(CBCS) B.SC.(HONS.) BIOMEDICAL SCIENCES

Biochemistry
(32581301)
Core Course - (CC) Credit:6

Course Objective(2-3)

The objective of this course is to effectively incorporate the fundamentals of metabolism through key biochemical pathways and make learners appreciate the stringency of their regulation; introduce various biochemical techniques used in characterization of the proteins and a detailed account of how enzymes function: their kinetics, regulation and inhibition.

Course Learning Outcomes

1. Students will gain in-depth understanding on fundamental biochemical principles of metabolism of diverse biomolecules (Sugars, Proteins, Lipids and Nucleic acids) & the associated bioenergetics; and the interrelations, logics & patterns observed in metabolic pathways. They will also understand the role of enzymes in the biochemical reactions and the connect between biochemical/genetic defects and metabolic disorders.

2. Students will be able to demonstrate a thorough understanding and appreciate the importance of rigorous regulation of metabolic pathways.

3. Having understood the structural architecture of proteins in earlier semesters, students shall learn how biological molecules (especially proteins) are isolated and characterized through various techniques such as types of column chromatography, PAGE, IEF that are used in contemporary biochemistry research laboratories.

4. They will learn to appreciate, compare and contrast the analytical and preparative methods in Biochemistry used for purification and characterization of biomolecules.

5. They will get a grasp on central concepts underlying enzyme catalysis, their mechanism of action, kinetics and the role of cofactors in enzymes' activity. They will also gain knowledge of regulatory enzymes, their activity and kinetics.

6. The experiments they will perform shall help them in better understanding of how enzymes function and how separation techniques are used in analysis and purification of biomolecules.

Unit 1

Metabolic Pathways and their regulation Lectures (L1-L28)

Carbohydrate metabolism- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle and their regulation, Cori cycle, Electron transport chain, Oxidative phosphorylation, Hexose monophosphate shunt, Glycogen metabolism and its regulation.

Lipid metabolism- Mobilization of triglycerides, Metabolism of glycerol, Biosynthesis and - oxidation of saturated fatty acids (palmitic acid) and their regulation, Ketone bodies.

Protein metabolism- General overview, Transamination, Deamination, Glucose-Alanine cycle, Urea cycle and its regulation, Metabolism of phenylalanine and a branched chain amino acid.

Nucleic acid metabolism-
General overview, the outline of purine and pyrimidine metabolism,Gout and Lesch-Nyhan syndrome.

Unit 2

Analytical methods in proteincharacterization (L29-L36)

Paper and Thin-layer chromatography, Ion exchange chromatography, Gel filtration and Affinity chromatography, SDS-PAGE, IEF.

Unit 3

Enzymes (L37-L44)

Introduction to enzymes, Concept of lock and key and induced fit theory, Concept of activation energy and binding energy. Enzyme kinetics: Michaelis-Menten equation and its physiological significance, Double reciprocal plots. Enzyme Inhibition: types of inhibitors and their examples, Turnover number.

Unit 4

Coenzymes (L45-L46)

Classification: various types, functions. Structures of NAD^+, $NADP^+$, FAD and FMN.

Unit 5

Regulatory enzymes. (L47-L48)

General properties of allosteric enzymes, Co-operativity, Regulation by covalent modification, Zymogens.

Practical

1. To perform dialysis
2. Protein estimation by any one method: Lowry's/Bradford.
3. Separation of sugars/amino acids by Thin Layer Chromatography.
4. To perform SDS-PAGE.
5. Calculation of Void Volume of Sephadex G -25 column, using Blue Dextran.
6. Assay of any one enzyme, under optimal conditions.
7. To study the effect of temperature on the activity of enzyme.
8. To study the effect pH on the activity of enzyme.

References

1. Lehninger Principles of Biochemistry, 7thedition (2017), David L. Nelson and Michael M. Cox; W. H. Freeman, ISBN-13: 978-1464126116.

2. The Tools of Biochemistry, 2nd Edition (Reprint 2019), Cooper, T.G., Wiley Interscience, ISBN-13: 978-0471690542

3. Textbook of Biochemistry with Clinical Correlations, 7th ed. (2011), Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

4. Biochemistry (2019) 9th ed., Berg J.M, Tymoczko J.L, Gatto G. and Stryer L., W.H. Freeman and Company (New York), ISBN-10:1319114679, ISBN:13:978-1319114671.

5. Introductory Practical Biochemistry, 2nd edition (2005), S.K Sawhney, Ranbir Singh, Alpha Science International, ISBN-10:1842652451, ISBN-13: 978-1842652459.

6. An Introduction to Practical Biochemistry, 3rd edition (1987), Plummer, McGraw-Hill College; ISBN-13: 978-0070841659.

7. Principles and Techniques of Biochemistry and Molecular Biology, 8th edition(2018), KeithWilson and John Walker; Edited by Andreas Hofmann and Samuel Clokie, Cambridge University Press, Online ISBN - 9781316677056

Teaching Learning Process

The teaching learning process will involve interactive teaching, which will help students to participate actively in class-room and build confidence. To understand various concepts in Biochemistry, emphasis will be laid on promoting self-learning and enhancing their critical thinking through reasoning-based teaching and by making them comprehend the logics and central themes in Biochemistry. To help students get a grasp on the functioning of biochemical reactions and processes, exercises such as group work to build pathways and associate metabolic/genetic disorders through malfunctioning of key enzymes shall be encouraged. The hands-on performance of experiments will not only help them in understanding the concepts better, but will also develop their interest in a research career.

Assessment Methods

Learning outcomes will be assessed by written assignments, tests, seminars/presentations by students; their practical skills shall be assessed by performance while doing experiments and by thought-provoking viva-voce interviews, where their ability to connect the learnt concepts to practical knowhow will be encouraged and assessed . Feedback on students' learning abilities shall also be factored in.

Keywords

Metabolic pathways, enzymes, Michaelis-Menton equation, SDS, IEF, chromatography, zymogens, coenzymes, ketone bodies, metabolic disorders.

Biophysics
(32581501)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. Biological phenomena cannot be understood fully without physical insight. The course will demonstrate the role of fundamentals of chemistry and physics in understanding the biological processes including the methods to study the structure and functions of macromolecules and the chemical reactions occurring in living cells.

2. The students will be able to learn theoretical basis of various analytical and biomedical techniques including various spectroscopic techniques, hydrodynamic methods, molecular biophysics.

3. The students will be introduced to various physical principles responsible for maintaining the basic cellular function and integrity of biological membranes including transport across them.

Course Learning Outcomes

After completing the course, students shall be able to:

· appreciate the interdisciplinary frontier of science in which the principles and techniques of physics are applied to understand biological problems at every level, from atoms and molecules to cells, organisms and environment.

· analyze the data generated through spectroscopic techniques such as UV-Visible, Infrared, Mass spectroscopy, NMR, etc.

· understand the concepts of viscosity and sedimentation methods and their biological applications.

· comprehend the thermodynamics of the structure of biomolecules and consequences of their structural instability.

· understand the physical basis of transport across biological membranes.

· perform the experiments and demonstrate the interpretation of the data and further be able to deliver scientific conclusions.

· apply their biophysics knowledge to analyze the known experiments and to develop newer experimental methods for new biophysical applications.

Unit 1

Biophysical techniques (L1-L20)

Basic principles of electromagnetic radiation: Energy, wavelength, wave numbers and frequency, Review of electronic structure of molecules.

UV-visible spectrophotometry: Beer Lambert law, Light absorption and its transmittance, Factors affecting absorption properties of a chromophore, Structural analyses of DNA/ protein using absorption of UV light.

Fluorescence spectroscopy: Theory of fluorescence, Static and dynamic quenching, Resonance energy transfer, Fluorescent probes in the study of protein and nucleic acids.

Optical rotatory dispersion and Circular dichroism: Principle of ORD and CD, Analysis of secondary structure of proteins (denatured and native form) and nucleic acids using CD.

Infra-red spectroscopy: Theory of IR, Identification of exchangeable hydrogen, Number of hydrogen bonds, Tautomeric forms.

Magnetic resonance spectroscopy: Basic theory of NMR, Chemical shift, Medical applications of NMR.

Mass spectrometry (MALDI-TOF): Physical basis and uses of MS in the analysis of proteins/ nucleic acids.

X-ray crystallography: Diffraction, Bragg's law and electron density maps (concept of R-factor and B-factor), Growing of crystals (Hanging drop method).

Unit 2

Hydrodynamic methods (L21-L30)

Viscosity: Methods of measurement of viscosity, Specific and intrinsic viscosity, Relationship between viscosity and molecular weight, Measurement of viscoelasticity of DNA.

Sedimentation: Physical basis of centrifugation, Svedberg equation, Differential and density gradient centrifugation, Preparative and analytical ultracentrifugation techniques, Fractionation of cellular components using centrifugation with examples.

Flow Cytometry: Basic principle of flow cytometry and cell sorting, Detection strategies in flow cytometry.

Unit 3

Molecular biophysics (L31-L42)

Basic thermodynamics: Concept of entropy, enthalpy, free energy change, heat capacity.

Forces involved in biomolecular interactions with examples: Configuration versus conformation, Van der Waals interactions, Electrostatic interactions, Stacking interactions, Hydrogen bond and hydrophobic effect, Ramachandran plot.

Supercoiling of DNA: Linking number, twist and writhe.

Protein folding: Marginal stability of proteins, Thermodynamic and kinetic basis of protein folding, Protein folding problem (Levinthal's paradox) and role of molecular chaperones in cellular protein folding, Basics of molecular and chemical chaperones, Protein misfolding and aggregation, Diseases associated with protein misfolding.

Unit 4

Biological membranes (L43-L48)

Transport of solutes and ions, Fick's laws of diffusion, Ionophores, Transport equation, Membrane potential.

Practical

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Effect of different solvents on UV absorption spectra of proteins.
2. Study of structural changes of proteins at different pH using UV spectrophotometry.
3. Study of structural changes of proteins at different temperature using UV – spectro-photometry.
4. Determination of melting temperature of DNA.
5. Study the effect of temperature on the viscosity of a macromolecule (Protein/DNA).
6. Use of viscometry in the study of ligand binding to DNA/protein.
7. Crystallization of enzyme lysozyme using hanging drop method.
8. Analysis, identification and comparison of various spectra (UV, NMR, MS, IR) of simple organic compounds.

References

Physical Biochemistry: Principles and Applications, 2nd edition (2009), David Sheehan John Wiley. ISBN-13: 978-0470856031.

2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd edition (1982), David Freifelder, W.H. Freeman and Company. ISBN-13: 978-0716714446.

Additional Resources:

1. Physical Chemistry: Principles and Applications in Biological Sciences, 4th edition (2001), I. Tinoco, K. Sauer, J.C. Wang and J.D. Puglisi, Prentice Hall, ISBN-13: 978-0130959430.

2. Molecular Biology of the Gene, 7th 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.

3. Biophysics, 1st edition (1983), W. Hoppe, W. Lohmann, H. Markl and H. Ziegler, Springer- Verlag, ISBN-13: 978-3540120834.

4. The Physics of Proteins: An introduction to Biological Physics and Molecular Biophysics, 1st edition (2010), H. Frauenfelder, S.S. Chan and W.S. Chan, Springer, ISBN-13: 978- 1441910431.

5. Principles of Instrumental Analysis, 6th edition (2006), D.A. Skooget. al., Saunders College Publishing. ISBN-13: 978-0495012016.

6. Principles of Physical Biochemistry, 2nd edition (2005), K.E. Van Holde, W.C. Jhonson and P. Shing Ho, Prentice Hall Inc. ISBN-13: 978-0130464279.

7. Biophysical Chemistry, 1st edition (1980), C.R. Cantor, P.R. Schimmel, W.H. Freeman and Company. ISBN-13: 9780716711889.

8. Crystallography Made Crystal Clear: Guide for Users of Macromolecular Models, 3rd edition (2010), Gale Rhodes, Academic Press. ISBN: 9780080455549.

9. Introduction to Protein Structure, 2nd edition (1999), C. Branden and J. Tooze, Garland Publishing, ISBN-13: 978-0815323051.

Teaching Learning Process

The course in biophysics is designed to encourage the acquisition of subject knowledge, understanding and skills and academic and professional skills required for biological physics-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning and project-based learning, substantial laboratory-based practical component and experiments, open-ended project work, games, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

Progress towards achievement of learning outcomes will be assessed using the

following methods: time-constrained examinations; closed-book and open-book tests; problem based assignments; practical assignment laboratory reports; observation of practical skills; individual/ team project reports; oral presentations, including seminar presentation; viva voce interviews; computerized adaptive testing; peer and self-assessment etc.

