approach, Volume 1 Oxford University Press, 2000.
4. UdoReischl; Molecular Diagnostics of infectious diseases; Humana Press.
5. Adrian J Harwood, Methods in Molecular Biology; Protocols for gene analysis.

Preamble

Cancer is defined as uncontrollable cell growth. The complexities of the causes and the different types of cells that give rise to this disease have underscored the need for a better understanding of the basic biology of cancer. Advancements in basic and biomedical research have led to more effective treatments, enhanced detection methods, and better prevention strategies. This course aims to provide a comprehensive overview of the biology and pathology of cancer. This course will cover the genetic and molecular basis of cancer, role of mutations in cancer cells, and how they lead to the dysregulation of essential biological properties like programmed cell death, cell proliferation and differentiation, invasion and metastases, cancer etiology and epidemiology.

Unit 1**(6 Lectures)**

Introduction to Cancer, cardinal manifestations of cancer, History of Cancer Research, Overview of the hallmarks of cancer

Unit 2**(6 lectures)**

Cell Proliferation and Differentiation: Tumour growth and proliferation in vivo, cell cycle control, check points, DNA damage induced check points, Check point defects in tumour cells, differentiation, extracellular and intracellular factors of differentiation, Differentiation and cancer therapy.

Unit 3**(4 lectures)**

Apoptosis and cancer: Apoptosis, Apoptosis caused by caspases, caspase activation pathways, apoptosis dysregulation in cancer

Unit 4**(4 lectures)**

Growth factors and signal transduction in cancer: Background, growth factors, classification of growth factors and its receptors, abnormalities associated with growth factors in cancer cells, signalling pathways in cancer. Signalling pathways and its implications for cancer therapy.

Unit 5**(5 lectures)**

Oncogenes: Mutagens, carcinogens and mutations, Tumor viruses and the discovery of oncogenes, Tumor cells and genetic abnormalities, mechanism of oncogene activation, oncogenes in the initiation and progression of neoplasia

Unit 6**(6 lectures)**

Invasion and Metastases: Tumour-host and tumour-stroma interactions, adhesion, tumour cell migration, angiogenesis, genetic regulation of invasion and metastases, cancer stem cells, therapeutic intervention

Unit 7**(6 lectures)**

Tumour antigens: Introduction, categories of tumour antigens, application of tumour antigens for clinical immunotherapy

Unit 8

(6 lectures)

Cancer etiology: Genetic predisposition to cancer, chemical carcinogenesis, multistage carcinogenesis (tumour initiation, tumour promotion, malignant conversion and tumour progression), caretaker and gate keeper genes, carcinogen metabolism, DNA damage and repair, hormones and the etiology of cancer, radiation and cancer, UV-radiation and cancer, physical carcinogens and cancer, virus and cancer, parasites and cancer.

Unit 9

(2 lecture)

Cancer Epidemiology: Incidence of cancers in india and other parts of the world.

Text book:

(1) Robin Hesketh. Introduction to Cancer Biology, Cambridge University Press, 2012 (ISBN: 9781107601482)

(2) Weinberg, Robert A. The Biology of Cancer, Second Edition. New York: Garland Science, 2013.

20BIC314

Hormone: Biochemistry and Function

This course introduces fundamental concepts related to hormonal regulation of bodily functions at the level of tissues and cells. Students will be exposed to important cellular pathways that are activated by hormones, and the ensuing biochemical changes that take place within cells resulting in functional outcomes. Disorders related to hormonal imbalance will be introduced to help students apply concepts of hormonal regulation in disease conditions. Principles behind therapies for endocrinal disorders will also be discussed.

Unit : 1

(lectures 5)

Introduction to endocrinology: Functions of hormones and their regulation. Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy.

Unit : 2

(lectures 10)

Hormone mediated signalling: Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP₃, DAG, Ca²⁺, NO. Effector systems - adenylyclase, guanylyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras - MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.

Unit : 3**(lectures 7)**

Hypothalamic and pituitary hormones: Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.

Unit : 4**(lectures 4)**

Thyroid hormone: Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimoto's disease.

Unit : 5**(lectures 5)**

Hormones regulating Ca²⁺ homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca²⁺ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit : 6**(lectures 4)**

Pancreatic and GI tract hormones: Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II.

