UNIVERSITY OF MUMBAI
No. UG/307of 2017-18

CIRCULAR:-

Attention of the Head, University Department of Bio-Physics and the Principals of the affiliated Colleges in Science and the recognized Science Institutions is invited to this office Circular No. UG/71 of 2016-17 dated 21st September, 2016 relating to syllabus of the Master of Science (M.Sc.) degree course. They are hereby informed that the recommendations made by Board of Studies in Biophysics, under the Faculty of Science and Technology at its meeting held on 13th June, 2017, have been accepted by the Academic Council at its meeting held on 30th July, 2017 **vide** item No.4.6 and that in accordance therewith, the revised syllabus as per the (CBCS) of M.Sc. in Biophysics (Sem -III & IV), has been brought into force with effect from the academic year 2017-18, accordingly. (The same is available on the University's website : www.mu.ac.in)

MUMBAI – 400 032
8th December, 2017
To

(Dr. Dinesh Kamble)
I/c REGISTRAR

The Head University Department of Bio-Physics and the Principals of the affiliated Colleges in Science and the recognized Science Institutions.

A.C/4.6/30/07/2017

****

No. UG/307-A of 2017 MUMBAI-400 032 8th December, 2017

Copy forwarded with Compliments for information to:-

1) The Co-ordinator, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Biophysics,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

AC - 30/07/2017
Item No -4.6

UNIVERSITY OF MUMBAI

Program: M.Sc.
Course : Biophysics
Syllabus for the Semester III & IV

(Choice Based Credit Semester effect from the academic year 2017–2018)

Revised syllabus of M.Sc. Biophysics Part II
Semester III & IV
(Choice Based Credit system)

Semester III

Paper code	Paper nomenclature	Lectures	Credit	Practical Paper No & Code	Hrs	Credit	Total Credit
PB-CCT 301	Physiological Biophysics	60	04	Lab course I (BP-LBC 301)	60	02	06
BP-CCT 302	Bio crystallography & Magnetic Resonance Techniques	60	04	Lab course II (BP-LBC 302)	60	02	06
BP-CCT 303	Radiation Biophysics	60	04	Lab Course III (BP-LBC 303)	60	02	06
PB-CCT 304	Advanced in Biophysical Techniques	60	04	Lab Course IV Research Project /Review literature	60	02	06
	Total						24
	Semester IV						
BP-CCT 401	Medical Biophysics	60	04	Lab Course I (BP-LBC 401)	60	02	06
BP-CCT 402	Environmental Biophysics	60	04	Lab Course II BP-LBC 402			
BP-CCT 403	Nanobiophysics and nanomedicine	60	04	Lab Course III (BP-LBC 403)	-	-	04
BP-CCT 404	Elements of Bioinformatics, molecular modelling and drug design	60	04	Lab Course IV (BP-LBC 404) Research Project	60	02	06
					120	04	04
	Total						24
	Grand Total (Sem III & IV)						48

Total credits for M.Sc. Part II =(Sem III- 24 and sem IV-24) =48

Evaluation: The students will be evaluated internally and externally. The internal evaluation is done by teachers and external evaluation done by the committee appointed by the University norms. Standard passing and scale as per the university norms.

M.Sc. BioPhysics Syllabus

Semester III & IV

Choice Based Credit System

To be implemented from the Academic year 2017-2018

SEM: III

Theory Papers

SEMESTER III

Paper I : Physiological Biophysics

Course Code	UNIT	TOPIC Heading	Lectures	Credits
BP-CCT 301	I	Biophysics of Nerve & Muscle:	15	04
	II	Biophysics of Circulatory & Excretory system:	15	
	III	Biophysics of respiration	15	
	IV	Biophysics of special senses	15	
		Total	60	