Keywords

Spectroscopy, UV, NMR, IR, CD, Fluorescence, X-ray, Viscosity, Centrifugation, Flow Cytometry, Supercoiling, Protein Folding, Membrane Transport, Fick’s law

Biorganic Chemistry
(32581101)
Core Course - (CC) Credit:6

Course Objective(2-3)

Course objective

Bioorganic Chemistry is a discipline that integrates organic chemistry and biochemistry. It aims at understanding the relevance of biological processes using the fundamental concepts of organic chemistry. This course includes basic principles of organic chemistry like concepts of acids and bases, molecular forces responsible for the activities of biomolecules, principles of stereochemistry and their importance in understanding various bio- molecular reactions along with introduction to biomolecules.

Course Learning Outcomes

Course-level learning outcomes

The student at the end of the course will be able to understand

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the concept of PH and its effect on structure of biomolecule. The application of Henderson- Hasselbach equation.

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The structure and role of zwitter ion and isoelectric point of proteins.

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Explain the different acid-base theories and concept of leveling solvent

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Describe chemical bonding and its role in biological systems.

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Identify and differentiate various inter and intra molecular forces and their effect on structure of different biomolecules.

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Identify, assess and analyse different types of stereo isomers and their properties in organic compounds and biomolecules

.

Explain the structures and function of biomolecules (carbohydrates, amino acids, lipids and nucleotide)

- To understand the mechanism of biologically significant name reaction and their role in biological systems.

Unit 1

Unit I: Aqueous Solutions (06 lectures)

Water, pH and buffers, concept of pKa (titration curves of amino acids), Henderson-Hasselbach equation, buffering zone, buffer index, concept of pI and zwitter ion.

Unit 2

Unit II: Concept of Acids and Bases. (04 Lectures)

Arrhenius concept, Bronsted Lowry concept, Lewis concept, the levelling effect, effect of pH on the structure of biomolecules.

Unit 3

Unit III: Chemical Bonding and Molecular Forces (06 Lectures)

Introduction to ionic interactions and covalent bond, inter-molecular and intra-molecular forces, types of intermolecular forces and their characteristics: ion-dipole, dipole-dipole, dipole-induced dipole and dispersion (London) forces, hydrogen bond (intra-molecular and inter-molecular), effect of inter/intra-molecular forces on structure of different biomolecules.

Unit 4

IV: Stereochemistry (08 Lectures)

Unit Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diasteroisomers.

Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity,

Geometrical isomerism: Definition, nomenclature– E and Z.

Unit 5

Unit V: Introduction to Biomolecules

(i)

Carbohydrates (05 Lectures)

Monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers,

Disaccharides- structure, reducing and non-reducing sugars.

Polysaccharides- Starch, glycogen and cellulose.

(ii)

Lipids (02 Lectures)

Fatty acids, triacylglycerols, steroids (cholesterol)

(iii)

Amino Acids (08 Lectures)

Structure and classification of amino acids, ionization, chemistry of peptide bond, non-ribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids,

Definition of a peptide, peptide unit, peptide group, bond length, cis and trans conformation, , primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structures (with examples).

(iv)

Nucleotides (02 Lectures)

Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding by bases, tautomers of bases

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Unit 6

Unit VI: Biologically significant name reactions: (07Lectures)

Aldol (Glucogenesis), retro-aldol (Glycocolysis), Benzoin condesation (umpolung-decarboxylation of pyruvate in the presence of TPP) Claisen condensation (Synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugar metabolism), Bayer Villiger reaction (FAD dependent ketone synthesis), Pinacole-pinacolone rearrangement (1,2-carbon carbon shift),

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Practical

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1.

Preparation of solutions based on molarity, normality, percentage, dilutions etc.

2.

Preparation of buffers.

3.

Estimation of Mohrs salt/ oxalic acid by titrating with KMNO

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4.

Estimation of Cu (II) ions iodometrically using Na

2

S

2

O

3

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5.

Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling/ Tollen/ Benedict, Selvinoff, Osazone, Bialstests.

6.

To determine the Iodine number of the given oil/ fat.

7.

To find pKa value of given acetic acid/ amino acid.

8.

Absorption spectrum of DNA/ Protein

References

SUGGESTED READINGS

1.

Concise Inorganic Chemistry, 5

th

edition (1999), J. D. Lee; Wiley-Blackwell, ISBN-13: 9780632052936.

2.

Organic Chemistry, 6

th

edition (1996), I L Finar; ELBS, Longman Higher Education. ISBN- 13: 978-0582305601.

3.

Lehninger: Principles of Biochemistry, 5

th

edition (2008), David L. Nelson and Michael M. Cox; Prentice Hall Publishers, ISBN-13: 978-0321707338

4.

Biochemistry, 4

th

edition (2003), Campbell, M. K. and Farrel, S. O.;Brooks/Cole, Cengage Learning (Boston), ISBN: 0030348498.

5.

An Introduction to Practical Biochemistry, 3

rd

edition (1987), Plummer, McGraw-Hill College; ISBN-13: 978-0070841659

6.

Organic Chemistry, 6

th

edition (1992), R. T. Morrison and R. N. Boyd; Pearson Education. ISBN-13: 9780136436690.

7.

Biochemistry, J. M. Berg, J. L. Tymoczko and L. Stryer, 6

th

edition (2006), W. H. Freeman and Co.,ISBN-13: 978-0716787242

8.

Bioorganic Chemistry, 3

rd

edition (1999), Hermann Dugas; Springer Verlag. ISBN-13: 978- 0387989105

Teaching Learning Process

Teaching learning process

1. Use of blackboard and chalk method to communicate the concepts.

2. Use of Power Points presentations to visually explain various processes.

3. Verbal explanation, seminars, case studies, workshops and Open discussions.

4. Quizzing and questioning

Assessment Methods

Assessment Methods

Written class tests and assignments

Quizzing/ viva, Problem solving exercises

Seminar presentations

Final University Examination

Keywords

Key words

pH, Henderson Hassalbalch equation, zwitterion, isoelectric point , enantiomers, diastereoisomers, conformers, biomolecules, carbohyrates, amino acids, proteins, nucleotides, name reactions.

Cell and Radiation Biology
(32581102)
Core Course - (CC) Credit:6

Course Objective(2-3)

Objectives

1.

To provide information about cells, including their composition, their function and cell-cycle checkpoints, cell’s cytoskeleton and signallingin the cell.

1. To help the students to explore and gain insight into radiation-induced biological responses at molecular, cellular and tissue levels.
2. To develop practical skills by applying the theoretical knowledge of cell biology in practical to understand more about the cell.

At the end of the course students should:

- Have an enhanced knowledge and appreciation of the cell and radiation biology
- Be able to develop cogent and critical arguments based on the course material
- Be able to perform, analyse and report on experiments and observations in cell biology
- Be able to integrate related topics from separate parts of the course

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Course Learning Outcomes

Course-level learning outcomes

Course-level learning outcomes relating to Cell and Radiation Biology course within B.Sc. (Honors) degree programme in Biomedical Science are indicated in the following section:

Cell and Radiation Biology (Semester–I/ Core Course):

Course-level learning outcomes that a student of this course is required to demonstrate are indicated below:

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Explains about the historical background, cell theory, structure of prokaryotic, &

eukaryotic cells, and clarifies the microorganism’s structures

.

Demonstrates the structure, functions and nature of cell membrane, clarifies the use of RBC ghosts, describes the transport of molecules across membrane, explains about endocytosis and exocytosis

.

Describes the structure of cell organelles and their specific functions, about various lysosomal storage diseases, explains the structure and types of chromosome, recognizes significance of polytene and lampbrush chromosomes

.

Describes about Mitosis and Meiosis, explains thesignificance and regulation of cell cycle, explains cell signalingand signal transduction pathways

.

Demonstrates the concepts of cell junctions, describes structure and functions cytoskeletal elements

.

Explains about radiations and their effects, radioactive decay, radioisotopes in diagnosis and radiotherapy, also clarifies the safety measures in handling radioisotopes

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Unit 1

Unit I: The Cell (02 Lectures)

Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells, mycoplasma, viruses, viroids, prions.

Unit 2

Unit II: Cell Membrane and Membrane Transport (09 Lectures)

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Functions, different models of membrane structure, types of membrane lipids, membrane proteins: types, methods to study membrane proteins (detergents, RBC ghosts), RBC membrane as a model, membrane carbohydrates, membrane asymmetry and fluidity, Lipid rafts.

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Transport of small molecules: Passive transport (simple diffusion and facilitated diffusion) and active transport and their types (P, V, F and ABC transporter) with example of Na

+

/K

+

pump.

- Transport of macromolecules: Endocytosis (pinocytosis, phagocytosis), exocytosis.

Unit 3

Unit III: Cell Organelles (14 Lectures)

Structure and functions of various organelles:

- Nucleus: Different components, nuclear envelope- its structure, pore complex, nucleo- cytoplasmic interaction (NLS and NES), nucleolus- structure and functions.
- Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Diversity in structure and significance of polytene and lampbrush chromosomes. Mitosis and Meiosis: Different phases and their significance.
- Endoplasmic Reticulum: RER- biosynthesis and processing of proteins, co-translational and post-translational transport of proteins, signal hypothesis, protein sorting. SER- detoxification, biosynthesis of membrane, carbohydrate metabolism, steroid synthesis.
- Golgi Apparatus: Golgi stack (cis, trans and medial cisternae), flow of proteins through GB. Glycosylation and protein sorting.
- Lysosomes: Development of different forms of lysosomes, role in cellular digestion,

lysosomal storage diseases- Hurler syndrome, Hunter syndrome, Tay-Sachs disease and Inclusion cell disease (I-cell disease).

- Peroxisomes: Assembly, functions- H_2O_2 metabolism, oxidation of fatty acids. Glyoxysomes.
- Mitochondria: Detailed structure, endosymbiotic theory, its genome, and functions in brief.
- Chloroplast: Detailed structure, its genome and functions in brief.

Unit 4

Unit IV: Cell Junctions and Cytoskeletal Elements (06 Lectures)

- Basics concepts of anchoring junctions, tight junctions, communication junctions (gap junction and plasmodesmata).
- Structure, assembly and functions of: Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies).
- Microfilaments: Globular and filamentous actin. General idea about myosin.
- Intermediate Filaments: Different classes

Unit 5

Unit V: Cell Cycle and Overview of Cell Signaling (06 Lectures)

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Different phases of cell cycle and their significance. Checkpoints and regulation of cell cycle.

- Signaling Molecules and their receptors (extracellular and intracellular); Functions of extracellular receptors; Intracellular signal transduction pathways (cAMP, cGMP, steroid hormone response element).

Unit 6

Unit VI: Radiation Biology (11 Lectures)

A. Introduction to Radiation Biology:

Introduction of radiations, basic concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life

B. Biological effects of Radiation:

Effects of Ionizing and non-ionizing radiation on cells; Acute, delayed and late radiation effects (with particular reference to nervous system, gastrointestinal and hematopoitic syndrome)

C. Application in Biomedicine:

Use of radioisotopes in biology: Autoradiography, radioisotopes in diagnosis (thyroid disorders, cancer) and therapy (radiotherapy).

D. Radiation Biosafety:

Precautions and safety measures in handling radioisotopes.

Practical

Practical

1. Microscopy- Theoretical knowledge of Light and Electron microscope.
2. To study the following techniques through electron/ photomicrographs: fluorescence microscopy, autoradiography, positive staining, negative staining,

freeze fracture, freeze etching shadow casting, endocytosis and phagocytosis.
3. To explain mitosis and meiosis using permanent slides.
4. Measurement of cell size using stage micrometer.
5. To cytochemically demonstrate presence of proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
6. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
7. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
8. To study the effect of isotonic, hypotonic and hypertonic solutions on cells.
9. To prepare polytene chromosomes.

References

References

1.

The Cell: A Molecular Approach, 5

th

edition (2009), Cooper and Hausman. Sinauer Associates, Inc. ISBN-13: 978-0878933976.

2.

Cell and Molecular Biology: Concepts and Experiments, 6

th

edition (2009), Gerald Karp, Wiley. ISBN-978-0470483374.

3.

Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder, 2

nd

edition (1983), W. H. Freeman and Company. ISBN: 0716714442 / 0-7167- 1444-2.

4.