Unit : 7**(lectures 4)**

Hormones of adrenals: Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit : 8**(lectures 4)**

Reproductive hormones: Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

Unit : 9**(lectures 2)**

Growth factors PDGF, EGF, IGF-II, and erythropoietin.

Text Books

1. Guyton and Hall Textbook of Medical Physiology, 2nd edition (2016), J. E. Hall; Elsevier

- (1) Fundamentals of cell culture.
- (2) Facilities and Applications.

- (3) Media preparation for Animal cells culture.
- (4) Types of cell culture: Primary and secondary cell culture, cell lines, stem cell cultures,
- (5) Tests: cell viability and cytotoxicity,
- (6) Cryopreservation.

Text book:

- (1) Basic Cell Culture Protocols (3rd edition) by Cheryl D. Helgason, Cindy L. Miller.
- (2) Masters, J.R.W. Animal Cell Culture: A Practical Approach. 3rd Edition. Oxford University

20BIC382

Enzymology Practicals

- 1. Solution preparation for enzyme assays.
- 2. Alkalinity measurement in the given water sample
- 3. Measurement of factors affecting enzyme activity such as Temperature, pH and ionic concentrations.
- 3. Identification of enzyme (Amylase/ Trypsin) in preparations
- 4. Specific activity of enzyme determination
- 5. Determination of K_m and V_{max}

20CHE101

Chemistry

Preamble

This course deals with the basic introduction to organic chemistry, focusing primarily on the basic principles to understand the structure and reactivity of organic molecules, emphasis is on substitution, elimination, alkanes, alkenes, alkynes and their related reactions, understanding of different reaction mechanism and methods used for organic compound preparation.

Unit-1

(3 lectures)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.

Unit-2

(4 lectures)

Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.

Unit-3

(6 lectures)

Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

Unit-4

(3 lectures)

Aromaticity: Benzenoids and Hückel's rule. Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Unit-5 **(8 lectures)**

Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis and, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Unit-6 **(12 lectures)**

Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO_4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Unit-7 **(9 lectures)**

Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: Formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis and oxidation with hot alk. KMnO_4 .

Text books:

- (1) Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014);
- (2) Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, NewDelhi (1988);
- (3) Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S; Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010;
- (4) Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

20CSA103

Computational Skills

Preamble

Understanding computer and computer related skills is a must and the interface between biology and computer is intertwined. The course provide an introduction to beginners on different aspects of computer knowledge for tackling biology related aspect.

Computer Fundamentals

Unit-1 **(15 lectures)**

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices User Interface with the Operating System, System Tools

Data Representation

Unit-2

(15 lectures)

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode

Networks terminology

Types of networks, router, switch, serverclientarchitecture

Multimedia

Introduction, Characteristics, Elements, Application, Problem Solving, Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

General Awareness IT Act, System Security (virus/firewall etc.)

Text Books

[1] V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.

[2] Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson Education.

20CSA185

Computational SkillsPracticals

1. Defined projects will be done by the students and evaluated by the instructor.
2. Document Preparation
3. Presentation Software
4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting
5. Spreadsheet Handling, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

Text Books

[3] V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.

[4] Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson Education.

20CUL201

Cultural Education

Unit 1

(15 lectures)

Culture – definition and scope. Values and culture, cultural freedom, Culture and Education
Culture of Research – creativity and responsibility in research.Spirituality and Culture –
spirituality as a way of life, spirituality and religion.Culture and women – gender oppression,

motherhood.Culture and the Media.Culture and Politics – national values and political harmony.Philosophy and Culture, epistemology.

20ENG102

English I

Unit-1

(20 lectures)

Adopting the platform of English for the expression of science.Understanding the English language for constructing meaningful sentences. Basics of English, Writing structured sentences, Articulating for clear and efficient delivery of concepts. Includes a) Ability to speak and write clearly in English b) Ability to listen to and follow scientific viewpoints and engage with audience. Develop strategies and skills to enhance their ability to read. Reading science related books and comprehension. Articulated presentation on books and scientific articles in layman’s language. Writing exercise should contain sentence structure correctness, comprehending the concepts effectively. Developing capabilities to communicate science in layman’s language through seminars.

