UNIVERSITY OF MUMBAI

SYLLABUS
For the
PET EXAMINATION
In
BIOPHYSICS
(with effect from March 2020 onwards)

Cover page

AC_____
Itam No _____

UNIVERSITY OF MUMBAI

Syllabus for the approval

Sr.No	Heading	Particulars
1	Title of the course	PET Biophysics
2	Eligibility for admission	
	M.Sc. Biophysics/ Medical Biophysics **OR** Qualified PET in Physics/ Chemistry / Biotechnology/ Zoology/ Botany/Biochemistry/ Microbiology / forensic Science / Bioinformatics / B.Tech (Biotechnology/ Bioinformatics) and allied branches of biological sciences. Candidate should qualify aptitude test to be conducted by the centre/ department of Biophysics, University of Mumbai, however other rules and regulations be applied as per VCD (No. Exam./Thesis/Univ/VCD/947 of 2018, June 15,2018)	
3	Passing Marks	50%
4	Ordinance / Regulations (if any)	VCD (No. Exam./Thesis/Univ/VCD/947 of 2018, June 15,2018)
5	No of years / semester	Not applicable
6	Level	Not applicable
7	Pattern	Not applicable
8	Status	New
9	To be implemented from the academic year	2019-20

Dongre PM
05-04-2020

Dr P M Dongre, Chairperson, BOS Biophysics

NEW SYLLABUS for PET BIOPHYSICS

(wef 2019-20)

PAPER I RESEARCH METHODOLOGY

Development of Research Proposal: Research: Definition, Characteristics, types, need of research, research proposal and its elements, formulation of research problem- criteria of sources and definition, Development of objectives and characteristics of objectives, Development of hypothesis and application, literature review, methods of data collections and analysis.

Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography.

Statistics Part I: Introduction, scope, application and use of statistics, collection and classification ff data, census and sampling, graphs and diagrams, arithmetic mean, median standard Deviation. 2.Correlation and regression for ungrouped data, scatter diagram, calculation and interpretation of correlation coefficient, linear regression coefficients and equation of the Lines of regression, nonlinear relationship transformable to liner form ($Y=Ab^x$, Ya^xb) 3. Probability, definition, addition and multiplicative laws (without proof). Random variable and its distribution, binominal probability distribution, examples and conditions means and variances, continuous variable, normal distribution, use of normal probability table for finding probabilities.

Statistics Part II:

1. Population parameter and sample statistics, sampling techniques, random sampling, stratified random sampling, systematic sampling standard error of mean.
2. Estimation, Point & interval, confidence interval for proportion.
3.Hypothesis attesting, Type I and Type II errors levels of significance, one-tailed and two tailed test, application to single proportion, equality of the population means and two population proportions.
4. Chi-square test for independent attributes in r x c table, special case of 2 x 2 tables.
5. Students test for significance of correlation coefficient y for p=0 (small sample test)

Statistics Part III:

1.Fishers z transformation coefficient for getting yp-0 in large samples test of significance for y (p=0)

2..Design of experiment: Principle and concepts of completely randomized design, randomized block design and Latin square design,

3.variance ratio F-test-Analysis of variance in one-way classification .

4.Non-parametric test: Distribution-free method, sign test for method pairs, Wilcoxon test for unpaired data Run test.

IPR& Copyrights: Historical prospective of IPR, Invention & creativity, invention v/s innovation, importance and need for protection of IPR, Patents, concept of patents, type of patents, benefit of patents, procedure of application, preparation of documents, process of patent examination of patent application, patent database and information system, recent development in patent, patents in science. Copyright in scientific work, scientific misconduct, falsification, code of ethics in research, types of plagiarism, trade marks

References:

1. Biostastistics:A foundation for analysis in the Health Sciences, 7th Ed.(1998) Wayne D, Wiley
2. DNA Microarrays, David Bowtell& J Sambrook (2002), CSHL Press
3. Principles of Statistics, 2nd Ed. M Pagano & K Gauvreau (2007), Thomson Publication
4. Law Relating to patents, Trade marks, copyright design and Geographical Indications (2000), Universal law Publishing by Wadehra BL
5. Intellectual Property A very short Introduction (2017) by Siva Vaidlyanathan , Oxford Press, USA
6. Fundamentals of Intellectual property Right for students, Industrialist & Lawyers (2017) by Anil Kumar HS & B Ramkrishna , Notion Press, Chennai
7. Research Methodology: Methods and Techniques (1990) by Kothari C R New Age International