An Introduction to Radiobiology, 2

nd

edition (1998), A. H. W. Nias, Wiley Blackwell, ISBN- 13: 978-0471975908.

5.

The World of the Cell, 7

th

edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin Cummings, ISBN-13: 978-0805393934.

6.

The Cell: A Molecular Approach, 6

th

edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13:978-1605351551.

Teaching Learning Process

Teaching-learning processes

Cell biology course in biomedical science is designed to encourage the acquisition of disciplinary/ subject knowledge, understanding and developing academic and professional skills required for biomedical science-based professions, jobs and research. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning, practicum and project-based learning, substantial laboratory-based practical component and experiments i.e. use of microscopes, preparation of slides, and various staining procedures, technology-enabled learning etc. will be adopted to achieve this. Development of practical skills will constitute an important aspect of the teaching-learning process. Some teaching strategies will be taken up to enhance the reasoning/ analytical problem-solving skills of students.

Assessment Methods

Assessment methods

The assessment of students’ achievement in Cell and radiation biology will be aligned

with the course learning outcomes and the academic and professional skills that the programme is designed to develop. A variety of assessment methods that are appropriate within the disciplinary area of biomedical science will be used. Learning outcomes will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, practical assignment laboratory reports, observation of practical skills, seminar presentation; viva-voce interviews; computerized adaptive testing, literature surveys and evaluations etc.

Keywords

Keywords

Cell membrane, Membrane transport, Mitosis, Meiosis, Chromosome, Mitochondria, Lysosomal storage diseases, Cell junctions, Cytoskeletal Elements, Cell cycle checkpoints, Cell signalling, Radiation biology, Radiotherapy

Genome Organization and Function
(32587902)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. The paper Genome Organization and Function deals with the more intriguing concepts of genome packing within the nucleus, the regulatory strategies either at transcriptional or translational level, gene silencing, RNAi and mechanisms of regulatory effects of non-coding RNA.

2. This course will review the basic concepts of organization and architecture of human genome.

3. The paper concludes with an introduction to the different model organisms and explains their importance in investigations of basic principles in genetics.

Course Learning Outcomes

1. Students will acquire basic concepts of genome, its organization and maintenance, DNA methylation and CpG islands.

2. Students will learn about packaging of DNA into chromosome structure, changes in histone and chromosome remodeling proteins.

3. Students will learn the concept of regulatory mechanisms governing -over-expression and under-expression of genes.

4. Students will understand transcriptional control in prokaryotes (operons) and in eukaryotes (signal integration, combinatorial control, transcriptional activators and repressors, signal transduction).

5. Students will learn about translation-dependent regulation of mRNA and protein stability and post-translational control.

6. Students will understand Regulatory RNA (RNA interference, riboswitches, miRNA and siRNA) and X-inactivation.

7. Students will gain knowledge about the need of model organisms and functioning of genes through these model organisms.

Unit 1

Organization of Human genome (L1-L8)

General features: Genome size, gene density and diversity, Types of repetitive DNA, gene families and super families, Pseudogenes and processed pseudogenes, RNA encoding genes.

Nucleosomes: Basic unit of DNA condensation, Packaging of DNA into chromosome structure,

Nucleosome assembly.

Unit 2

Gene regulation in Prokaryotes and Eukaryotes (L9-L33)

a) Transcriptional regulation in prokaryotes: Principles of transcriptional regulation.

Bacterial gene regulation with reference to lactose, tryptophan and arabinose operon. Role of sigma factors in gene expression.

b) Eukaryotic gene regulation: Transcriptional control - Conserved mechanism of regulation, activators, signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulators, examples of steroid receptors, MAP kinase and STATs pathways.

c) Eukaryotic gene regulation: Post-transcriptional control, Regulation of translation, Translation-dependent regulation of mRNA and protein stability, post-translational control and role of ubiquitin.

d) Eukaryotic gene regulation: Genomic control – gene amplification and deletions, DNA rearrangements, Chromosome puffs, DNA methylation, CpG islands, Changes in histone and chromosome remodeling proteins, Nucleosome modifications, Nucleosomes positioning.

Unit 3

Regulatory RNAs (L34-L38)

Riboswitches, RNA interference, miRNA, siRNA, Piwi-interacting RNA, Regulatory RNA and X-inactivation (reference of calico cats).

Unit 4

Understanding gene function through model organisms (L39-L48)

Model organisms and the need to study them. Mechanism of choosing the right model organism. Advantages and disadvantages of the organism as a model. Study of model systems in developmental genetics. Early studies of the organism as a Model organism, life cycle, Genetic techniques and Use of the organism as model organism today.

Different types of model organisms: Escherichia coli, Saccharomyces cerevisiae (Baker’s yeast), Drosophila melanogaster (Fruit fly), Mus musculus (Mouse), Danio rerio (Zebra fish)

Practical

1. Preparation of various stock solutions for mentioned experiments.

2. Comparative analysis of genomic DNA and plasmid DNA by restriction enzyme digestion and estimation of size of a DNA fragment after electrophoresis using DNA markers.

3. Quantification of unknown DNA using Lambda-HindIII marker.

4. Perform Southern Hybridization.

5. Perform Western Blotting.

6. Drosophila as a model system for studying toll-9 gene for Asthma using bioinformatics tools.

7. Isolation and Identification of Auxotrophic and Drug Resistant Mutants of E. coli.

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

References

1. 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.

2. Principles of Genetics, 6th edition (2011), D. Peter Snustad, Michael J. Simmons; John Wiley and Sons, ISBN-13: 978-0470903599.

3. The World of the Cell, 7th edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin Cummings, ISBN-13: 978-0805393934.

4. Human Molecular Genetics, 3rd edition (2003), Tom Strachan and Andrew Read; Garland Science Publishers, ISBN -13: 978-0815341826.

5. The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13: 978-1605351551.

6. Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp; Wiley Publishers, ISBN-13: 978-1118206737.

7. Genomics: The Science and Technology behind the Human Genome Project, 1st edition (1999), Cantor and Smith; John Wiley and Sons, ISBN-13: 978-0471599081.

8. Concepts of Genetics, 10th edition, (2012). William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. ISBN-13: 978-0321724120.

9. Molecular Biology: Principles and Practice, 1st edition (2012), Cox, Doudna and Donnell, ISBN-13: 978-0-716-7998-8.

Additional Resources:

1. DNA Replication, 2nd edition (2005), Arthur Kornberg; University Science Books ISBN-13: 978-1891389443.

2. Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422.

Teaching Learning Process

Teaching and learning activity will mainly include extensive class room discussions. Students will be asked questions and queries of the previous class before every new class to helping them in the better understanding of the topics and clearing their doubts. Teaching will be conducted through both regular chalk and board and power point presentation. There will be regular question and answer activities and consultation of relevant text books and research articles. Development of practical skills will constitute an important aspect of the teaching-learning process.

Assessment Methods

Topics on current and important research areas will be assigned individually to students and they will be asked to retrieve literature and show them to teachers for verification. They will be motivated to make short presentations. Class tests will be conducted for internal examinations. Students will be given home assignments from time to time to improve their writing skills. Finally, there will be end semester university examination.

Keywords

Human genome, Repeats, Nucleosome, Gene regulation, MAP kinase, STAT pathway, Post –translational control, DNA methylation, miRNA, siRNA, X-inactivation, Model organism.

Human Genetics
(325879903)
Core Course - (CC) Credit:6

Course Objective(2-3)

· This course is designed to develop an appreciation for the groundwork carried out so far in areas that contributed to our understanding of human genetics and diseases, relate to how it has been built on the numerous genetic studies carried out over decades to contribute to the understanding of relationship between genotype and phenotype.

· The course will also introduce the sequencing of the Human Genome and new methods of investigating biological function, research into the genetic and molecular

basis of human disease.

Course Learning Outcomes

After the completion of this course, students will be able to:

· understand the patterns of inheritance of monogenic traits from pedigree data for both Mendelian and non-Mendelian traits.

· describe objectives, tools, approaches and outcomes of Human Genome Project (HGP). They will be aware of the ethical and societal issues raised by the new knowledge derived by using new technologies.

· comprehend the techniques and advances in the analysis of DNA and protein expression, identification of genes involved in diseases, and gene/sequence mapping strategies.

· apply principles of genetics at population level.

· understand genetic basis of common diseases and methods of prenatal diagnosis.

· proficiently explore relevant literature, web sites and databases for research into human genetics.

Unit 1

Inheritance for Monogenic Traits (L1-L7)

History of Human Genetics: Early Greek concepts about inheritance, Cytogenetics history (the works of Winiwater, Painter and Tjio and Levan), Landmark achievements of Galton, Garrod etc.

Patterns of Inheritance: Recapitulation of principles of human inheritance pattern through pedigree analysis: Autosomal inheritance-dominant, recessive, sex-linked inheritance, sex-limited and sex- influenced traits and mitochondrial inheritance. Deviations from the basic pedigree patterns- non-penetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity and uniparental disomy, mosaicism and chimerism, consanguinity and its effects, epigenetic modifications and imprinting.

Unit 2

Techniques for Genomics (L8-L21)

DNA sequencing (Maxam-Gilbert and Sanger Method, introduction to NGS), DNA fingerprinting, polymorphism screening (genotyping of SNPs and microsatellite markers), expression and proteome analysis (microarray, 2-D analysis, pull down assays).

Physical maps (different types- restriction, cytogenetic maps, use of FISH in physical mapping, radiation hybrids and clone libraries in STS mapping) and genetic maps. Genetic markers and their applications.

Principles and strategies, positional and candidate gene approaches, positional- cloning approach (examples- HD, CFTR), concept of twin and adoption studies.

Unit 3

Human Genome Project (L22-L25)

History, organization and goals of human genome project, Tools (Vectors- BAC, PAC, YAC and sequencing techniques) and approaches (Hierarchical and shotgun sequencing), outcomes ethical issues and applications in human diseases

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Unit 4

Population Genetics (L26-L28)

Genotypic and allelic frequencies, linkage disequilibrium, haplotype construction (two loci using SNPs and/or microsatellites).

Unit 5

Clinical Genetics (L29-L38)

Inborn errors of metabolism and their genetic basis (example- phenylketonuria), genetic disorders of haemopoietic systems (examples- sickle cell anemia and thalassemia), genetic basis of color blindness, genetic basis of familial cancers (example- retinoblastoma), genetics of mental retardation.

Diagnosis and screening of genetic disorders, prenatal genotyping for mutations in -globin gene and sickle cell anemia, DNA profiling: establishing identity and relationships, applications in personalized medicine (genetic polymorphism in drug metabolism genes e.g. cytP450 and GST and their effect on drug metabolism and drug response), genetic counseling.

Prenatal Diagnosis: Brief introduction, methods of prenatal diagnosis and its application

with example of Aneuploidy and Thalassemia.

Unit 6

Guided short project (L39-L48)

Short project involving, data analysis/in silico analysis of genomes/ literature-based project; guiding the students through identification of the project, discussions on approach and methodology, and strategies for data analysis.

Practical

1. PTC testing to prove monogenic inheritance.
2. Demonstration of DNA fingerprinting.
3. Polymorphism analysis using PCR.
4. Mapping of clones/STS on plasmids or BACs.
5. Video based demonstration of tools for prenatal diagnosis.
6. Haplotype construction.
7. Web based analysis: retrieval of a desired human sequence from NCBI database and sequence alignment using BLAST.
8. Preparation of Human metaphase chromosomes and Giemsa staining.

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

References

1. Strachan and Read. Human Molecular Genetics.4th Edition. Garland Science, 2010. ISBN: 978-0815341499.

2. Cantor and Smith. Genomics, 2002, John Wiley and Sons, Inc. ISBN: 9780471599081.

3. Vogel and Motulsky, Human Genetics: Problems and Approaches, 3rd Edition, Springer Verlag, 1997. ISBN: 978-3-540-37653-8.

Additional Resources:

1. J.N. Pasternak. An introduction to Human Molecular Genetics, 2nd Edition, Wiley-Liss, 2005. ISBN: 978-0-471-47426-5.

2. G.N. Wilson. Clinical Genetics: A short Course. Wiley-Liss, 2000. ISBN: 978-0471298069.

3. T.A. Brown. Genomes, 2nd edition, Oxford: Wiley-Liss; 2002. ISBN-10: 0-471-25046-5.

Teaching Learning Process

The teaching process will create learning environments where students are active participants as individuals and as members of teams. A wide range of learning resources incorporating student experiences, interests and real-life situations will be integrated with classroom instruction. Multiple representations, examples, explanations and variety of technology that support student learning will be used. Students will be effectively engaged in hands-on sessions and discussions to promote higher-order thinking skills. Project work emphasizing on literature and database survey for human genetic diseases will also form an important part of teaching-learning process.