Unit-2

(25 lectures)

Skill development: Critical Thinking: a) Ability to substantiate critical readings of scientific texts in order to persuade others. b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Problem Solving: a) Ability to closely observe the situation, and apply lateral thinking and analytical skills. Analytical Reasoning: a) Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments. b) Ability to use critics and theorists to create a framework and to substantiate one’s argument in one’s reading of scientific texts.

Suggested Reading

- 1.H.G. Wells. ***A short History of the world***.PenguinClassics.U.K 2006. (A book recommended by Einstein).
2. Walter Isaacson. ***Einstein: His Life and Universe***, Published by Simon & Schuster 2007.
3. Alexander Graham Bell ***How to Improve the Race***
4. Linus Pauling***A Lifelong Quest for Peace***Editor: Richard L. Gage 1990
5. Stephan Hawkings***On the Shoulders of Giants*** by Running Press 2002

20ENG112

English II

Unit-1

(20 lectures)

Research-Related Skills: a) Ability to problematize; to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers. b) Ability to plan and write a research paper. Teamwork and Time Management: a) Ability to participate constructively in class room discussions. b) Ability to contribute to group work. c) Ability to meet a deadline. Scientific Reasoning: a) Ability to analyze texts, evaluating ideas and scientific strategies. b) Ability to formulate logical and convincing arguments. Reflective Thinking: Ability to locate oneself and see the influence of location—regional, national, global— on critical thinking.

Unit-2

(25 lectures)

Self-Directing Learning: a) Ability to work independently in terms of organizing laboratory, and critically analyzing research literature. b) Ability to postulate hypothesis, questions and search for answers. Digital Literacy: a) Ability to use digital sources, and apply various platforms to convey and explain concepts of biochemistry. Multicultural Competence: a) Ability to engage with and understand cultures of various nations and respect and transcend differences.

Leadership Readiness: Ability to lead group discussions, to formulate questions related to scientific and social issues. Life-long Learning: a) Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day basis of learning.

Suggested Reading

1. Roger Holloway. C. V. **Raman: 51 Success Facts - Everything You Need to Know About C. V. Raman**, Published by Lightning Source, 2014.
2. Carl Edward Sagan. **Cosmos** by Random House Publishers
3. Alexander Graham Bell **How to Improve the Race** or
4. Linus Pauling **A Lifelong Quest for Peace** Editor: Richard L. Gage 1990
5. Stephan Hawkings **On the Shoulders of Giants** by Running Press 2002

20IPR201

IPR

Unit-1

(15 lectures)

Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of Biotechnological inventions.

Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

20MAT102

Biostatistics

Preamble

Strategy to execute a research is central to the successful completion and execution of a scientific endeavour. Based on the literature, several methodologies have been developed to tailor a particular strategy and the appropriate use of sample numbers for reliable results and meaningful outcome.

Unit-1

(10 lectures)

Introduction to Biostatistics-Need for Statistical Methods in Medicine, Public Health, Biology, Biotechnology & Nano Sciences –Their uses and Misuses, Types of Variables, Data collection Methods, Population and Sample. Basics of Mathematics- (a) Differential & Integral Calculus Differentiation – Derivative of a function, Integration as the inverse operation of Differentiation,

Methods of Integration. (b) Linear Algebra – Set Theory, Matrix Algebra (i) Set Theory- Sets and their operations. (ii) Matrix Algebra- Special type of Matrices, Determinants.

Unit-2 (10 lectures)

Study Designs-Prevalence and incidence studies, Case control and Cohort studies, Experimental studies – randomization. Estimation of Minimum Sample size in Different Designs of Studies and Sampling Methods. Descriptive Data Analysis Methods- Statistical Tables, Diagrams & Graphs, Measures of Averages, Measures of Dispersion, Correlation Analysis Methods, Regression Analysis Methods. Theory of probability and Standard Distributions- Probability: Random experiment, Sample space, Events, Mutually exclusive and exhaustive events, Frequency and classical definition of probability, Axiomatic definition of probability, Addition and multiplication theorems, Conditional probability and independence, Baye's theorem Random Variables and

Unit-3 (15 lectures)

