M.Sc. in Biophysics, Semester III

MBP301: Radiation Biophysics

Unit-I **[12L]**

Electromagnetic spectrum, properties of non-ionizing and ionizing radiation& their biological effects, radiation units, radioactive decay, ionisation power of radiations, binding energy of nucleus, concept of stable and unstable nuclei, different regions of ionising radiations in detectors, hazards of non-ionizing radiation and their control, medical application of radiation sources principles of detection and different methods of counting and counters, dosimetry of high-energy photons, electrons and ions, mapping of gamma detector output.

Unit-II **[12L]**

Biological effects of UV radiation, UV in treatment of skin disorders, Biological effects of LASER, application of LASER, application of microwave radiation and ultrasonic waves, chromosome aberration and gene mutation, molecular aspects of radiation damage and repair, somatic and genetic effects of radiation,

Unit-III **[12L]**

Application of ionizing radiation in industry, agriculture and research, internally administered isotopes, radio-iodine in thyroid function analysis, principles of isotope dilution analysis, circulation time, renal, liver and lung function analysis, principles of X-ray diagnosis, high kV radiography, special procedures such as topography, fluoroscopy, stereoscopy, image intensifiers and television monitoring,

Unit-IV **[12L]**

Biomedical imaging techniques and principles of analogue and digital imaging, Ultrasound imaging, nuclear magnetic resonance imaging, X-ray imaging and CT scan, Principle of tomographic techniques, computerised tomography, position emission tomography, application and interpretation of images

References

1. Roy R.R& Nigam B.P. Nuclear Physics, Theory and Experiment, Wiley.

2. Halliday D, Introductory Nuclear Physics, 2nd Edition, John Wiley.

3. Knoll G.F. Radiation detection and measurements, John Wiley.

4. Altman K.I. Gobes G.B. & Okada S. Radiation Biochemistry, Vol. I & II AP

5. Alper T. Cellular Radiology, Cambridge University Press.

6. Coggle J.E. Biological Effects of Radiation. 2nd edition, Taylor & Francis.

7. Orton C.G. Radiation Dosimetry: Physical and Biological Aspects, Plenum Press.

8. Dunn F and O'Brien, W.D. (eds) Ultrasonic Biophysics, Dowden-Hatchinson& Ross Inc.

9. Chadwick K.H. &Leenbouts H.P. Molecular Theory of Radiation Biology, Springer Verlag.

10. McAingh T.F. (eds) Physics in Medicine and biology, encyclopedia, Pergamon Press.

11. Atlik F.H. Introduction to Radiological Physics and Radiation Dosimetry, John Wiley

MBP302: Microbiology, Genetics and Immunology

Unit-I   **[12L]**

History of microbiology, Microbial world, origin and evolution of microorganisms, Differentiating characteristics of each group of microorganisms, Functional features of cells of microorganisms, Bacterial staining- Types and significance, Microbial growth, Media for growth, Phases of growth, Control of microbial growth.

Unit-II   **[12L]**

Normal microflora of human body. Determinants of infectious diseases: attachment, colonization, entry, growth and multiplication. Toxigenicity: exotoxin, endotoxins, fever, shock, inflammation. Host-parasite interactions: pathogenicity, virulence, transmission. Nonspecific defense mechanisms of host: general barriers, physical barriers, chemical barriers, biological barriers. Human pathogenic microorganisms.

Unit-III   **[12L]**

Mendelian principles-dominance, segregation, independent assortment, deviation from mendelian inheritance, codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance & expressivity phenocopy, linkage & crossing over, Sex determination. Chromosomal and molecular basis of sex determination, Gene dosage compensation, Gene expression, copy number variation, Mutation, Mutational load assessment, Introduction to human genetic disease, Mitochondrial genome and associated diseases, Monogenic and Polygenic diseases, Conventional and modern approach of diagnosis.

Unit-IV   **[12L]**

Cells and tissues of immune system, Primary and Secondary lymphoid organs, (Thymus, bone marrow, lymph nodes, Spleen), B and T lymphocyte and their functions. Innate and adaptive immunity, concepts of antigen, antigenicity, Immunogen and immunogenicity, structure and function of immunoglobulin, Clonal formation, Monoclonal antibodies, Major Histocompatibility Complex (MHC) molecules, Antigen presentation, Humoral and cell mediated immune response, Hypersensitivity reactions, Antigen-antibody interactions.

References

1. Fundamental Immunology, Editor William E. Paul, Publisher Lippincott Williams & Wilkins, 2012, ISBN 1451117833, 9781451117837.

2. Basic Immunology: Functions and Disorders of the Immune System, Authors: Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, PublisherElsevier Health Sciences, 2012, ISBN, 145575899X, 9781455758999.

3. Immunology: Understanding the Immune System, by Klaus D. Elgert, PublisherJohn Wiley & Sons, 2009, ISBN 0470081570, 9780470081570.

4. Microbiology: Principles and Explorations, by Jacquelyn G. Black, Publisher John Wiley & Sons, 2008, ISBN0470107480, 9780470107485.

5. Alcamo's Fundamentals of Microbiology: Body Systems, Glendale Community College Jeffrey C Pommerville, Jeffrey Pommerville, PublisherJones & Bartlett Publishers, 2012, ISBN1449605958, 9781449605957.

6. Human genetics, A.Gardner, R.T.Howell and T.Davies, Published by VinodVasishtha for Viva Books private limited, 2008.

7. Fundamentals of Genetics by S.S. Gahalain, Publisher Anmol Publications Pvt. Limited, 2004, ISBN8126120029, 9788126120024.