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PPER II CORE SUBJECT : BIOPHYSICS

General physico-chemical principles: The electronic structure of atom, Ionic bond, Covalent bonds, Hydrogen bonds Van der Waals forces, Electric dipoles, Polarization and induced Dipoles, Casimir interactions. General understanding of Quantum mechanics, Pauli Exclusion Principle, Ionization energy, Electron affinity and Chemical bonding, Electronegativity and strong bond, Secondary bonds. Interatomic potentials for strong bonds, Interatomic potential for weak bonds, Non-central forces, Bond energies, Spring constants.

Thermodynamic equilibrium, laws of thermodynamics and living system, Entropy, Enthalpy and free energy, Internal energy, Carnot cycle, Chemical potential, Oxidation reduction potential. 0^{th}, I^{st}, 2^{nd}& 3^{rd} order reaction, Activation energy and Rate constant, Diffusion, Osmosis, Osmotic pressure, Osmoregulation, Surface tension, Dialysis, Adsorption, Viscosity, Thermal conduction, Sedimentation filtration of biological fluid, Hydropathy, Biological importance of hydropathies.

Precipitation, Biological significance of precipitation, Colloids & their types, Kinetic & electrical properties of colloids, Stability of colloids, Gibbs Donnan Equilibrium in living systems

Radioactivity: Energy of Radiation, Radioactive emission, α-ray, β-ray, ϒ-ray, and their properties, detection of nuclear radiation, Geiger-Muller counter, Proportional counter, Scintillation counter, Liquid Scintillation counter, Crystal counter, Radioactive decay, (α, β,decay), Half-life, Units of measurements of radioactivity, types of radioactivity, Isotopes, Isobar, Isotones and their characteristics. Radioactive equilibrium, Variety of isotopes, Radioactive isotopes, Nuclear reaction and production of artificial radioactivity, Autoradiography.

Cellular Biophysics: Origin and evolution of cell, shape and size of cell; General organization of prokaryotic and eukaryotic organisms basic concepts and their detailed structure and functions, Prokaryotic cell wall, Eukaryotic cell wall, their functions, ribosomes, physical and biological properties of protoplasm. Cytoskeleton – basic components, properties and functions in prokaryotic and eukaryotic cells. Cell differentiation, localization of cytoplasm determinants in eggs, localization of yolk and cytoplasm in different types of cells, Nucleocytoplasmic interaction and cell function, Extracellular matrix – its development, mechanism of alpha adrenergic and related response, modulation of extracellular matrix by tumor cells – Fibroblast interactions, growth factors in cultured cells – early cytoplasm, single and cytoskeleton response; Role of cytoskeleton in maintaining cell-shape, contraction, behavior, apoptosis and mortality, impact of xenobiotic on the components of cytoskeleton.

Kinetics of cell growth, role of protein kinase in cell growth, cell cycle, cell cycle events G_1, S, G_2, cytokines, control of cell cycle in dividing and non-dividing cells, synchronization of cell growth, cell transformation, malignant tumor growth, apoptosis. Intra and extracellular factors and signals affecting cell growth, cell division, cellular behavior during cytokinesis, chemotaxis and asymmetrical cell division.

Strategies of chemical signaling: endocrine, paracrine and synaptic. Signaling mediated by intracellular receptors: mechanism of transduction by cell surface receptor protein, role of calmodulin, Calcium and cyclic nucleotides, phosphoinositol cycle, sodium proton exchanger, molecular events involved during sperm-ovum (egg) interaction, implications and the mechanisms of sperm-zone interaction, role of soluble factors produced by follicle somatic cells on gamete interactions, factors influencing sperm –ovum (egg) recognition and binding, morphological intercellular connections in different types of cell and tissues.