Probability Distributions :- Definition of discrete and continuous random variables, Probability density functions and distribution functions, Standard univariate discrete distributions – Binomial, poisson & Negative Binomial, Standard univariate continuous distributions – Normal, Log normal & Exponential. Sampling distributions – Chi- square distribution and F & 't' distributions. Logic of Statistical Inference- Concept of 'statistic' and 'parameter', Estimators and its properties, point and Interval estimation of parameters, Confidence intervals, concepts of standard error Principles of test of significance, Bayesian Inference Methods. Methods of tests of Significance of Significance of Statistical Hypotheses- Concept of Statistical Hypotheses –Null and Alternative hypotheses, Type I and Type II errors, Significance level, Critical region and Power of a test, P- value and its interpretation; Large and Small Sample Test – Normal test, Student's 't' test, Chi-square tests, Analysis of variance & Non parametric methods.

Unit-4 (10 lectures)

Statistical methods in planning and analysis of clinical trials;
Statistical aspects of diagnostic tests.

Nonparametric methods-Non-parametric methods for estimation, Methods for tests of significance for the independent and correlated samples, Nonparametric Methods for more than two populations.

Multivariate analysis Methods- Principles of Multivariate analysis, Multivariate regression analysis, Multivariate logistic regression analysis.

Practicals- (Statistical Software to be used: SPSS & SAS): (i) Practical in Descriptive Data Analysis Methods, (ii) Practical in Study Designs, (iii) Practical in Sampling Theory, (iv) Practical in Biostatistical Inference, (v) Practical in Testing of Hypotheses, (vi) Practical in Nonparametric Methods, (vii) Practical in Clinical Trials, (viii) Practical in Multivariate Regression Analysis.

20MMD102

Cell Biology-1

Preamble

This course is to introduce the cell as a basic unit of life to the students of molecular medicine. It will elaborate the basic structure of the eukaryotic cells and the differences between the prokaryotic and eukaryotic cells. Further, the course will make the students

understand the basic organization of eukaryotic cells, the endomembrane system, structure and functions of cell organelle, intracellular transport, the cytoskeleton, communication of cells with its surroundings and other cells and how cells reproduce through cell division. The course is devised in such a manner that the students will get a basic idea on the cellular bases of diseases.

Unit 1 **(5 lectures)**

The Cell: Introduction to cell theory, Comparison of a generalized pro- and eukaryotic cell
Methods in Cell Biology: Elementary idea of microscopy and cell fractionation.

Unit 1 **(5 lectures)**

Organization of cell: Extranuclear (Elementary knowledge of structure and function of plasma membrane; Introduction to endomembrane system (endoplasmic reticulum, Golgi complex, lysosome, peroxisome; Introduction to cytoskeleton; Structure and functions of mitochondria); Nuclear (Nuclear envelope, nucleolus and biogenesis of ribosome).

Text Books:

(1) Karp: Cell and Molecular Biology (2008, John Wiley)

(2) Lodish et al: Molecular Cell Biology (2008, Freeman)

20MMD111

Cell Biology-2.

Preamble:

This course is to introduce the cell as a basic unit of life to the students of molecular medicine. It will elaborate the basic structure of the eukaryotic cells and the differences between the prokaryotic and eukaryotic cells. Further, the course will make the students understand the basic organization of eukaryotic cells, the endomembrane system, structure and functions of cell organelle, intracellular transport, the cytoskeleton, communication of cells with its surroundings and other cells and how cells reproduce through cell division. The course is devised in such a manner that the students will get a basic idea on the cellular bases of diseases.

Unit 1 **(Lectures 5)**

Membrane transport: Principles of membrane transport, Channel proteins, carrier proteins; Passive and active transport

Unit 2 **(Lectures 5)**

Intracellular transport and protein sorting; Signal peptides and protein targeting; Entry and

passage of proteins through endoplasmic reticulum; Processing and sorting of proteins in Golgi Apparatus; Endosomes and lysosomes; Nuclear pore complex and nuclear transport.