Assessment Methods

Progress towards achievement of learning outcomes will be assessed using the following methods: time-constrained examinations; closed-book and open-book tests; problem-based assignments; practical assignment laboratory reports; observation of practical skills; individual/ team project reports; oral presentations, including seminar presentation; viva voce; peer and self-assessment etc.

Keywords

Mendelian Inheritance, Pedigree, Human Genome, Genetic Mapping, Sequencing, ELSI, Prenatal Diagnosis, Haplotype, Linkage Disequilibrium

Human Pathology
(32581601)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course of Human Pathology aims at preparing the students in basic understanding of diseases and their pathogenesis. The topics are of introductory nature and build the concepts of how human system works in altered and diseased states under the influence of various internal and external stimuli Thus the pathology syllabus builds on the existing knowledge that the students have gained in Physiology, cell and tissue biology. Consequently it incorporates topics like cellular adaptations, inflammation, neoplasia, cellular ageing and other infectious and non-infectious diseases. Laboratory exercises have been designed to substantiate and clarify the theoretical concepts.

Course Learning Outcomes

Having successfully completed this course, students shall be able to:

1. Understand and Integrate the general principles, terminology, and modes of spread of disease (Neoplastic and Non-neoplastic).

2. Define and conceptualise various aspects of disease (eg. etiology, pathogenesis, signs, symptoms, pathological features, sequelae).

3. Describe the causes and mechanism of various cellular adaptations and cell injury.

4. Differentiate and assess the role and importance of apoptosis and necrosis along with the concept of ageing.

5. Describe the cardinal signs and basic pathophysiology of inflammation. Explain associated events, vascular changes, molecular mediators, morphological effects, outcomes and systemic effects.

6. Describe the basic concept and mechanism of healing responses after acute and chronic injury using examples of tissue remodelling in liver and rheumatoid arthritis

7. Discuss disorders of hemodynamics (edema, congestion, and shock) and hemostasis (hemorrhage and thrombosis), as well as various forms of embolism.

8. Conceptualize infarction, hypertension along with pathogenesis, stages and clinical consequences of shock.

9. Describe the definition and concepts of dysplasia, oncogenes, tumor suppressor genes, neoplasia, tumour classification, staging and grading. Differentiate benign and malignant neoplasia and recognize clinical complications of tumors. Conceptualize cancer stem cells.

10. Demonstrate an understanding of predisposing factors, causes, pathogenesis, morphology and potential complications of some lifestyle and infectious diseases

Unit 1

Introduction, Cellular Adaptations, Cell Injury and Cell

(L1-8)

History of pathology, basic definitions and familiarization with the common terms used in pathology, techniques used in pathology. Basic Concepts in cell and Tissue remodelling.. Causes and mechanisms of cell injury: reversible and irreversible injury, Cellular responses: Hyperplasia, Hypertrophy, Atrophy, Metaplasia, Necrosis, Apoptosis, subcellular and intracellular response, (with suitable examples of diseases), Concepts and mechanisms of Cell ageing.

Unit 2

Inflammation and its role in diseases

(L9-16)

General features of acute and chronic inflammation: Vascular changes, cellular events, termination of acute inflammatory response, Molecular mediators of inflammation, morphological effects and outcome of acute inflammation. Systemic effects of chronic inflammation, granulomatous inflammation.

Unit 3

Tissue Renewal & Repair, Healing and Fibrosis

(L17-24)

Mechanism of tissue regeneration, role of ECM, repair by healing, scar formation and fibrosis, cutaneous wound healing, fractures and healing tissue remodelling in liver (mechanism of fibrosis and cirrhosis) and rheumatoid arthritis

Unit 4

Hemodynamic Pathology

(L25-30)

Edema, hyperaemia, congestion, haemorrhage, haemostasis and thrombosis, Embolism, Infarction and shock and hypertension.

Unit 5

Tumor Pathology and Pathogenesis

(L31-38)

Definitions, nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, mechanism of tumor invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes, DNA repair genes and cancer stem cells.

Unit 6

Pathophysiology diseases

(L39-48)

A. Etiology and Pathophysiology of lifestyle Diseases: Diabetes, Atherosclerosis and ,Myocardial infarction and Asthma,

B. Etiology and Pathophysiology of infectious Diseases: Diarrheal diseases like cholera, Tuberculosis

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Urine Analysis: Gross examination of urine for colour, odour etc. Abnormal constituents like protein, ketone bodies, glucose, blood, urea (any three)

2. Tissue Processing, embedding, sectioning. Staining and preparation of permanent histological slide.

3. Study of histological slides showing hypertrophy, hyperplasia, dysplasia, leukemia, cirrhosis and any common cancer.

4. Diagnostic tests for detection of various Diseases – CRP, VDRL, RA, Pregnancy, Dengue and HIV (any four)

5. PCR based diagnostics (for any one disease)

6. Measurement of Erythrocyte Sedimentation Rate.

References

1. Robbins and Cotran Pathologic Basis of Disease, 8th edition (2009), Vinay Kumar, Abul K. Abbas, Jon C. Aster, Nelson Fausto; Saunders Publishers, ISBN-13:978-1416031215.

2. General and Systematic Pathology, 2nd edition (1996), J., Ed. Underwood and J. C. E. Underwood; Churchill Livingstone, ISBN-13:978-0443052828.

3. Medical Laboratory Technology Methods and Interpretations Volume 1 and 2, 6th edition (2009), Ramnik Sood; Jaypee Brothers Medical Publishers, ISBN-13:978-8184484496.

Additional Resources:

1. Pathophysiology, 3rd edition (2012), Lee-Ellen C. Copstead-Kirkhorn and Publisher Saunders, ISBN-13:978-1455726509.

Teaching Learning Process

1. Use of blackboard and chalk method to communicate the concepts
2. Use of Power Points presentations to visually explain various processes.
3. Verbal explanation, seminars, case studies, workshops and Open discussions
4. Quizzing and questioning
5. Visit to a Pathology Lab

Assessment Methods

1. Written class tests and assignments
2. Quizzing/ viva, Problem solving exercises
3. Seminar presentations
4. Final University Examination

Keywords

Etiology, Pathogenesis, Necrosis, Inflammation, Tissue injury, Tissue repair, Fibrosis,

Neoplasia, Oncogenes

Human Physiology and Anatomy I
(32581202)
Core Course - (CC) Credit:6

Course Objective(2-3)

The prime concern of this course is to integrate the individual functions of all the cells and tissues and organs into functional whole, the human body. Since function is dependent on a structure, the course lays stress on functional anatomy of the organs. It attempts to highlight the necessary bodily balances and internal bodily control so called homeostasis as well as present their abnormal function in disease. It provides a link between basic sciences and Medicine

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Course Learning Outcomes

Having successfully completed this course, students shall be able to learn and appreciate:

1. The usefulness of dividing the human body in different anatomical planes and sections, cavities, along with the role of feedback system in maintaining homeostasis. Different cell junctions, functional anatomy of the epithelial and connective tissues while focussing on integumentary and skeletal system. Overview of structure, types and function of cartilage, bone and joints.

2. Structure, function and regulation of components/different formed elements of blood and the mechanism of clotting. Distinguish between blood groups, basis of their classification, their importance in blood transfusions and tissue grafting and basic concepts of blood and bleeding disorders

3. Apply the basic concepts of action potential/ graded potential in the conduction of nerve impulse. Explain the action and significance of different neurotransmitters at the synapse along with the mechanism of synaptic transmission using different ligand gated ion channels, G protein coupled receptors and their ligands as example.

4. The organization of brain, with identification, structures and function of different

brain regions. Identify different neural pathways and explain their significance. Demonstrate the basis of division of autonomic nervous system and effect of its stimulation on different organs.

5. Stimulus modality, sensory adaptation and the role of generator potential in the sensory physiology of touch, gustation, olfaction, hearing and vision. Recognize and explain the common disorders related to the senses.

6. Describe and Distinguish between the structure, mechanism and regulation of contraction of skeletal, cardiac and smooth muscles. Enlist the energy requirements, characteristic features of different muscle fibers and their role in generating muscle tension. Demonstrate the concept of muscle fatigue, adaptation to physical training, and muscle degeneration and associated disorders.

Unit 1

Body organization, Integumentary

(L1-4)

General Anatomy of the body, Introduction to various kinds of body planes, cavities their membranes, Tissues level of organization (Types, origin, function & repair). Structure and functions of human skin.

Unit 2

Blood

(L5-12)

Composition and Function of blood and its components: WBC, RBC, platelets. Hematopoiesis, Hemoglobin structure and function. Hemostasis and blood coagulation mechanism, blood groups and blood banking. Basic concepts about Anemia, abnormal hemoglobin, Polycythemia, Thalassemia, Leukemia.

Unit 3

Nerve physiology

(L13-19)

Resting membrane potential, structure and function of neuron. Action potential, electrophysiology of ion channels and conduction of nerve impulse, Synapse, and its types, Synaptic Transmission, Neurotransmitters; types and function.

Unit 4

Nervous System I: Organization of nervous system

(L20-27)

Structure and function of Central nervous system, Peripheral nervous system and Autonomic nervous system (spinal and cranial nerves). Reflexes suitable examples, and reflex arch. Temperature regulation of the human body by hypothalamus. Overview of disorders associated with the nervous system

Unit 5

Nervous System II: Special senses

(L28-35)

Concept of receptors in the body and their types, Structure, Functional anatomy, regulation and common disorders of the following sensations: Vision, Hearing, Taste, Smell and Touch.

Unit 6

Muscular and Skeletal system

(L36-48)

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. Cartilage: structure, types and function. Bones: structure, function, location and types. Process of bone formation. Joints: structure, function and types. An overview of disorders of skeletal system

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

(any 8)

1. Estimation of hemoglobin (Sahli's method) and determination of blood group.

2. Determination of bleeding time and clotting time of blood.

3. Determination of total erythrocyte count.

4. Determination of total leukocyte count.

5. Preparation of blood smears and identifying various WBC

6. To perform differential leukocyte count of blood.

7. Determination of specific gravity of blood.

8. Determination of osmotic fragility of RBC. .

9. To study different human organs and their sections through permanent histological slides T. S. of brain, spinal cord, skeletal fibres, cardiac muscles, skeletal muscles, cartilage joints and different tissues. (Minimum 8 slides covering the systems mentioned in theory.)

References

1. Guyton and Hall Textbook of Medical Physiology, 13th edition (2006), J. E. Hall; W B Saunders and Company, ISBN-13: 978-1416045748.

2. Human Physiology, 12th edition (2009), Stuart I. Fox; Tata McGraw Hill, ISBN-13: 9780077350062.

3. Principles of Anatomy and Physiology, 13th edition (2011), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN-13: 978-0470565100.

4. Lab Mannual on Blood Analysis and Medical Diagnostics, 1st edition (2012), Dr. GayatriPrakash; S. Chand, ISBN: 81-219-3967.

5. Textbook of Practical Physiology, 8th Edition (2012), CL Ghai; Jaypee Publication, ISBN-13: 978-8184481419.

Additional Resources:

1. Ganong's Review of Medical physiology, 25th Edition (2015), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN-13: 978-0071780032.

Teaching Learning Process

1. Use of blackboard and chalk method to communicate the concepts

2. Use of Power Points presentations to visually explain various processes.

3. Verbal explanation, seminars, case studies, workshops and Open discussions

4. Quizzing and questioning

Assessment Methods

1. Written class tests and assignments

2. Quizzing/ viva, Problem solving exercises

3. Seminar presentations

4. Final University Examination

Keywords

etiology, cellular injury, necrosis, apoptosis, cellular adaptation, inflammation, repair, fibrosis, hemodynamic disorders, infarction, shock

Human Physiology and Anatomy II
(32581302)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic physiology of the human body and its interrelations with respect to heart, lung, kidney, gonads , endocrine glands and digestive system. It would give sufficient exposure to the physiological concepts that provide the foundations needed for further studies in pharmacology, pathology and pathophysiology. The mechanisms of deranged function cannot be appreciated without an in-depth understanding of basic biophysical and physiological mechanisms. The purpose of curricula is to provide guidelines for the breadth and depth of knowledge in

the physiological principles and concepts that are considered minimal and essential for further progress in understanding mechanisms of disease and body defences. The curricular objectives are focused primarily on normal body function. Accordingly wherever possible clinical examples have been illustrated to the underlying physiological principles.