Paper II: Bio Crystallography & Magnetic Resonance Techniques

Course Code	UNIT	TOPIC Heading	Lectures	Credits
BP-CCT 302	I	NMR Spectroscopy	15	04
	II	ESR Spectroscopy	15	
	III	X-ray diffraction of the macromolecules: Concept of crystallization	15	
	IV	Fibre Structure Determination	15	
		Total	60	

Paper III: Radiation Biophysics

Course Code	UNIT	TOPIC Heading	Lectures	Credits
BP-CCT 303	I	Interaction of Radiation with Matter	15	04
	II	Interaction of radiation with living cells I	15	
	III	Interaction of radiation with living cells II	15	

	IV	Biological Effects of Radiation:	15	
		Total	**60**	

Paper IV: Advanced Biophysical Techniques

Course Code	UNIT	TOPIC Heading	Lectures	Credits
BP-CCT 304	I	Thermal Techniques (ITC&DSC) & Mass Spectrometry	**15**	04
	II	Force Spectroscopy	**15**	
	III	Advanced Microscopy I	**15**	
	IV	Advanced Microscopy II	**15**	
		Total	**60**	

Practical Papers

Course code	Title	Credits
PB-LBC 301	Lab Course I	02
BP-LBC 302	Lab Course II	02
BP-LBC 303	Lab Course III	02
BP-LBC 304	Research Project / Review literature	02

Syllabus details

SEMESTER III

Paper I: Course code: BP-CCT 301: Title: Physiological Biophysics

Course Code	Title	Credits: 04
BP-CCT 301	Physiological Biophysics	Lectures: 60

Unit I: *Biophysics of Nerve & Muscle*: **15 lectures**

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.

Unit II: *Biophysics of Circulatory & Excretory system*: **15 lectures**

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.

Unit III: *Biophysics of respiration*: **15 lectures**

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 (sp.- e. aviation), adaptive changes

Unit IV: *Biophysics of special senses*: **15 lectures**

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.

Paper II : Course Code : **BP-CCT 302: Bio crystallography & Magnetic resonance techniques**

Course code	Title	Credit:04
BP-CCT 302	**Bio crystallography & Magnetic resonance techniques**	Lectures: 60

Unit I: NMR Spectroscopy: **15 lectures**

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.

Unit II : ESR Spectroscopy: **15 lectures**

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

Unit III: X-ray diffraction of the macromolecules: 15 Lecture

Prag' 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.

Unit IV: Fiber Structure Determination & IR Spectroscopy: 15 lectures

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

Infrared reflectance absorption spectroscopy, Instrumentation, absorption studies of peptide, structure

confirmation, Two dimension infrared correlation spectroscopy, principle, technique, 2-D IR studies of protein, protein unfolding study, protein aggregation, denaturation etc.

Paper III: Course Code: BP-CCT 303: Title: Radiation Biophysics

Course code	Title	Credit:04
BP-CCT 303	**Radiation Biophysics**	Lectures: 60

Unit I: Interaction of Radiation with Matter 15 lectures.

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.

Unit II: Interaction of radiation with living cells I: 15 lectures

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.

Unit 3: Interaction of radiation with living cells II: 15 Lecture .

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

Unit IV: Biological Effects of Radiation : 15 lectures.

Introduction, 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

Paper IV: BP-CCT 304 : Advanced Biophysical Techniques

Course code	Title	Credit:04
BP-CCT 304	**Advanced Biophysical Techniques**	**Lectures: 60**

Unit I Thermal techniques (ITC & DSC) and Mass Spectrometry: 15 Lecture

Isothermal Calorimetry (ITC): Thermodynamic Background to Isothermal Titration Calorimetry, Basic principles, Isothermal Titration Calorimetry of Biomolecules, study of Protein-drug interaction, study of DNA-Drug Interactions, Dehydration and Salt Effects in Protein-DNA interactions. Microcalorimetry of Protein-Protein Interactions.

Differential Scanning Calorimetry (DSC): Principle, equilibrium, thermodynamics analysis, the colorimeter criteria for two state behaviour, characterization of ligand binding , unfolded states of protein.