Unit 3 **(Lectures 5)**

Mitochondria and energy transfer: Electron transport and oxidative phosphorylation

Unit 4 **(Lectures 5)**

Cytoskeleton: Organisation and functions; Microtubular organelles

Unit 5 **(Lectures 5)**

Cell-cell communication: Cell junctions; Cell adhesion and extracellular matrix; General principles of cell signaling.

Unit 6 **(Lectures 5)**

Cell reproduction: Basic features of cell cycle; Mitosis, mitotic spindle and chromosome movement; Process and phases of meiosis and its significance; Genetic regulation of cell cycle

Text books:

(1) Karp: Cell and Molecular Biology (2008, John Wiley;

(2) Lodish et al: Molecular Cell Biology (2008, Freeman).

20MMD112

Immunology

Preamble

Immunology is the study of the defence mechanisms the body mount against invading foreign bodies. As a result of the concerted action of various cells and tissues constitute the immune defence mechanism to eliminate the foreign invader. How this defence is achieved, and the mechanistic aspects is dealt in this module.

Unit 1 **(5 Lectures)**

Immune system, Concept of Innate and Adaptive immunity; Immune Cells and Organs.

Unit 2 **(7 Lectures)**

Antigens; Adjuvants; Antibodies; Antigenic determinants on antibodies; VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit 3 **(5 Lectures)**

Major Histocompatibility (Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation.

Unit 4 **(5 Lectures)**

Complement System.

Unit 5**(6 Lectures)**

Generation of Immune Response, Introduction to tolerance, Immunological Disorders and Tumor Immunity.

Unit 6**(7 Lectures)**

Types of autoimmunity and hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome,

Unit 7**(7 Lectures)**

Immunological Techniques (Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy).

Text book:

- (1) Janeway's Immunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition, Garland science publishing, 2007.

20MMD183 Immunology Practicals

- (1) Separation of serum & plasma,
- (2) Blood staining,
- (3) Blood grouping,
- (4) Antigen-Antibody reactions: agglutination, precipitation, immuno-electrophoresis, Coomb's test,
- (5) ELISA,
- (6) RIA,
- (7) WIDAL.

Text Book:

1. Manual of Molecular and Clinical Laboratory Immunology, Eighth Edition by Barbara Detrick, John L Schmitz, Robert G Hamilton.

20MMD184**Cell Biology Practicals**

This lab is aimed to demonstrate use of microscopy in the study of cells, the morphology and internal organization of various types of cells, permeability of plasma membrane and different phases in mitosis and meiosis.

- (1) Drawing of ultrastructure of cell and different organelles (from photographs provided).

- (2) Familiarization with the student's light microscope and stereobinocular microscope.
- (3) Application of centrifuge – separation of sperm from other testicular cells by low speed centrifugation.
- (4) Diversity of eukaryotic cells – methylene blue staining of buccal epithelium, sperm, neurons, striated muscle cells; Leishman staining of mammalian blood cells.
- (5) Permeability of plasma membrane – effect of isotonic, hypotonic and hypertonic solutions on mammalian RBC.
- (6) Staining of nucleolus (RNA) and chromatin (DNA) with methyl green-pyronin Y.
- (7) Staining of mitochondria with Janus green in buccal epithelium.
- (8) Mitosis using somatic cells.
- (9) Meiosis using germ cells.

Text books:

- (1) Karp: Cell and Molecular Biology (2008, John Wiley).
- (2) Lodish et al: Molecular Cell Biology (2008, Freeman).

20MMD201

Microbiology

Preamble

Microbiology deals with the organisms that are at micron range can only be seen through a microscope. They are highly adaptable to different environment and exist in symbiotic relationship with higher order organisms. Their biology is explained in detail.

Unit-1

(2 lectures)

History and classification of microorganisms.

Unit-2

(10 lectures)

Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Unit-3

(7 lectures)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

Unit-4

(6 lectures)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit-5 (5 lectures)

Bacterial Reproduction: Transformation, Transduction and Conjugation.

Unit-6 (4 lectures)

Endospores and sporulation in bacteria.

Unit-7 (15 lectures)

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents.

Unit-8 (11 lectures)

Food and industrial microbiology; probiotics, biological waste management.

Text book:

(1) Microbiology by Prescott, L.M., 6th Edition. McGraw-Hill Companies. 2002.

20MMD202

Developmental Biology.