Spectroscopy: Principle, instruments and application of spectroscopic instruments: UV Visible: absorption of light, radiation sources, sample holders, monochroamtors, radiation detectors, single and double beam instruments, colorimeter. IR spectroscopy: Rotational and vibration spectra, Instrumental features, applications. Raman effect, strokes and anti-strokes lines, advantages, applications. CD ORD principles and applications. Fluorescence: Fluorescence and

phosphorescence, bioluminescence and chemiluminiscence phenomenon, quenching, energy transfer, and applications. Atomic absorption spectroscopy: Principle and instrumentations.

Microscopy: Principle, instrumentation and application of microscopy, image formation, magnification, resolving power. optimum resolution, image defects, different types of Microscopy: Dark field ,Phase contrast, polarization microscopy, Interference microscopy, Fluorescence microscopy, Electron microscopy: Electron guns, Electron lens, electrostatic focussing, magnetic focussing, SEM, STEM, Atomic force microscopy.

Separation Techniques: Electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, PAGE, SDS-PAGE, Disc gel, gradient gel, electrophoresis of nucleic acid and its application, Pulse field electrophoresis, single cell gel electrophoresis, Isolectrophoresis, preparative electrophoresis, 2-D gel electrophoresis, Capillary, Iso-Electric focusing, applications in biology and medicine. Chromatography, TLC, adsorption, partition, ion exchange , gel filtration, affinity and FPLC, GLC. HPLC: mobile phase systems, modes of operations, application, Hydrodynamics method :fundamental principles' Centrifugation: principle, preparative centrifuge, analytical, ultracentrifuge, sedimentation and diffusion, Ultracentrifugation and their applications in molecular weight, size determination. Viscosity and its application, dialysis, solvent fractionation, isoelectric precipitation,

Membrane structure and Models: Membrane architecture, Lipid vesicles and planar bilayer membrane, membrane permeability, transmembrane helices, hydropath Plot, Membrane asymmetry, Membrane fluidity, Functional reconstitution of membranes. Models of membrane fusion: bilayer fusion, viral fusion, cellular fusion, SNAREs, cell-cell fusion, fusion in mitochondria, Lipid bilayer and early models, Fluids mosaic model, Evidence from model system and biomembranes. Membrane Channels, voltage gated channels, ligand gated channels, channel conductance.

Physics of membrane: Membrane deformations: bending, sharing shape fluctuation etc, Differential geometry of membranes, Elastic properties, Elastic constants, Charge-induced microstructures and domain. Hysteresis of domains formation, Lateral phase separation, Critical concentrations fluctuation, selective lipid protein interactions, Membrane melting

Membrane transport: Transport system with non-electrolytes and electrolytes. Transport with chemical reaction system: Primary and secondary active transport. Transports of molecules by simple and facilitated diffusion, Transport by flux coupling. Transport by phosphotransferase system, Transport by vesicle formation, Ionophores, epithelial transport.

Electron Transport & oxidative phosporylation: Reduction potential and free energy changes in redox reaction, organization of electron treansport chain, chemiosmotic coupling, proton gradient drive and synthesis of ATP, P/O ratio for oxidative phosporylation, Cytosolic NADH electron

feeding into electron transfer.

Electrical properties of membranes & Lipid Membrane Technology : Cell surface charge, Resting membrane potential, Action potential, properties of action potential, Nernst equation, Goldman equation, Nernst-Plank equation, Hodgkin-Huxely equation, Hodking-Kartz experiment, Voltage clamp, Na+, K+ conductance, Membrane impedance and capacitance, Transmembrane potential, Zeta, stern and total electrochemical potential, Chemical synapse, post synaptic potential. Historical perspective of lipid model systems lipid monolayer. Liposomes: small and large unilamellar and multilamellar vesicles, planner lipid bilayer, Application of liposomes in biology and medicine.

Principles of proteins structure and conformations: Basics aspects of protein structure, Polypeptide chain geometrics, estimates of potential energy, results of potential energy calculations, hydrogen bonding, hydrophobic & hydrophilic interactions and water as universal solvent in biological systems, Disruption of hydrophobic interactions by urea, ionic interactions, hydrophobic versus ionic interactions, Disulfide bond, Ways of pairing N-half cystine, formation of specific disulfide link, prediction of protein structure .