Course Learning Outcomes

1.The structure and functioning of heart, pattern and significance of blood flow in the blood vessels, heart sounds, ECG and purpose of lymph and lymphatic circulation.

2. The overall function of lung, its functional anatomy and blood flow pattern associated with it. The neural control and other regulators of respiration and to understand daily phenomenon like cough sneezing yawning etc

3. Kidneys and the structures within the kidneys and their functions. Outline the process of micturition and abnormalities associated with it. Distinguish acidosis and alkalosis and appreciate its significance and control

4. The anatomy of the female and male reproductive systems, including their accessory structures The student would understand the role of hypothalamic and pituitary hormones in reproductive system. Trace the route of a sperm mother cell from its production till it fertilize an oocyte. Explain the events in the ovary prior to ovulation, development and maturation of the sex organs and the emergence of secondary sex characteristics during puberty.

5. The role of the endocrine system to maintain homeostasis Understand the chemical composition and mechanisms of hormone action, their site of production, regulation, and effects of hormones of the pituitary, thyroid, parathyroid, adrenal, and pineal glands . Hormonal regulation of the reproductive system. The role of the pancreatic endocrine cells in the regulation of blood glucose In addition the contributions of hormones released by the heart, kidneys, and other organs with secondary endocrine functions. The student would be aware of several common diseases associated with endocrine system dysfunction

6. Classify the organs of the alimentary canal from proximal to distal, and understand their function Identify the accessory digestive organs and their functions. Describe the histology that is four fundamental tissue layers of the digestive tract. Contrast the contributions of the enteric and autonomic nervous systems to alimentary tract functioning. Gain awareness about common dysfunctions of digestive system like constipation, gastritis, ulcers, diarrhoea etc.

Unit 1

Cardiovascular system

(L1-9)

Structure and function of heart, Properties of cardiac muscle, The Cardiac Cycle, Electrocardiogram. Circulatory system: General Principles of circulation and hemo-dynamics cardiovascular regulatory mechanism, Lymphatic circulation and micro-circulation.

Unit 2

Respiratory system

(L10-16)

Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolar ventilation, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration.

Unit 3

Renal Physiology

(L17-24)

Functional Anatomy of kidney, function and histology of nephron, Body fluid and electrolytes: their balances and imbalances. Urine formation (glomerular filtration and tubular reabsorption), renal regulation of urine volume and osmolarity, acid-base balance. Urinary bladder: structure, micturition and its regulation. Acidosis and alkalosis, basic concepts about kidney dysfunction

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Unit 4

Reproductive system

(L25-33)

Structure and function of male and female reproductive organ. Function and regulation of testicular and ovarian hormones. Gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, pregnancy, parturition and lactation Basic concepts of male and female infertility, menopause and various contraceptive measures

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Unit 5

Endocrine system

(L34-41)

General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Pineal, Thyroid, Parathyroid, Adrenal, and Pancreas. Basic concepts about hypo and hyper secretion of hormones and their diseases.

Unit 6

Gastrointestinal system

(L42-48)

Anatomy and histology of digestive tract, gastrointestinal physiology: General principles of gut motility secretion, digestion, absorption and assimilation. Gastrointestinal hormones, their formation, action and regulation. Physiological anatomy of liver, pancreas and their functions. An overview of gastrointestinal dysfunction

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Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Simple Reflex arc.

2. Physiological data acquisition based experiments (ECG).

3. Physiological data acquisition based experiments (EMG).

4. Physiological data acquisition based experiments (PFT).

5. To perform platelet count.

6. To determine the reticulocyte count.

7. To perform tests for sensations (taste, touch and smell.)

8. Blood Pressure recordings in humans.

9. To study various types of contraceptive (condoms, IUDs, oral and injectable contraceptives)

10. To study different human organs and their sections through permanent slides. T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, urethra, fallopian tubes, epididymis, prostate glands, lungs, trachea, bronchioles, pitutary, heart. (Minimum 8 slides covering the systems mentioned in theory.)

References

1. Guyton and Hall Textbook of Medical Physiology, 13th edition (2006), J. E. Hall; W B Saunders and Company, ISBN-13: 978-1416045748.

2. Human Physiology, 12th edition (2009), Stuart I. Fox; Tata McGraw Hill, ISBN-13: 9780077350062.

3. Principles of Anatomy and Physiology, 13th edition (2011), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN-13: 978-0470565100.

4. Lab Mannual on Blood Analysis and Medical Diagnostics, 1st edition (2012), Dr. GayatriPrakash; S. Chand, ISBN: 81-219-3967.

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Additional Resources:

1. Ganong’s Review of Medical physiology, 25th Edition (2015), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN-13: 978-0071780032.

Teaching Learning Process

1. Use of blackboard and chalk method to communicate the concepts
2. Use of Power Points presentations to visually explain various processes.
3. Verbal explanation, seminars, case studies, workshops and Open discussions
4. Quizzing and questioning

Assessment Methods

1. Written class tests and assignments
2. Quizzing/ viva, Problem solving exercises

3. Seminar presentations

4. Final University Examination

Keywords

Heart, ECG, Cardiac cycle, lymph, ventilation, gametogenesis, nephron, acidosis, micturition, digestion assimilation absorption, endocrine, pancreas, thyroid, pituitary, contraceptive, fertility

Immunobiology
(32581401)
Core Course - (CC) Credit:6

Course Objective(2-3)

Immunobiology is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is, therefore, key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to interference in the functioning and regulation of the immune system. This paper covers the structure, organization, function and regulation of and by the immune system keeping the above aspects in mind.

Course Learning Outcomes

Students learn various aspects of human immune system during healthy and disease stages which equip students to design better strategies for combating the immunological disorders.

2. Students will be familiarized with origin and maturation of all blood cell types in the bone marrow and the thymus. They will understand the functioning of various types of cells and the roles played by them in immune responses against pathogens.

3. They will also appreciate the concept of antigen-antibody interactions and the roles of major histocompatibility complex and associated cells in the presentation of antigens.

4. The students will also be able to understand the significance of various kinds of growth factors and cytokines in the activation and regulation of various lymphocytes.

5. Various techniques associated with immunological reaction will enhance the understanding of students about common laboratory instruments

6. Vaccine based immunotherapeutics and their designing will assist them to think about new paths for combating pathogens and working mechanism of immune system

7. Student will also be sensitized regarding the dysfunctioning of the immune system and autoimmune disorders

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Unit 1

Introduction:

L 1-2 Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity; primary and secondary immune response

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Unit 2

L -3-11 Structure, properties and functions of the immune system

(a) sHematopoeisis, T and B lymphocyte, Natural Killer cells, Monocytes and Macrophages; Neutrophils, Eosinophils, Basophils, Mast cells and Dendritic cells; thymus and bone marrow; lymph nodes, spleen, MALT, GALT and SALT; pattern recognition receptors.

(b) Mechanisms of pathogen killing by macrophages and neutrophils.

(c) Complement system: Components of the complement activation classical, alternative and lectin pathways; biological consequence of complement activation, methods to study complement fixation.

(d) Inflammation

Unit 3

L 12-31 Adaptive immune response

(a) Antigens and haptens: Properties (foreignness, molecular size, heterogeneity); B and T cell epitopes; T dependent and T independent antigens.

(b) Major Histocompatibility Complex (MHC): Organization of MHC and inheritance in humans; concepts of polygeny and polymorphism with respect to MHC.

(c) Antigen presenting cells, antigen processing and presentation pathways (cytosolic and endocytic), MLRs.

(d) Humoral immune response: Concepts of B cell development in bone marrow, generation of plasma cells and memory B cells in lymphoid organs. Antibodies: Historical perspective of antibody structure; structure, function and properties of the antibodies; different classes and subclasses and biological activities of antibodies; concepts of antibody diversity and class switching. (isotype, allotype and idiotype); transport of IgA, Hybridoma technology, monoclonal antibodies; basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies, antigen-antibody interactions.

(e) Cell mediated immune response: T cell maturation in thymus, thymic selection, self MHC restriction of T cells, T cell receptor complex. T cell sub-types and their effector function. Trimolecular complex formation between APC and Naïve T cells, clonal expansion. Cytokines properties of Interferon and Interleukins (IL1, IL2, IL4).

Unit 4

L 32-39 Immunological principles of various reactions and techniques

Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), western blotting, immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy

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Unit 5

L 40-43 Vaccines and Immunotherapeutics

Types and their characteristics, adjuvants, overview of National Immunization program.

Unit 6

L 44-47 Dysfunctions of immune system

Types of hypersensitivity, overview of autoimmunity. Immunodeficiency disorders: Animal models of primary immunodeficiency (nude mouse and SCID mouse); specific impaired functions in lymphoid and myeloid lineage.

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To perform immuno-diffusion by Ouchterlony method.
2. Immuno-diffusion by Mancini method
3. Analysis of the ouchterlony and Mancini method
4. To perform ELISA checkerboard experiment.
5. To perform Complement fixation assay
6. To perform Agglutination inhibition Assay
7. To perform sandwich dot ELISA.
8. To perform Widal test.

References

1. Immunology, 9th edition, (2019), by Judy Owen / Jenni Punt / Sharon Stranford (2013-01-01), W.H. Freeman and Company, New York. ISBN-10: 1-4641-8978-1; ISBN-13: 978-1-4641-8978-4.

2. Microbiology, 10th edition, (2017), by Joanne Wille, Linda Sherwood, Christopher J. Woolverton, McGraw Hill. ISBN-10: 1259281590

3. Roitts Essential Immunology, 13th edition, (2017), Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,

Wiley-Blackwell Science. ISBN: 978-1-118-41577-1.

4. Immunology, 7th edition, (2013), by Judy Owen / Jenni Punt / Sharon Stranford (2013-01-01), W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.

Teaching Learning Process

The Course in Immunobiology is designed to encourage the acquisition of subject knowledge. It will integrate with skills required for biomedical science based professions and jobs. Learning experiences are aimed at developing practical skills which would prepare the students for industry. Various approaches to teaching-learning processes, including lectures, seminars, tutorials, workshops, peer teaching, learning, project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, technology-enabled learning, internship in industry and research establishments will be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

The assessment of students in immunobiology will be done keeping in mind the skills acquired during the course. Students will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, assignments, observation of practical skills and seminar presentation.

Keywords

Innate immunity, adaptive immunity, B cells, T cells, antigen, antibody, Major Histocompatibility Complex, autoimmunity, hypersensitive reaction, vaccine

Medical Microbiology
(32581303)
Core Course - (CC) Credit:6

Course Objective(2-3)

The Medical Microbiology course has been formulated to impart basic and medically relevant information on the microbes. The microbial structure, growth and development, methods and role of sterilization in the context of study of microbes are included. The pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject. This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes. Lastly the course deals with the problem of emerging antimicrobial resistance with reference to known pathogens.

Course Learning Outcomes

1. Medical microbiology describes a broad perspective to study structure, classification, and disease caused by microbes including bacteria fungi, protozoa and viruses.

2. The course helps to understand the nature of microorganism, their systematic classification and contribution of various scientists in the discovery of disease causing pathogens.

3. Explains pathogenesis, etiology, clinical symptoms, control and cure of microbial diseases in addition to introducing antimicrobial action of antibiotics

4. What are the basic nutrient requirements of microorganism and how they behave in variable atmospheric conditions?

5. Describes use of various culture media used for cultivation of microbes, their optimum physical and chemical cultural requirements and techniques for purification and preservation of microbes.

6. Analyzing optimum growth conditions helps in growth and cultivation of useful microorganism.

7. The microbial genetics helps to understand the basic phenomenon of gene functioning and effects of various mutagens on microorganism. Elucidates different methods of gene transfer and causes of genetic variation

8. Fermentation tools give basic knowledge related to large scale cultivation of microbes for research, food, industry and improvising the existing strains for economic exploitation

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Unit 1

L 1-8 Fundamental Concepts

(a) History of microbiology with special emphasis on contribution of Louis Pasteur and Robert Koch in Medical Microbiology.

(b) Major Divisions of life- Domains, Kingdoms, Classical and Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny..

(c) Requirements for microbial growth, growth factors, culture media- synthetic and complex, types of media. Obtaining Pure Cultures, Preserving Bacterial Cultures, Growth Curves and generation time, Control of microbial growth, general concept of effect of environmental factors on growth of microbes.