Preamble

This course will describe the general patterns and mechanisms involved in the development of bilateral organisms including the mammals. Specifically, the course will deal with sex determination, gametogenesis, developmental organization, axis formation, 3 germ layer formation, organogenesis and implications of development in health and disease. The course is expected to provide the students a deeper understanding about the developmental origin of health and disease in adulthood.

Unit-1 (6 lectures)

Patterns and Processes of Becoming: A Framework for Understanding Animal Development (Making New Bodies: Mechanisms of Developmental Organization; Specifying Identity: Mechanisms of Developmental Patterning; Differential Gene Expression: Mechanisms of Cell Differentiation; Cell-to-Cell Communication: Mechanisms of Morphogenesis).

Unit-2 (3 lectures)

Gametogenesis and Fertilization: The Circle of Sex (Sex Determination and Gametogenesis; Fertilization: Beginning a New Organism).

Unit-3 (3 lectures)

Early Development: Cleavage, Gastrulation, and Axis Formation (The Genetics of Axis Specification in Drosophila; Mammals).

Unit 4 (3 Lectures)

Building with Ectoderm: The Vertebrate Nervous System and Epidermis: Neural Tube Formation and Patterning; Brain Growth; Neural Crest Cells and Axonal Specificity; Ectodermal Placodes and the Epidermis.

Unit 5 **(4 Lectures)**

Building with Mesoderm and Endoderm: Organogenesis; Paraxial Mesoderm: The Somites and Their Derivatives; Intermediate and Lateral Plate Mesoderm: Heart, Blood, and Kidneys; Development of the Tetrapod Limb; The Endoderm: Tubes and Organs for Digestion and Respiration

Unit 6 **(3 Lectures)**

Postembryonic Development: Metamorphosis: The Hormonal Reactivation of Development; Regeneration; Aging and Senescence

Unit 7 **(8 Lectures)**

Development in Wider Contexts: Development in Health and Disease: Birth Defects, Endocrine Disruptors, and Cancer; Development and the Environment: Biotic, Abiotic, and Symbiotic Regulation of Development; Development and Evolution: Developmental Mechanisms of Evolutionary Change.

Text Books:

- (1) Gilbert: Developmental Biology (11th ed., 2006, Sinauer);
- (2) Balinsky: An Introduction to Embryology (1981, CBS);
- (3) Wolpert: Principles of Development (3rd ed. 2007, Oxford).

20MMD211

Molecular Biology and Genetic Engineering

Preamble

Molecular Biology encompasses the basic study and understanding of the execution of central dogma.

Unit 1 **(10 Lectures)**

Genome organization: Structure of DNA, Types of DNA, Organization of Chromatin, Histone and Non-histone proteins, Nucleosome. Concept of Gene, Introns and Exons. Nature and Properties of Genetic Code.

Unit 2 **(10 Lectures)**

The replication of DNA in Prokaryotes and Eukaryotes: Chemistry of DNA synthesis, Mechanism of Replication: Initiation, Elongation, synthesis of Leading and lagging strands, Termination. Various models of DNA replication (D-loop mitochondrial, Theta mode of

replication, rolling circle model, Replication of linear ds-DNA). Enzymes and proteins involved in DNA replication. Denaturation and renaturation of DNA, Cot curves.

Unit 3

(5 Lectures)

The mutability and Repair of DNA: Replication Errors (Transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization) and their repair: mismatch repair, SOS response (recombination), Excision Repair, Photoreactivation. Types of mutations.

Unit 4

(10 Lectures)

Information Transfer –I: Mechanism of Transcription: Basic transcription apparatus, Initiation, elongation and termination of transcription, Eukaryotic transcription of mRNA, tRNA and rRNA, types of RNA polymerases, transcription factors, Inhibitors of transcription-rifampicin and α -amanitin.

Unit 5

(5 Lectures)

Post-Transcriptional Modifications: Split Genes, Concept of introns and exons, RNA splicing, Spliceosomes and Self splicing introns, alternative splicing and exon shuffling, mRNA transport.