Protein structure & Stability: Principles of ionization equilibrium ionization of side chain, equilibria in proteins. Predicting properties from amino acid composition, Usual amino acids. Primary structure sequencing of polypeptide, hemoglobin, homologies in proteins, Secondary structure alpha and beta conformation, collagen structure, stability of alpha helix, Ramchandran plot, Tertiary structure, structure of myoglobin and hemoglobin, Quaternary structure, symmetry consideration, Analysis of subunits and chain arrangement of subunits, stability of globular quaternary structure. Protein folding rules, pathways and kinetics

Enzyme structure & mechanisms: Enzymes, classification & structure, active site and its identification, mechanisms of enzyme action with special reference to chymotrypsin, carboxypeptidase and lysozyme, Enzyme kinetics, Michaelis-Menten equation, Inhibitors, kinetics of competitive, non competitive and uncompetitive inhibitors, Allosteric cooperative behaviour, ligand protein interaction, Hill equation, Mettaloenzymes. Determination V_{max}, K_m, various graphical plots.

Glycobiology& Lipids: Carbohydrates, classification and types, stereochemistry, mutarotation, glycoprotein and proteoglycan, Biosynthesis of glycoprotein, structure and roles of polysaccharides, lipids: types of lipids, classification and biological significance **Hormones action:** cAMP/cGMP, G protein and G protein family receptor, G protein cascades, c-AMP and protein kinase, protein phosporylation, Inositol triphosphate and DAG signals .

DNA structure : Nucleic acid composition, DNA, RNA base compositions, Chargaff's rule, primary and secondary structure of nucleic acids, sequence information, DNA motifs, DNA

repeats and their significance. A, B & Z DNA structure, major & minor groves in DNA, Protein DNA interactions, supercoiling of DNA, Topoisomerase I and relaxed DNA, DNA gyrase, eukaryotic gene. Replication in vivo, semi-conservative mechanism of replication.Direction of replication.Discovery of DNA polymerase I and its function.DNA synthesis in vitro, other DNA polymerases, role of various proteins/enzymes in DNA synthesis. Model of DNA synthesis, molecular basis of mutations, DNA repair mechanisms, reverse transcription.

DNA Synthesis & Translation: RNA polymerase and its action, promoter sites of DNA template, sigma factor, elongation and termination of RNA chain, processing of precursors-RNA,sn-RNA and tRNA, mRNA. RNA polymerase I and transcription of mRNA in eukaryotic cells. Transcription factors in eukaryotes. Ribozyme and self splicing, genetic code-discovery and silent features. Recent advances, amino acid activation, fidelity of aminoacyl, tRNA synthesis, tyrosyl AMP complex, tRNA structure and function. Ribosomal RNA structure, Architecture of Electron Microscopy and neutron diffraction. Initiation of protein synthesis, translocation and peptide bond formation, termination and stop codon, protein synthesis in eukaryotes

Regulation of Gene expression in prokaryotes & Eukaryotes: Operator-operon concept, Negative and positive control of transcription with example of lac operon and Arbinose operon. Control of transcription, control of regulatory protein, transcription termination, repressor, croprotein. Eukaryotic RNA, role of histone, nuclosome, bidirectional replication, repetitive DNA, transcription; factor IIIA

Recombinant DNA Technology: Preparation, DNA analysis & Enzymatic Manipulation of DNA & RNAGenomic DNA from mammalian tissue plant tissue and bacteria resolution recovery of large and small fragments of DNA using various Electromagnetic techniques, chemical synthesis of oligonuleotides, genes and their uses analysis of DNA sequences by blotting and hybridization.Restriction endonuclease and mapping enzymes for modification and radioactive labeling of nucleic acids, construction of hybrid DNA molecules. Polymerase chain reaction (PCR). Preparation and analysis of RNA

DNA transformation in Mammalian cell and System for study of cloned Genes: Transformation of DNA using calcium Phosphate, DEAE, Dextrin and Elecroporation and its optimization and uses. Bacterial Yeast expression vectors gene transfer Into cultured cells. Development and use of transgenic animals. Manipulation and geneexpression in prokaryotes, Heterogenous protein production in eukaryotic cells.