Unit 2

L 9-12 Bacterial Cells - fine structure and function

Size, shape and arrangement of bacterial cells; Cell membrane, cytoplasmic matrix, inclusion bodies (eg magnetosomes), nucleoid, Ultrastructure of Gram +ve and Gram –ve bacterial cell wall, Pili, Capsule, Flagella and motility, endospore

Unit 3

L 13-16 Microbial Genetics

Mutations, Bacterial recombination: general and site specific and replicative, bacterial plasmids fertility factor, col plasmid, bacterial conjugation (Hfr, F, F+, F-), transformation, transduction- generalized and specialized.

Unit 4

L 17-19 Host–Pathogen relationship in the infectious diseases

Relationship between Normal microbiota and host, Opportunistic microorganisms, nosocomial infections, Development and spread of infectious disease: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types. Routes, mechanisms of invasion and establishment of infection.

Unit 5

L 20-33 Microbial diseases

Respiratory tract infections (Tuberculosis); Gastrointestinal tract infections including Diarrhea caused by Salmonella and E.coli, staphylococcal food poisoning. Clinical symptoms and life cycle of Candida albicans and Plasmodium.

General life cycle of a virus, structure, enveloped and un-enveloped viruses, plaque assay, growth curve, classification based on genetic material and detail study of influenza and HIV virus with curative agent. Virods, virusoids and prions.

Unit 6

L- 34-48 Industrial Microbiology and Antimicrobial Chemotherapy

Industrial microbiological processes in industry, basic design of fermentation-continuous and discontinuous: Importance w.r.t medical microbiology like vaccine development and diagnostics.

Range of activity and mechanism of action of antibiotics-sulfa drugs, penicillin, aminoglycosides, quinolones, cyclosporine, tetracycline and macrolides, their effectively and various test for antimicrobial activity

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of different media: synthetic media, Complex media-nutrient agar, Luria Agar.

2. Staining methods: Gram’s staining, Acid fast staining (permanent slide only), Capsule staining and spore staining.

3. Study and plot the growth curve of E coli using turbidometric method and to calculate specific growth rate and generation time.

4. To perform antibacterial testing by Kirby-Bauer method.

5. Staining and morphological characterization of Aspergillus sp., Pencillium sp. and Saccharomyces sp.

6. Demonstration of PCR based method of detection.

7. Isolation of bacteriophages (any with a non-pathogenic host) and calculation of the plaque forming units (pfu).

References

1. Microbiology: An Introduction, 9th edition (2008), Gerard J. Tortora, Berdell R. Funke, Christine L. Case; Benjamin Cummings. ISBN-13: 978-0321733603.

2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International. ISBN-13:978-0071313674.

3. Bailey and Scotts Diagnostic Microbiology, 12th edition (2007), Betty A. Forbes, Daniel F. Sahm and Alice S. Weissfeld; Mosby Elsevier Publishers, ISBN-13: 978-0808923640.

4. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International, ISBN-13: 978-0070492585.

5. Brock Biology of Microorganisms, 13th edition (2010), Michael T. Madigan, John M. Martinko, David Stahl and David P. Clark, Pearsons, Benjamin Cummings, ISBN-13: 978- 0321649638.

6. Microbiology: A Laboratory Manual, 10th edition, (2013), James Cappuccino and Natalie Sherman, Benjamin Cummings. ISBN-13: 978-0321840226

Teaching Learning Process

The Syllabus of Medical Microbiology is designed to encourage the acquisition of subject knowledge, skills required for biomedical science based professions and jobs. Learning experiences are aimed at developing practical skills which would prepare the students for industries and educational organizations. Various approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching, learning, project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, technology-enabled learning, internship in industry and research establishments will be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

The assessment of students in Medical Microbiology will be done keeping in mind the skills acquired during the course. Students will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, assignments, observation of practical skills and seminar presentation

Keywords

Bacteria, MIC, Virus, Cell wall, Flagella, Fermentation, Lysogeny, Antibitics and antiviral agents

Medicinal Chemistry
(32581403)
Core Course - (CC) Credit:6

Course Objective(2-3)

The introduction of Medicinal Chemistry course at undergraduate level to Biomedical Science students has been conceived to make them understand the: • concealed chemical science interlinked to other science disciplines such as biophysics, chemistry, biology, biochemistry, pharmacology etc. • application of the area in revealing new drug design and targets through studying the drug-receptor interactions and signaling mechanism in cell for lead discovery. • The course emphasizes on various drug targets in the body and drug development strategies with mechanism of action and concept of drug resistance.

Course Learning Outcomes

After completing the course, students shall be able to: • understand the various stages involved in the drug development, drug-receptor interactions, identify association between chemical structure and its physicochemical properties. • demonstrate a strong foundation via problem solving, critical thinking and analytical reasoning in the fundamentals and application of medicinal chemistry. The course will involve extensive laboratory work and knowledge of medicinal chemistry. They will be able to comprehend the physicochemical basis for the rational drug design, analogue synthesis, and mechanism of action of drugs. • design and carry out small molecule (low molecular drug-relevant compounds) synthesis and natural product isolation experiments along with their purification and characterization through chromatography and spectroscopic methods. They will be able to accurately record and analyze the results of such experiments. • actively participate in discussions during seminars and group exercises; communicate the results of experiments conducted in oral as well as written formats. • appreciate the central role of chemistry in our daily life and will also learn safe handling of hazardous chemicals and follow the SOP for chemical waste disposal.

Unit 1

General introduction (L1-L2) Definition and scope of medicinal chemistry.

Unit 2

Drug target classification (L3-L16) Proteins as drug targets Receptors: The receptor role, ion channels, membrane bound enzyme activation, agonist and antagonists, concept of inverse agonist, desensitization and sensitization of receptors, affinity, efficacy and potency. Enzymes: Enzyme inhibitors (competitive, non-competitive, suicide inhibitors), medicinal use of enzyme inhibitors. Nucleic acids as drug targets Classes of drugs that interact with DNA: DNA intercalators (amsacrine), Groove binders (netropsin), DNA alkylators (amines: mechlorethamine; nitrosoureas: carmustine), concept of antisense therapy.

Unit 3

How drug acts: Molecular aspects (L17-L24) Structure and functions of cell surface receptors, Signal transduction mechanism (GPCRs, Tyrosine kinase, guanylate- cyclase linked receptors and intracellular receptors that regulate DNA transcription).

Unit 4

Physicochemical principles of drug action and Measurement of drug effects (L25-L38) Partition coefficient, Drug dissolution, Acid-base properties, Surface activity, Bioavailability, Stereochemical aspects of drug action, Electronic structure (Hammett correlations) and determining relationship between chemical and biological data (Hansch approach). Kinetic analysis of ligand receptor interactions using Scatchard plot, Double reciprocal plot, Hill plot, Forces involved, Relationship between dose and effect (graded and quantal response).

Unit 5

Principles of drug design (L39-L44) Introduction to SAR, Strategies in the search for new lead compounds, Analogue synthesis versus Rational drug design, Concept of prodrugs.

Unit 6

Introduction to combinatorial synthesis (L45-L48) Methods of parallel synthesis, Methods in mixed combinatorial synthesis (mix and split method), Limitations of combinatorial synthesis.

Practical

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Recrystallization of organic compound, determination of its melting point and TLC. 2. Preparation of Benzocaine. 3. Preparation of Benzoquinone. 4. Determination of partition coefficient of Aspirin in octanol-water system. 5. Preparation of Phenacetin. 6. Preparation of Hippuric acid. 7. Preparation of s-benzyl thiouronium salt. 8. Extraction of caffeine from tea leaves and study its absorption properties. 9. Phytochemical screening and qualitative chemical examination of various plant constituents by solvent extraction. (Detection of alkaloids, carbohydrates, glycosides, phytosterols, oils and fats, tannins, proteins, gums and mucilages). 10. Extraction of piperine from black pepper.

References

1. Introduction to Medicinal Chemistry, 4th edition (2009), Graham l. Patrick, Oxford University Press. ISBN-13: 978-0199234479. 2. The Organic Chemistry of Drug Design and Drug Action,2nd edition (2004), Richard B. Silvermann, Elsevier, Academic Press. ISBN: 978-0126437324.
Additional Resources:1. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd edition (2005), Thomas Nogrady and Donal F. Weaver, Oxford University Press. ISBN-13: 978-0195104561. 2. Wilson Gisvold textbook of Organic Medicinal and Pharmaceutical Chemistry, 11th edition (2003), edited by Block and Beale, Baltimore, Lippincot. ISBN-13: 978-0781734813. 3. The Practice of Medicinal Chemistry, 2nd edition (2003), Camille G. Wermuth, Academic Press. ISBN-13: 978-0127444819. 4. Principles and Practice of Medicinal Chemistry, 2nd edition (2003), Frank. D. King. The Royal Society of Chemistry.ISBN-13: 978-0854046317. 5. Introduction to Medicinal Chemistry: How Drugs Act and Why, 1st edition (1996), Alex Gringauz, Wiley VCH. ISBN-13: 978-0471185451.

Teaching Learning Process

The course in medicinal chemistry is designed to encourage the acquisition of subject knowledge, understanding academic and professional skills required for biological and medicinal chemistry-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learningand project-based learning, substantial laboratory-based practical component and experiments, open-ended project work, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

Progress towards achievement of learning outcomes will be assessed using the following methods: time-constrained examinations; closed-book and open-book tests; problem-based assignments; practical assignment, laboratory reports; observation of practical skills; individual/team project reports; oral presentations, including seminar presentation; viva voce interviews; computerized adaptive testing; peer and self-assessment etc.

Keywords

Receptor, Antisense, QSAR, enzyme inhibitor, DNA interacting agent, signal transduction, prodrug, combinatorial synthesis

Molecular Biology
(32581402)
Core Course - (CC) Credit:6

Course Objective(2-3)

The paper Molecular Biology encompasses the basic study and understanding of the execution of central dogma. The objective is to offer detailed and comprehensive knowledge about the mechanisms of DNA replication, repair, transcription and translation in prokaryotes and eukaryotes so that students can apply this knowledge in enhancing their analytical and research problem solving skills.

Course Learning Outcomes

1. Students will acquire basic concepts of central dogma.

2. Students will understand the concept of DNA replicated and repair and hence the consequences of improper processes.

3. Students will gain knowledge about the mechanisms of transcription, posttranscriptional processes and translation.

4. Students will learn about mutations, which are considered instrumental for species deviation and eventually diversity.

Unit 1

The replication of DNA in Prokaryotes and Eukaryotes (14 Lectures)

Chemistry of DNA synthesis, Enzyme and proteins involved in DNA replication – helicase, topoisomerases, DNA polymerases, DNA ligase, primase, RNaseH, telomerase, sliding clamp, sliding clamp loader and SSBs. Mechanism of action of DNA polymerase, DNA transactions during replication - bidirectional replication, semi-conservative, discontinuous. Mechanics at the DNA replication fork: RNA priming, Initiation and termination of DNA replication (comparing prokaryotes with eukaryotes), Regulation of bacterial DNA replication, Replicating the 5’ end of linear chromosome, Replication coupled to chromatin synthesis in Eukaryotes, Various models of DNA replication including Trombone model, D-loop (mitochondrial), Theta mode of replication, Rolling circle model, Replication of linear ds-DNA. Denaturation and renaturation of DNA, Cot curves, Rot curves.

Unit 2

The mutability and Repair of DNA (6 Lectures)

Spontaneous and induced mutations, Types of mutations- point (non-sense, miss-sense, frame shift, insertion, deletion), Use of mutants to study gene functions, Effects on the gene product- loss of the function and gain of function. Replication Errors (transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization), DNA repair: Direct repair, Mismatch repair, Excision Repair, Photoreactivation, Recombination Repair, SOS response. AMES test to identify DNA damaging chemicals, Detection of mutations: CLB method and attached X method.

Unit 3

Information transfer –I: Mechanism of transcription (10 Lectures)

Basic transcription apparatus, Transcription in bacteria: Initiation, elongation and termination of transcription, Promoter sequences and concept of abortive initiation, Transcription in Eukaryotes: Types of RNA polymerases, RNA polymerase II and its promoters, TBP and other transcription factors, Transcription by RNA polymerase I and III, Inhibitors of transcription- rifampicin and -amanitin.

Unit 4

Post-transcriptional modifications (6 Lectures)

Split Genes, Concept of introns and exons, RNA splicing pathways: Spliceosomes and Self splicing introns (Group I and Group II introns), Ribozymes, Variants of splicing: alternative splicing, exon shuffling and RNA editing, Mutually exclusive splicing (example Drosophila Dscam gene), Mechanism determining the sex of Drosophila, mRNA transport.