Unit 6

(5 Lectures)

Mechanism of Translation: Features of genetic code and exceptions in some systems, Ribosome structure- rRNA and proteins, Charging of tRNA, aminoacyl-tRNA synthetases, Proteins involved in initiation (both in prokaryotes and eukaryotes), elongation and termination of polypeptides, Fidelity of translation, Inhibitors of protein synthesis – tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.

Text Books:

- (1) Friefelder, D. Molecular Biology. 2nd Edition. Narosa Book Distributors Pvt. Ltd. 2008.
- (2) Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular Biology of the Cell. 5th Edition. Garland Science. 2007.
- (3) Molecular Biology of the Gene, 6th edition (2007), Watson, J. D., Baker T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R; Benjamin Cummings Publishers, ISBN-13: 978-0805395921.
- (4) The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13: 978-1605351551.

Preamble

Genes are complexities in which the informations for a cellular complexity is stored. The study of this complexity is genetics and genomics.

Unit 1: (5 Lectures)

Elements of heredity and variation: Mendel and his experiments; Principles of segregation and independent assortment and their chromosomal basis; Test cross; Application of laws of probability to Mendelian inheritance

Unit 2: (5 Lectures)

Extension of Mendelism: Dominance relationships (complete dominance, incomplete dominance and co-dominance); Multipleallelism; Lethal alleles; Pleiotropy; Epistasis; Penetrance and expressivity; Phenocopy; Polygenic inheritance.

Unit 3: (5 Lectures)

Cytoplasmic and infective inheritance; Linkage: Linkage and crossing over; Structural and numerical alterations of chromosomes; Transgenic animals: strategies and applications

Unit-4 (8 lectures)

Introduction: What Is in a HumanGenome? Meiosis, Development and Aging

Unit-5 (8 lectures)

Transmission Genetics: Single-Gene Inheritance; Beyond Mendel'sLaws; Matters of Sex ; Multifactorial Traits; Genetics of Behavior

Unit-6 (8 lecture)

Genes and Regulation: Gene Expression and Epigenetics; Gene Mutation; Chromosomes

Unit-7 (6 lecture)

Population Genetics: Constant Allele Frequencies and DNA Forensics; Changing Allele Frequencies; Human ancestry and Evolution.

Text books:

- (1) Gardner et al: Principles of Genetics (1991, John Wiley).
- (2) Ricki Lewis: Human Genetics (12th edition, McGraw Hill).
- (3) Griffith et al: An Introduction to Genetic Analysis (2005, Freeman).
- (4) Gardner et al: Principles of Genetics (1991, John Wiley)

(5) Ricki Lewis: Human Genetics (12th edition, McGraw Hill)

(6) Griffith et al: An Introduction to Genetic Analysis (2005, Freeman)

20MMD213

Proteome and Proteomics

Preamble

Despite having the same number of chromosomes in all cells, there are different types of cells and different functions they elicit. This is due to differential gene expression. As a result, the protein expression pattern and proteome of the tissue or cell type is going to be very different. Understanding the cellular proteins by proteome analysis is essential for deciphering the importance of cell/tissue specific proteins role in homeostasis and related functions

Unit 1

(15 lectures)

What is proteome and proteomics and its significance. How proteins of a cell can be identified. Significance of different methods for studying proteomics. Significance of protein mass in proteomics. Mass spectrometry. Principles of mass spectroscopy.

Unit 2

(15 lectures)

Identification of proteins using mass spectrometry, Protein fragmentation; Peptide enrichment and separation; Ionization and its Importance; Time of Flight, MS/MS analysis, Peptide fragmentation and peptide sequencing. Significance of mass spectrometry in clinics.

Text Books:

1. Nawin C. Mishra, "Introduction to Proteomics: Principles and Applications" Wiley, 2010, ISBN: 0471754021
2. Proteomics for Biological Discovery: Timothy Veenstra and John Yates

20MMD281

Microbiology Practicals

- (1) Isolation of bacteria & their biochemical characterization;
- (2) Staining methods: simple staining,
- (3) Gram staining,
- (4) Spore staining,
- (5) Negative staining,
- (6) Hanging drop;
- (7) Preparation of media & sterilization methods,
- (8) Methods of isolation of bacteria from different sources;

- (9) Antimicrobial activity assays;
- (10) Enumeration of microorganism - total & viable count.
- (11) Bacterial mutagenesis – physical & chemical.
- (12) Preparation of *Escherichia coli* competent cells, Transformation of bacteria.