Micro sequencing Methods for proteins & Engineering proteins for purification: Modern advancement such as Tar Sequencing Strategies. DABITC/ PITC methods. Solid phase microsequencing; Fast atom Bombardment (FAB) mass spectra in protein sequencing. Choice of purification tag, Enzyme purification Tags. Affinity purification tag, ion exchange, hydrophane IC, covalent and chelate. Purification tags; PEG enzyme and PEG enzyme conjugates.

Chemical Approach to protein Engineering&protein engineering for thermo stability: Functional group modification chimeric Protein, protein engineering of Ab, Directed Mutagenesis and Protein Engineering. Directed Mutagenesis procedure adding disulfide bonds, reducing number of free sulphydryl residues, increasing /modifying Enzyme activity/specificity. Chimeric antibody, replacement of FC domains, Catalytic Antibodies (enzymes), Idiotype vaccines. Hybridoma technology. stability estimates from denaturation curve, Engineering physical and biology properties of protein by chemical modifications.

Biophysics of Nerve & Muscle: Structure of nerve, classification of nerves, myelinated and non-myelinated nerve, generation of nerve impulse, propagation of nerve impulse, synapse, synaptic transmission, Inhibitory post synaptic potential (IPSP), excitatory post synaptic potential (EPSP), glial cell, blood brain barrier, Brain Waves (EEG) : origin of alpha, beta, delta & theta, sleep and wakefulness. Regulation of body temperature by physical, chemical & neural mechanisms, acclimatization,Molecular structure of skeletal, cardiac and smooth muscle, motor unit, molecular basis of muscle contractions (isometric, isotonic & lengthening), work done by muscle, excitation contraction coupling, properties of muscle, neuromuscular transmission, Electromyography.

Biophysics of Circulatory & Excretory system: Initiation and conduction of cardiac impulse, Electrocardiogram (ECG) and its characteristics, Hemodynamic principles, Physics of Blood viscosity, specific gravity, physics of plasma and serum. Different blood vesicles present in the vascular system, arterial blood Pressure, measurement, effect of hydrostatic pressure on arterial and venous blood pressure, blood volume, blood flows (laminar & turbulent), Reynolds number. Peripheral resistance and its role in vascularity. Cardiac output, factors affecting on cardiac output (Exercise, Haemorrhage& blood pressure), myocardial infarction. Structure of nephron, glomerulus, tubules. Tubular functions: Reabsorption & Excretion. Osmotic equilibrium: maintenance of osmotic pressure, regulation of body fluid osmolarity. Glomerular filtration rate and factors affecting it, oedema. Function of kidney (autoregulation, acid base balance). Renal blood flow.

Biophysics of respiration: Introduction to respiratory system, structure of lungs, diffusion, exchange and transport of gases, physics of pulmonary circulation, perfusion and ventilation. Control of respiration (neuronal & chemical), lung capacities and volumes, lung function tests. Effect of altitude changes on body, high altitude- mountain sickness, low altitude- deep sea driving, adaptive changes, effect of changes in gravitational forces on body (space, aviation), adaptive changes.

Biophysics of special senses: Structure of the eye, Optics of Vision: refraction, refractive errors, visual acuity, monocular & binocular vision, size of image, role of ocular lens, cataract

formation, retinal pigments, rods and cones, Photochemistry of vision, visual cycle. Neurophysiology of vision, colour vision, visual pathway, blindness. Structure of ear, physics of audition (amplitude, frequency, pitch), unit of measurement of sound, intensity, conduction of sound through bone ossicles, impedance matching. Role of inner ear (cochlear mechanism), mechanisms of hearing, detection of localization of sound (direction), loudness of sound (amplitude), discrimination of pitch of sound, Audiometry, deafness, hearing aids. Taste & Smells: taste receptors & their role, conduction, pathway of smell. Balance & Rotation: Biophysics of posture movement, organisation of vestibular apparatus, mechanical sensors, fluid dynamics of semicircular canals, role of utricle, saccule & otolith organs, importance of vestibular function.

NMR Spectroscopy: Modern techniques for structure elucidation FT and FFT Nuclear over Hauser effect. Basic 2D Spectroscopy benefits of 2D experiments (COSY NOESY). Assignment problem in biopolymers, Ligand binding to macromolecules, Chemical exchange, ^{1}HNNR spectroscopy, monitoring of cellular pH, gradient in tumour cells etc. Fluidity gradient in lipids, chemical shift, anisotropy of P resonance in membranes.