Unit 5

Information transfer-II: Mechanism of translation (12 Lectures)

Features of genetic code and exceptions in some systems, Types of RNA: Messenger RNA, Ribosomal RNA and Transfer RNA, Ribosomal structure, Charging of tRNA, amino-acyl tRNA synthetases, Proteins and factors involved in translation, Process of translation: Initiation, elongation and termination (prokaryotes and eukaryotes), Fidelity of translation, Translation-Coupled removal of defective mRNA, Protein folding, covalent modifications and targeting, Inhibitors of protein synthesis – tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.

Practical

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Calculations and preparation of various stock and working solutions of molecular biology experiments (Number 2 to 8).

2. Isolation of genomic DNA from bacterial cells.

3. Fractionation of DNA by agarose gel electrophoresis.

4. Isolation of genomic DNA from blood/tissue.

5. Quantitative estimation of salmon sperm/ calf thymus DNA using colorimetric assay using Diphenylamine reagent.

6. Quantify and analyze the purity of DNA using spectrophotometer (estimating at 260 nm, 280nm and 320nm).

7. In vitro gene amplification method of Polymerase Chain Reaction (PCR): Primer designing and setting up of the reaction.

8. Native-Polyacrylamide Gel Electrophoresis for DNA

References

1. 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.

2. Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp. ;

Wiley Publishers ISBN-13:978-1118206737.

3. The World of the Cell, 7th edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin

Cummings, ISBN-13:978-0805393934.

4. Molecular Biology: Principles and Practice, 1st edition (2012), Cox, Doudna and Donnell,

ISBN-13: 978-0-716-7998-8.

Additional Resources:

1. DNA Replication, 2nd edition (2005), Arthur Kornberg; University Science Books ISBN-

13: 978-1891389443.

2. Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and

Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.

Teaching Learning Process

Teaching and learning activity will mainly include extensive class room discussions,

Students will be asked to orally revise the previous class before every new class to helping them in the better understanding of the topics and clearing their doubts. Teaching will be conducted through both regular chalk and board and power point presentation. There will be regular question and answer activities and consultation of relevant text books and research articles. Student queries will be entertained by the teachers.

Assessment Methods

Topic on current and important research area will be assigned individually to students and they will be asked to retrieve literature and show them to teachers for verification. They will be motivated to make short presentations. Class tests will be conducted for internal examinations. Students will be given home assignments from time to time to improve their writing skills. Finally there will be end semester university examination

Keywords

Replication, Mutation, Repair, AMES test, Transcription, RNA splicing, Translation.

Pharmacology
(32581502)
Core Course - (CC) Credit:6

Course Objective(2-3)

Pharmacology is the science concerned with the study of drugs and how they can best be used in the treatment of disease in both humans and animals. The course starts with the general considerations and lead to understanding of various drugs acting on different body systems. It is a very important biomedical discipline, with roots both in basic biology and chemistry, and plays a vital role in helping to safeguard our health and welfare.

Course Learning Outcomes

After studying the syllabus students are expected to understand/learn the following:

1. Broad range of chemicals that act as medicine for humans and their various sources.
2. How drugs are administered in the body i.e. routes; and under which conditions is one route preferred over another in patients.
3. Various types of drug receptors in the body and their functioning.
4. Basics of absorption, transport, excretion of drugs and effects of metabolism on drug action.
5. Basics of quantification of half life, bio-availability and elimination of drugs in the body and factors affecting them.
6. The action effect sequence, how response changes with dose of drug administered, basics of measurement of response, efficacy and potency of drug. Different factors affecting action of the drug.
7. The concept, mechanism, classification, use and contraindication of drugs of various classes.
8. Assessment of the choice and role of antibiotics in drug therapy and the problems arising from their indiscriminate use.
9. The importance and use of hormones and hormone antagonists as drugs in endocrine system related disorders. Hormone replacement therapy and its application.

Unit 1

Unit I: Introduction to Pharmacology

(L1-L4) Nature and Source of drugs, routes of drug administration, their advantages and disadvantages, receptor and receptor subtypes.

Unit 2

Unit II: Pharmacokinetics and Pharmacokinetics

(L5-L18) Drug absorption, distribution, metabolism, and excretion, bio-availability, first Pass metabolism, excretion and kinetics of elimination, Bio-availability, biological half life of drug and its significance, drug-drug interactions.

Unit 3

Unit III: Brief introduction to autacoids

(L19-L22) Drug therapy of inflammation, NSAIDs and other drugs (aspirin, celecoxib).

Unit 4

Unit IV: Mechanism of action of different classes of drugs

(L23-L34) General aspects, classification and mechanism of action of following classes of drugs along with side effects and contraindication of the drugs mentioned against each class should also be covered.

(a) General Anesthetics:	Halothane
(b) Sedatives and Hypnotics:	Diazepam
(c) Cholinergics:	Bethanechol, Rivastigmine
(d) Skeletal Muscle Relaxants:	Succinylcholine
(e) Adrenergics:	Isoprenaline, Propranolol, Salbutamol
(f) Dopaminergics:	Dopamine, Syndopa
(g) Diuretics:	Furosemide

Unit 5

Unit V: Chemotherapy of microbial diseases

(L35-L40) Antibacterial (sulfonamides), Antifungal (amphotericin B)

Unit 6

Unit VI: Hormones and hormone antagonists

(L41-L48) Insulin and oral hypoglycemic agent (tolbutamide, rosiglitazone), thyroid and anti-thyroid drugs (eltroxin, carbimazole), HRT, estrogen and progestins (progesterone, hydroxyprogesteronecaproate).

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Handling of laboratory animals.
2. Routes of drug administration (Oral, I.M.)
3. To study the presence of acetaminophen in given sample.
4. To study the stages of general anesthesia.
5. To determine partition coefficient of general anesthetics.
6. Effect of analgesic (Tail-flick test).
7. Anti-anxiety effect of Valium (Plus maze test).
8. Fixing of organ bath and kymograph.
9. To record CRC of acetylcholine using guinea pig ileum / rat intestine.
10. Determination of dose ratio.
11. Study of competitive antagonism using acetylcholine and atropine.

References

1. Essentials of Medical Pharmacology, 7 th edition (2010), K.D. Tripathi, Jaypee Brothers, ISBN:9788184480856.

2. Hand book of Experimental Pharmacology, 4th edition (2012), S.K. Kulkarni, VallabhPrakashan, 2012. ISBN 13: 97881857311.

Additional Resources:

1. Pharmacology, 7 th edition (2011), H.P. Rang, M.M. Dale, J.M. Ritter and P.K. Moore, Churchill Livingstone. ISBN:9780702045042.

Teaching Learning Process

1. Use of blackboard and chalk method to communicate the concepts.
2. Use of Power Points presentations to visually explain various processes.
3. Verbal explanation.
4. Open discussions.
5. Quizzing and questioning.

Assessment Methods

1. Written class test
2. Written assignments
3. Quizzing/ viva
4. Presentations
5. Final University Examination

Keywords

Drugs, Medicine, Pharmacokinetics, Pharmacodynamics, Therapeutics, Mechanism of Action, Classification, Clinical uses, Anti-microbial, Hormone, hormone analogues.

Principles of Genetics
(32581201)
Core Course - (CC) Credit:6

Course Objective(2-3)

- The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance.
- Introduction to pedigree analysis for autosomal and X-linked traits
- Understanding of difference between prokaryotic and eukaryotic genome organization, prokaryotic and eukaryotic transposons, and basic cytogenetics.
- Understanding of mechanisms of sex determination
- Introduction to Population Genetics

Course Learning Outcomes

- The flavor of genomics as a progression from Mendelian genetics will be introduced, that can motivate the students to take up self-learning and Webinars. They will learn about classical experiments which led to discovery of genetic material. They will also learn structure of DNA, its replication and mutations.
- Students should be able to explain Mendelian laws of inheritance, deviations from

monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage).
- Students should be able to distinguish between sex-linked, sex-limited and sex-influenced traits.
- Students should be able to interpret pattern of inheritance for autosomal and X-linked traits from pedigrees.
- Students will learn the concept of extra-nuclear inheritance.
- Students will learn the difference in genome organization between prokaryotes and eukaryotes.
- Students will learn about transposable genetic elements with examples of prokaryotic IS-elements and composite transposons and eukaryotic Ac-Ds system.
- Students will gain insight into genetic and environmental sex determination mechanisms.
- Students will be introduced to basic population genetics. They should be able to understand Hardy-Weinberg Law and its relevance. They should be able to calculate allele and genotype frequencies using HW law.
- Students would be skilled with understanding of Binomial distribution and Chi-square test of goodness of fit.

Unit 1

Overview of changing paradigms in genetics (L1- L6)

A brief overview of how genetic principles took shape, leading to the concept of a blueprint of life within the cell to the physical entity of DNA. Basic structure of DNA, salient features of the double helix, semi-conservative replication– Messelson and Stahl experiment. Also mention the surprises we have from the genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.

Unit 2

Concept of genetic inheritance (L7-L24)

Concept of alleles, haploid and diploid status, phenotype and genotype: Mendel’s laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance, concept of linkage and crossing over, cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions.

Gathering family history, pedigree symbols and construction of pedigrees. Patterns of inheritance for monogenic traits and risk assessment with examples for autosomal inheritance-dominant, recessive, sex-linked inheritance, sex-limited and sex-influenced traits, mitochondrial inheritance. Prenatal diagnosis of genetic defects.

Unit 3

Extra nuclear inheritance (L25-L29)

Criteria for extra nuclear inheritance, plastid inheritance in Mirabilis jalapa, kappa particles in Paramecium, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria and chloroplast).

Unit 4

Genome Organization and Cytogenetics (L30-L40)

Organization of Genomes in Prokaryotes and Eukaryotes, Establishing the central Dogma, Nucleosomes organization and assembly. Euchromatin, Heterochromatin- constitutive and facultative heterochromatin.

Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.

Karyotyping- banding pattern and nomenclature (G and Q banding), Structural abnormalities (Duplication, Insertion, Deletion, Translocation – Reciprocal and Non-Reciprocal). Numerical abnormalities (Aneuploidy and Euploidy). Common syndromes due to numerical chromosome changes, common syndromes due to structural alterations (translocations, duplications, deletions).

Unit 5

Introduction to mechanisms of sex determination (L41-L44)

Chromosomal theory of sex determination, mechanisms of sex determination, environmental factors and sex determination in human and Drosophila, Barr bodies, dosage compensation.

Unit 6

Basic population genetics (L45-L48)

Gene pool and gene frequency, Hardy Weinberg law and its application for calculating allelic and genotype frequencies.

Practical

1. Observation of wild type and mutant phenotypes in Drosophila.
2. Preparation of culture media for Drosophila and study different stages of life cycle of Drosophila.
3. Verification of Mendelian laws through Drosophila / seeds – dominant, recessive and sex- linked
4. Preparation of Barr body.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.
8. Demonstration of Hardy-Weinberg Law using seed simulation.

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

References

1. Principles of Genetics, 7th edition (2015), Snustad DP and Simmons MJ, John Wiley and Sons, Inc; ISBN: 978-1-119-14228-7.
2. Concepts of Genetics, 12th edition, (2019). William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian; Pearson Education, ISBN-13: 9780134832227.

Additional Resources:

1. Human Molecular Genetics, 5th edition (2019) by Tom Strachan and Andrew Read; Taylor & Francis Ltd, ISBN -13: 9780367002503.

2. Principles of Genetics, 8th edition (2006), Gardner EJ, Simmons MJ, Snustad DP. John Wiley and Sons, Inc.; ISBN: 9788126510436.

3. An introduction to Genetic Analysis, 10th edition (2010), Griffith AJF, Miller JH, Suzuki DT, Lewontin RC, Gelbert WM., W. H. Freeman and Co. New York. ISBN-13: 978-429229432.

4. Principles of Genetics, 7th edition (2010), Robert H. Tamarin Publisher: Mcgrawhill; ISBN: 9780070486676.

Teaching Learning Process

1. Class lectures through chalk and board or through presentations.
2. Interactive learning by open discussions on certain topics
3. Student presentations
4. Assignments
5. Numerical solving in class
6. Monitoring in Practical sessions

7. Sharing on-line video/animation links on relevant topics with students

Assessment Methods

1. Class tests
2. Written assignments
3. Student presentations
4. Oral questions for concepts taught in previous classes
5. End semester University examination.