Text Books:

- (1) Bailey & Scott's Diagnostic Microbiology, 14th Edition.

20MMD283

Molecular Biology Practicals

1. Preparation of various stock solutions required for Molecular Biology Laboratory.
2. Preparation of culture medium (LB) for E. coli (both solid and liquid) and raise culture of E. coli.
3. Isolation of chromosomal DNA from bacterial cultures and visualization on Agarose Gel Electrophoresis.
4. Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) and Spectrophotometer (A260 measurement).
5. Isolation of genomic DNA from blood/ tissue.
6. Demonstration of Polymerase Chain Reaction (PCR) technique
7. Demonstration of AMES test or reverse mutation for carcinogenicity

Text books:

- (1) Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp; Wiley Publishers ISBN-13: 978-1118206737.
- (2) Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422.

20MMD301

Stem cell Biology

Preamble:

Advancements in stem cell biology are occurring at a rapid pace. Breakthroughs in this field may lead to regenerative therapies for diabetes, heart disease, age-related organ failure, genetic diseases, Parkinson's, and severe tissue traumas such as spinal cord injuries. Stem cells are revolutionizing the regenerative medicine sector and it provides immense hope for

the medical world to treat the diseases that are once considered as non-treatable. Stem cells are also being used to gain a better understanding of mammalian development, cell differentiation and gene regulation. This course aims to provide a comprehensive overview of the basic biology and some applications of stem cells. This course will cover the basics of stem cells, classification of stem cells, embryonic stem cells, adult stem cells, self renewal and quiescence of stem cells, applications of stem cells, induced pluripotent stem cells and its applications, current controversies associated with stem cell research.

Unit 1 (4 Lectures)

Introduction to stem cells, self-renewal, clonality, potency, types of stem cells, differentiation potential of stem cells, basic concepts and definitions.

Unit 2 (3 Lectures)

Embryonic stem cells, defining properties of embryonic stem cells, Human embryonic stem cells, human embryonic germ cells

Unit 3 (3 Lectures)

Adult stem cells, types of adult stem cells

Unit 4 (4 Lectures)

Introduction, cell cycle kinetics of stem cells in vivo, mammalian cell cycle regulation and cyclin-dependent kinase inhibitors, role of cyclin-dependent kinase inhibitors in stem cell regulation. Molecular, epigenetic, and genetic control of stem cell differentiation and specializations.

Unit 5 (2 Lectures)

Stem cell Niche: Introduction, concept of stem cell niche and its importance

Unit 6 (3 Lectures)

Hematopoietic stem cells: Introduction, definition, sources of HSCs, identification of HSCs, uses of HSCs

Unit 7 (3 Lectures)

Mesenchymal stem cells (MSCs): Introduction, sources of MSCs, identification of MSCs, properties of MSCs, uses of MSCs

Unit 8 (3 Lectures)

Pluripotency and Induced pluripotency: Introduction, definition, induced pluripotent stem cells (iPSCs), potential application of iPSCs

Unit 9 (3 Lectures)

Stem cell application: Introduction, existing and potential clinical use of stem cells, application of stem cells to regenerative medicine.

Unit 10

(2 Lectures)

Controversies in stem cell research: Introduction, ethical issues associated with stem cell research, current controversies surrounding stem cell research.

Text book:

(1) Essentials of Stem Cell Biology, Second Edition, 2009, Edited by Robert Lanza, M.D., ISBN: 978-0-12-374729-7, Elsevier Inc.

(2) Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press.

20RM301

Research Methodology

Unit : 1

(lectures 15)

Identifying a scientific problem and collecting data to address the problem, Development of a hypothesis, Addressing the hypothesis with research question driven experiment strategy, experiment design, choosing appropriate controls, adoption of experimental techniques to address the hypothesis, sample collection and processing strategies with examples.

Unit : 2

(lectures 15)

Significance of developing protocols for experiments, execution of the experiments, generation of data, principles of data documentation. Interpreting the data, significance of critical evaluation, how to discuss and conclude your finding.