ESR Spectroscopy: Spin labeling: a reporter group technique requirement of such a group, Nitro-oxide spin label probes and their molecular structures, anisotropy of the order parameters, dynamics information obtained from ESR, molecular polarity from biochemical data, orientation Intra-molecular distances. Applications of these concepts of to study the structure and function of enzyme i.e. lysozyme etc. conformational change in trypsin, spin labeled ligands as probe for binding sites, lipid spin label in the biological membranes.

X-ray diffraction of the macromolecules: Brags law, Parameters governing crystallization of protein and nucleic acids; Analysis of diffraction data, evaluation of unit cell dimension and space group, phase determinations; Calculation and interpretation of electron density map crystal structure; Analysis of structures of proteins, nucleic acids, DNA-RNA and triple helical complexes.

Fiber Structure Determination: Diffraction by poly crystalline system; Diffraction by a helical chain and a discontinuous helix; X-ray scattering of helix; Analysis of the structure of fibrous proteins; Effect of intermolecular packing; X-ray scattering from nucleic acid fibers

Interaction of Radiation with Matter: Ionization and Excitation of matter by charged particles, Specific ionization, Linear Energy Transfer (LET), Bragg's law, Range Energy Relations, Bremsstrahlung, Interaction, of Gamma rays with Matter, Photoelectric effect, Compton effect, pair production, Attenuation and Absorption Coefficients, Radiation Units-Unit of Exposure, KERMA, Absorbed Dose and Derived Units- Equivalent Dose and Effective Dose.

Interaction of radiation with living cells *:* Kinetics of induction of damage in irradiated cells-physical stage, physicochemical stage, chemical stage, biochemical stage, induction of cellular

level damage. Mechanism of direct and indirect action of radiation, radiolytic products of water, radical reactions in the biological system. Critical target in the living cells evidences for DNA to be the primary target, Nature of the DNA damage Induced by Radiation. Relationship between DNA content and radiosensitivity. Cell lethality, mitotic death, interphase death and apoptosis, Models of Cell survival, Target Theory, its modifications multi target- single hit and single target- multi hit hypothesis, target size calculation, survival curve parameters-Dq, D_0, n ,slope etc and limitations of target theory, Linear Quadratic Model of cell survival and the mechanistic support to LQ model , α/β values for normal and tumour cells.

Factors modifying cellular radiation response: Physical factors modifying cell survival: dose, dose Rate, dose fractionation, LET, hyperthermia. Biological factors: Cell cycle stage, repair and recovery, Elkind and Sutton type (SLD repair), Repair of potentially lethal damage (PLDR). Mammalian cell sensitivity protocol, Law of Bergonie and Tribondeau, classification of cells into different sensitivity groups. Chemical modifiers: Oxygen, Chemical radioprotectors, sensitizers, repair inhibitors, Radiation induced Division delay, biochemical and biophysical changes. Induction of Mutations and Chromosomal Aberrations (CA), factors modifying chromosomal damage, Application of CA analysis in biodosimetry of absorbed radiation

Biological Effects of Radiation : Historical Data Base, Somatic and Genetic Effects,Immediate and Late Effects. Stochastic and Deterministic Effects. Damage to Individual Organs. Skin, Eye Lens, Reproductive System, Lungs, Endocrine Glands, Threshold Doses, Radiation Sickness, Radiation Syndromes: Haemopoietic Syndrome G.I. Syndrome, CNS Syndrome LD50 (60) Dose, Late Damage in Skin, Lung and Other Organs. Prenatal Radiation Effects, Radiation Carcinogenesis, Human Data, Risk Evaluation by A-Bomb Survivor Data, Genetic Risk Evaluation, Radiobiological Basis for Radiation Protection Standards, Maximum Permissible Limits For Radiation Exposure