Keywords

Genetics, Mendelian Inheritance, Linkage, Mitochondrial inheritance, Sex determination, Cytogenetics, Transposons, Hardy-Weinberg law, Chromatin, Gene-gene interactions, pedigree analysis

Toxicology
(32581602)
Core Course - (CC) Credit:6

Course Objective(2-3)

Different types of poisons have been known to humans since ages. Even in early times when science was in its infancy, curious people such as “Paracelsus” could predict “Every substance is a poison and, it is the right dose of the substance which differentiates remedy from poisons”. This thought is fundamental even to modern toxicology and pharmacology. There is an increasing use of chemicals in the modern society and hence, toxicology is becoming a more important subject to study with the passage of time. Modern toxicology is a vast, multidisciplinary subject encompassing various other basic fields of science. The present course content is designed to provide the basics of toxicology. It provides insight into measurement of toxicity, principles of exposure, molecular mechanism of toxicity and toxicants that harm our environment. Relevant importance has been given to those topics which can build a strong foundation in the subject, based on which, facts can be assimilated during subsequent higher studies.

Course Learning Outcomes

After studying the syllabus students are expected to understand/learn the following:

1. Form of toxicology practiced during antiquities across the world; and how the modern form of toxicology emerged.
2. Nature of toxic substances and how humans are exposed to them. Spectrum of toxic responses.
3. Types of toxicity and factors affecting the toxicity by a chemical.
4. Basics methods and biological parameters used to measure toxicity of a chemical. Basics of safety evaluation of toxicants.
5. Mechanisms/processes involved in absorption, transport, chemical modification and excretion of toxicants from the body.
6. How toxicants cause toxicity; interaction of toxicants with target bio-molecules in the body and resultant toxicity.
7. Through examples of two common classes of toxicants such as pesticides and metals, students are able to learn; how humans are exposed to them, their mechanism of action, symptoms of toxicity.
8. The process by which certain anthropogenic chemicals cause harm to wildlife/ ecosystem.
9. Basics of management, clinical evaluation of toxic patients, methods used to prevent further toxicity, and use of antidotes.

Unit 1

Unit I: Introduction

(L1-L3) Brief history, Different areas of modern toxicology, Classification of toxic substances, Various definitions of toxicological significance.

(L4-L5) Characteristic and types of toxic responses and tolerance to toxicants.

Unit 2

Unit II: Toxic exposure, response, evaluation of toxicity and mechanism of toxicity

(L6- L7) Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity.

(L8- L12) Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index.

(L13- L17) Delivery of the toxicant, general mechanisms involved in formation of ultimate toxicants and toxicities by them.

(L18- L20) Detoxification of ultimate toxicants.

Unit 3

Unit III: Fate of xenobiotics in human body

(L21-L28) Absorption, distribution, excretion and metabolism of xenobiotics (biotransformation, Phase- I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).

(L29-L30) Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.

Unit 4

Unit IV: Toxic agents

(L31-L38) Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.

Unit 5

Unit V: Eco-toxicology

(L39-L43) Brief introduction to avian and aquatic toxicology, Movement and effect of toxic compounds in food chain (DDT, mercury), Bio-accumulation, Bio-magnification, acid rain and its effect on ecosystems, concept of BOD and COD.

Unit 6

Unit VI: Clinical toxicology

(L44-L48) Management of poisoned patients, clinical methods to decrease absorption and enhance excretion of toxicants from the body, use of antidotes.

Practical

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Separation of a mixture of benzoic acid, beta- naphthol and naphthelene by solvent extraction and identification of their functional Groups.

2. Determination of Dissolved oxygen (DO) using Winkler method.

3. Determination of Biological oxygen demand (BOD) of water.

4. To perform quantitative estimation of residual chlorine in water samples.

5. To determine the total hardness of water by complexo-metric method using EDTA.

6. To determine acid value of the given oil sample.

7. To estimate formaldehyde content of given sample.

8. Calculation of LD50 value of an insecticide from the data provided.

9. Determination of COD (chemical oxygen demand) of the given water sample.

References

1. Cassarett and Doulls “Essentials of Toxicology” 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
2. Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.

Additional Resources:

1. Cassarett and Doulls Toxicology “The Basic Science of The Poisons” 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
2. Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
3. Lus basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Teaching Learning Process

1. Use of blackboard and chalk method to communicate the concepts.
2. Use of Power Point presentations to visually explain various processes.
3. Verbal explanations.
4. Open discussions.
5. Quizzing and questioning.

Assessment Methods

1. Written class test
2. Written assignments
3. Quizzing in classes/viva
4. Presentations
5. Final University Examination

Keywords

Toxicology, Toxicants, Poison, Xenobiotics, Toxic Agents, Toxicokinetics, Toxicodynamics, Ecotoxicology, Clinical Toxicology, Pesticides, Metal Toxicity, Toxic exposure

Computational Biology and Drug Design
(32587901)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This course will introduce the discipline of computational biology and drug design. It has been designed to explain the different aspects of nucleotide and protein sequence analyses, sequence alignments and their applications in understanding biology. 2. The course will also emphasize on the strategic issues in rational drug discovery and

development, principles of computational methods involved in lead generation, virtual screening, quantitative structure-activity relationship and molecular docking.

Course Learning Outcomes

After completing the course, students shall be able to: • explore primary literature in the publicly available databases and other online resources to critically assess biological and medicinal information. • perform sequence alignments and phylogenetic analysis. • understand microarray data analysis. • learn various aspects of protein structure and their visualization. • appreciate the role of modern computational techniques in the drug design, including virtual screening, de novo design, quantitative-structure activity relationships and molecular docking. • Design and conduct computational biology and drug design-based project for the purpose of solving a scientific problem. Further, they will be able to record and analyze the complex results in a clear and concise manner.

Unit 1

Introduction to computational biology (L1-L2) What is computational biology and bioinformatics, internet and bioinformatics, chemoinformatics. Introduction to linux and common terminal commands.

Unit 2

Biological databases and genome browsers (L3-L12) Introduction to various databases and their classification (primary and secondary databases) e.g. NCBI, DDBJ, EMBL, ENSEMBL, UCSC and their use in laboratories: literature, sequence, structure, medical, enzymes and metabolic pathways databases.

Unit 3

Sequence alignment and phylogenetic analysis (L13-L24) Local and global sequence alignments (Needleman-Wunsch and Smith-Waterman algorithms), pair-wise (BLAST and FASTA algorithms) and multiple sequence alignment (Clustal W) and its importance. Theory behind BLAST- how Hidden Markov Model (HMM) can be used to model a family of unaligned sequences or a common motif within a set of unaligned sequences and further be used for discrimination and multiple alignment, BLAST score, amino acid substitution matrices, s-value and e-value, calculating the alignment score and significance of e and p value. Basics and tools for phylogenetic analysis, cladistics, tree-building methods (character and distance-based methods), construction of phylogenetic trees and identifying homologs.

Unit 4

Microarray analysis (L25-L27) Introduction and use of DNA microarray to assay gene expression. Designing of the experiment, analysis and biological interpretation, principle and applications of protein microarray.

Unit 5

Drug discovery pipeline and lead generation (L28-L36) Drug life cycle, stages of drug discovery and strategic issues in drug discovery.2D and 3D molecular structures, molecular descriptors and fingerprints, molecular similarity and diversity, topological

descriptors, quantitative structure-property relationships.

Unit 6

Overview of drug development (L37-L48) HTS, clinical trials, Applications of chemoinformatics in drug research, chemical libraries, Protein 3D modeling, characterization of binding site, virtual screening, protein-ligand interactions, prediction of pharmacological properties, introduction to drug databases, PubChem and their use in drug development, Lipinski's rule of five, concept of energy minimization and force fields, introduction to rational drug design using example.

Practical

1. Retrieval of information from databases. 2. Sequence alignment using BLAST and Clustal W. 3. Phylogenetic analysis. 4. Microarray data analysis. 5. Molecular format conversion and hands-on molecular visualization program for displaying, animating and analyzing large bio-molecular systems using 3-D graphics. 6. Homology Modeling using SPDBV, model structure refinement using SPDBV and model validation. 7. Comparing structures, mutations, studying interactions creating electrostatic potential diagrams. 8. Virtual screening and molecular docking.

References

1. Bioinformatics: Sequence and Genome analysis, 2nd edition (2004), David W. Mount, Cold Spring Harbour Laboratory Press. ISBN-13: 978- 0879697129. 2. Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition (2004), Andreas D. Baxevanis and B.F. Francis Ouellette, John Wiley and Sons. ISBN-13: 978-0471478782. 3. Introduction to Medicinal Chemistry, 4th edition (2009), Graham l. Patrick, Oxford University Press. ISBN-13: 978-0199234479. 4. Molecular modeling - Principles and Applications, 2nd edition (2003), A. R. Leach, Pearson Education Limited, UK. ISBN 13: 9780582382107.

Additional Resources: 1. The Process of New Drug Discovery and Development, 2nd edition (2006), C.G. Smith and J.T. O'Donnell, Informa Healthcare, ISBN-13: 978-0849327797. 2. Cheminformatics (2003), J. Gasteiger, Thomas Engel; Wiley-VCH. ISBN: 9783527618279. 3. Cheminformatics in Drug Discovery (2006), edited by. T.I. Opera; Wiley Publishers, ISBN: 9783527604203. 4. Molecular Dynamics Simulation: Elementary Methods (1992), J. M. Haile, Wiley-Interscience, New York. ISBN-13: 978-0471184393.

Teaching Learning Process

This course is designed to encourage the acquisition of subject knowledge, understanding academic and professional skills required for computational data analysis-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learningand project-based learning, substantial laboratory-based practical component, open-ended project work, games, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

Progress towards achievement of learning outcomes will be assessed using the following methods: time-constrained examinations; closed-book and open-book tests; problem based assignments; practical assignment, laboratory reports; observation of practical skills; individual/team project reports; oral presentations, including seminar presentation; viva voce interviews; computerized adaptive testing; peer and self-assessment etc.

Keywords

Databases, NCBI, BLAST, sequence alignment, phylogeny, microarray, drug design, QSAR, modeling, virtual screening, docking.

Medical Biochemistry
(32587904)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The Medical Biochemistry course has been formulated to educate students on the clinical significance of biochemistry. Students would learn the principle and applications of the diagnostic enzymology, interplay of hormones in the metabolism and details of various biomolecules of diagnostic significance. These topics are incorporated in the course to impart relevant information on clinical biochemistry. This course will also focus on the contemporary methods and practical approaches that are used in the clinical laboratories for the investigation of the parameters to ascertain normal and diseased state.

Course Learning Outcomes

1. Students will learn to integrate the major biochemical pathways of biomolecules and their metabolic and hormonal regulation and understand how disruptions in intermediary metabolism lead to a disease.

2. They will be able to understand, how biochemical tools accomplish diagnostic and therapeutic intervention on metabolic and genetic disorders.

3. They will learn how to assess and correlate the tissue/organ-specific metabolic indicators with the physiological and clinical state of a patient. In particular, the role of

enzymes and isoenzymes as diagnostic markers in clinical tests will be understood.

4. An insight in to the mechanisms that hormones adopt to regulate metabolic pathways and their interplay in disorders such as obesity and diabetes will be gained.

5. With the help of diagnostic kits that are used in clinical laboratories, students will learn to do qualitative and quantitative analyses of specimen. Through the presentations made on the known case studies, students will learn how to apply the gained knowledge in diagnosis and prognosis of a disease and know the relevance of preventive measures taken in healthcare. Also, they will be introduced to quantitative analysis of biomolecules in clinical biochemistry.

Unit 1

L1-L11: Enzymes: Distribution and Diagnostic Significance

Basic Concepts and Scope of Medical Biochemistry,Properties of enzymes used in diagnosis.

Factors affecting levels of diagnostic enzymes in blood and the selection of a test.

Clinical significance of diagnostically important enzymes: creatine kinase, lactate dehydrogenase, alanine- and aspartate aminotransferases, with a detailed account of the biochemical reactions catalysed by these enzymes and of their clinical assays.

Kinetic assay and end point assay for the enzymes.

Isoenzymes: types of isoenzymes, allozymes, hybrid isoenzymes, isoforms, macrocomplexes, their tissue distribution, clinical and diagnostic significance.

Unit 2

Hormones (L12-L17)

Classification (with reference to their biochemical nature).

Mechanism of action - one example from each class of hormones, with special reference to epinephrine and thyroid hormones (T3 and T4) and their functions.