8. Genetics, Authors Daniel L. Hartl, Maryellen Ruvolo, PublisherJones & Bartlett Publishers, 2011, ISBN 1449626114, 9781449626112

MBP303: Membrane Biophysics

Unit-I **[12L]**

Composition of biological membrane, function of primary components, hydrophobic effect, lipid-water systems, phase transition in lipid mixtures, critical fluctuations, lipid protein interactions, membrane rafts, correlation of physical properties of cell membrane and cell proteins, elastic properties of the membrane, spontaneous curvature, membrane melting, charge induced microstructures & domains.

Unit-II **[12L]**

Membrane transport, diffusion, electro-diffusion, types of transportation, thermodynamic model, chemical potential, osmotic pressure, water permeability, cellular mechanisms of volume regulation, structure, selectivity & permeability of ion channels, Voltage-gated channels, ligand-gated channels, stretch-activated channels, Na^+, K^+ and Ca^{2+} channels, pumps as channels.

Unit-III **[12L]**

Donnan equilibrium, the resting membrane potential, Nernst equation, Goldman equation, Nernst-Plank equation, Hodgkin-Huxely equation, Hodking-Kartz experiment, Voltage clamp, transport by flux coupling, transport by phosphotransferase system, membrane impedance and capacitance, transmembrane potential, Zeta, Stern and total electrochemical potential, chemical synapse, post synaptic potential, action potential, properties of Action potential

Unit-IV **[12L]**

Conduction of the electrical activity, spread of electrical signals: passive vs. active, the action potential and its propagation through nerves, Saltatory conduction, propagation in a syncytium, membrane excitability, TRP channels as molecular sensors & integrators, channels and cell excitability, chloride channels and muscle excitability, synaptic integration

References

1. Membrane Biophysics, Authors: Mohammad Ashrafuzzaman, Jack A. Tuszynski, Springer Science & Business Media, 2012, ISBN3642161057, 9783642161056.
2. Structure and dynamics of membranous interfaces, Kaushik Nag, Wiley, 2008, ISBN-0470116315, 9780470116319.
3. Mechanics of the Cell by David Boal, PublisherCambridge University Press, 2012, ISBN-1139501771, 9781139501774.
4. Particles at Fluid Interfaces and Membranes: EditorsP. Kralchevsky, K. Nagayama, Elsevier, 2001, ISBN-0080538479, 9780080538471.
5. The Structure of Biological Membranes, Editor Philip L. Yeagle, CRC Press, 2004, ISBN-1420040200, 9781420040203.
6. Methods in Membrane Lipids, EditorAlex DoPico, Humana Press, 2007, ISBN 1588296628, 9781588296627.

MBP304: Systems Biology

Unit-I [12L]

MATLAB Desktop: Command Window, Help Browser, Editor / Debugger. Creating, Writing, and Saving a MATLAB File. Simple Mathematics: Variables, Operators, Built-in Functions, Mathematical Expressions. Vectors and Matrices: Generating vectors, generating matrices, Array Addressing or Indexing, Arithmetic Operations on Arrays.

Unit-II [12L]

M-File: Scripts, Functions. Basic Plotting; Relational Operators; Flow Control: If-Else-End Constructions, For Loops, While Loops; Logical Operators.

Linear equation, system of linear equation, solution of these equations MATLAB, ODEs, Euler's method, Runge-Kutta methods, solution of system of ODEs, their programs in MATLAB, direct function for solving ODEs in MATLAB.

Unit-III [12L]

Deterministic and stochastic description of cellular processes, mathematical modelling of chemical reaction networks, Enzyme Kinetics: Michaelis-Menten kinetics, Two-substrate reactions. Regulation of Enzyme Activity: Competitive inhibition, Allosteric regulation. Cooperativity; Compartmental. Solve above model using MATLAB code.

Unit-III [12L]

Phase Plane Analysis: Direction fields, Nullclines. Stability: Stable and unstable steady states, Linearized stability analysis. Stability criterion and Lyapnounov exponent; Limit Cycle Oscillations, Bifurcation Analysis, and Sensitivity Analysis: Local sensitivity analysis, determining local sensitivity coefficients. Parameter Fitting; Draw the above planes and calculations in MATLAB.

Recommended Books:

[1]   W. Liu, Introduction to modeling biological cellular control systems, Springer, Milan, 2012.

[2]   S.C. Chapra, Applied numerical methods with MATLAB for engineers and scientists, 3. ed, McGraw-Hill, New York, NY, 2012.

[3]   B.P. Ingalls, Mathematical modeling in systems biology: an introduction, MIT Press, Cambridge, Massachusetts, 2013.

[4]   M. Ullah, Stochastic approaches for systems biology, Springer, New York, 2011.

Reference Books:

[5]   S. Attaway, MATLAB: a practical introduction to programming and problem solving, Butterworth-Heinemann, Amsterdam ; Boston, 2009.

[6]   S.H. Strogatz, Nonlinear dynamics and Chaos: with applications to physics, biology, chemistry, and engineering, Addison-Wesley Pub, Reading, Mass, 1994.

[7]   C.F. Gerald, Wheatley, Patrick O, Applied numerical analysis, Pearson Educations Inc. : Dorling Kindersley, Boston, 2004.

[8]   C.P. Fall, Computational cell biology, Springer, New York, NY, 2005.