Biophysical Aspects of Radiotherapy: Tumour Biology, Growth Kinetic Factors, Cell Cycle, Potentially Doubling Time, Volume Doubling Time, Cell Loss Factor, Studies with Transplanted Tumour System, Basis of Fractionated Radiotherapy, Brachytherapy, 4 R's of Fractionated Radiotherapy, Causes of Clinical Radio resistance and Approaches to Overcome Radio resistance. New Modalities of Radiotherapy, Light Ion Particles, Neutrons, Boron Capture Therapy, Radiolabelled Immunotherapy, Recent Developments, Bio- Effect Models for Radiotherapy, Strandquist's Cube Root Rule, NSD, TDF, BED, Application of LQ Model in Developing Bio-effect Models for Radiotherapy

Physics of Radiotherapy, Nuclear Medicine and Diagnostic Radiology: Physical Principles

of X-Ray Diagnosis - Interactions of X-Rays with Human Body, Differential Transmission of X-Ray Beam, Spatial Image Formation, Visualization of Spatial Image, Image Quality - Density, Contrast, Detail and Definition of Radiographs, Choice of kV, mA, Filtration, FSD, Screens, Films, Grids, Contrast Media. CT Scanners and Their Applications, Overview of Digital Subtraction Radiography and Mammography.

Scope of Radiotherapy - Beam Therapy and Brachytherapy, Construction and Working Principles of Radiotherapy Delivery Devices - Telecobalt Unit, Medical Electron Linear Accelerator, Remote after Loading Brachytherapy Units, Output and Source Strength Measurements, Central Axis Dosimetry Parameters, Overview of Modern Radiotherapy Techniques, Need and Necessity of Quality Assurance Programme in Radiotherapy.

Nuclear Medicine*:*Unsealed Sources, Production of Radionuclides Used in Nuclear Medicine - Reactor and Accelerator Based Radionuclides, Radionuclide Generators and Their Operation Principles, assessment of radiochemical purity of Radiopharmaceuticals, particle sizing, stability & pyrogenic testing, Principle of localization and usages of radiopharmaceuticals, General Concepts of Radionuclide Imaging. Principle of dynamics studies in radiation medicine imaging of various body organs. Physics of positron emission tomography and cyclotron, operational characteristics of scanner, magnetic resonance imaging. Absorption Studies using labelled Compounds, Quality Control in Radiation Medicine.

Basic Radiation Protection : Basic Principles of Radiation Protection, Justification, Optimization and Dose Limitation. Practical Aspects of Implementation of Radiation Protection in Medical Applications, Regulatory Aspects of Radiation Protection. Medical radioprotection in children, dithermy, short wave and micro wave dithermy. Thermal response of tissues, use of diathermy therapy. Effect of heat and cold on body tissues. Applications in therapy and contradiction for use.

Environmental Biophysics: microenvironment, energy exchange, mass and momentum transport, conservation of energy and mass, continuity in the biosphere. Water potential in organism and their surrounding, general understanding of conductance of heat, mass and transport; molecular diffusion, diffusive conductance of integument, conductance of heat, mass and transport in laminar force convection. Atmospheric temperature and its behaviour, temperature variation, modelling of vertical and temporal variation in air temp, thermal time, temperature and biological development. Animal shapes and heat conductance, radiation fluxes in natural environment, direct and diffuse short wave, irradiance, solar radiation, absorptive for thermal and solar radiation. **Animal, Plants and their environment:** energy concept, metabolism, conduction of heat in animal coats and tissues, quantitative analysis of animal

thermal response, operative temperature, complexicities of animal energetic, animal and water; human and their environment: metabolism, evaporation, survival I cold heat, Leaf temperature, aerodynamics temperature of plant canopies, transpiration, canopy transpiration, assimilation models, biochemical model, stomotal conduction, leaf area index and light transmission, light transmission through stomatal conductance, transmission of diffuse radiation, light scattering in canapoies, reflection of light in plants, light scattering in canopies, reflection of light by plant.**Electromagnetic radiation & gravity in living system :** Introduction to gravity, space flight and human health , evolution and gravity, gravity and plant, impact of gravity on aquatic species, microbes and invertebrates, gravity and biodiversity, fundamental and applied aspects of extremely low frequency, radio and microwave fields, bioacoustics, biomedical aspects of laser. Magnetic environments and geomagnetic fields, behavioural changes, magnetic field and ecosystem, magnetic field and human health.

Reference: References of MSc (Biophysics) CBCS by papers , University of Mumbai (Ref. **AC/4.33/24/06/2016 & UG/7/2016-17**)