Mass Spectrometry: Basic principle, methodology, methods for structural characterization and molecular mass, chemical cross linking analysis of biomolecules (selective chemical labelling, non specific chemical labelling), Dynamic and kinetic study of biomolecules, protein-protein interaction, study of membrane protein, protein aggregation, study of macromolecular assembly (proteosomes, ribosomes, molecular chaperon etc). Definitions of Genomics, Transcriptomics, Proteomics. Methodologies involved eg, 2D Gel Electrophoresis, PCR, Microarrays. Application of Mass Spectrometry in proteomics, Protein identification, Drug design and development.

Immunological Techniques: Antigen-Antibody interaction, Principle and application of Immunological techniques in Biology and medicine. ELISA, RIA, Rocket Electrophoresis, Immunoelectron Microscopy.

Unit II: Force spectroscopy: **15 lecture**

Atomic force microscopy: principle, technique, single molecule manipulation, protein mechanics, relevant forces in biology, mechanical proteins, mechanical unfolding proteins, AFM for probing single membrane protein, structure –function characterization of protein, Understanding high speed AFM for protein - protein interaction. Single molecule force spectroscopy (SMFS): Principle and methodology, SMFS for protein study, Technical limitation of SMFS.

Optical traps and Magnetic tweezers: Overview of optical traps, methodology, application to study of single molecule (structural and mechanical properties), overview of magnetic tweezers, experimental design, determination of applied force, nucleic acid under force & torque.
Unit III: Advanced Microscopy I **15 lectures** Principle and methodology & applications of electron microscopy, structure determination of macromolecular complexes by cryo-electron microscope, analysis of 2D crystal by electron microscopy. Cryo electron microscopy & tomography of virus particles. Raman Microscopy, CARS microscopy, DIC, Patch Clamp technique, Rapid flow-fast flow in enzyme catalysis.
Unit IV: Advanced Microscopy II **15 lecture** **Fluorescence Microscopy**: principle, single particle tracking, tracking the movement of molecular motor, tracking flurophores inside living cells, rotational movement, single molecule imaging in living cells, understanding FRET, single molecule FRET, quantitative single molecule FRET to bimolecular system, basics of Fluorescence Correlation spectroscopy, FCP in living cells, Fluorescence speckle microscopy, Image correlation spectroscopy, Principle and Methods of ultrafast structural dynamics of biological systems

SEMESTER III Practical

Course Code	Lab courses	Credits
BP-LBC 301	**Lab Course I** 1. The study of biological samples/cells using fluorescence /DIC microscopy 2. Protein-protein interactions using spectroscopy (fluorescence/UV visible) techniques. 3. Study of ligand binding interaction using Surface Plasmon Resonance Analyzer (SPR) (Demonstration). 4. Damage to plasmid pBR 322 DNA/ Onion DNA by physically/ chemically and its observation under UV transilluminator 5. Study of DNA damage using comet assays 6. Determination of partition coefficient of amino acids and hydrophobicity/ association studies. 7. Protein folding using denaturation by urea and refolding/renaturation of RNAase. 8. Structural study of protein using Circular Dichroism /FTIR (Demo) 9. Protein folding using denaturation by urea and refolding/renaturation of RNAase.	2

	10. Preparation and staining of microtome sections of mammalian tissues (Demo)	
BP-LBC 302	**Lab Course II** 1. Study of surface potentials (EEG/ERG/ EMG/ EOG/ECG etc) of human subjects 2. Study of pulmonary functions. 3. To study the velocity of nerve impulse 4. Study of evoked potentials in human and animal subjects 5. Study of cardiopulmonary test/ Heart Rate recovery 6. Measurement of BP and Pulse in human subjects 7. Study of reaction time in human subjects 8. Study of Ergography 9. Study of hearing response to different frequency in human subject. 10. A study of field of vision of human subject (Perimeter) 11. PCV, MCV, ESR, 12. Study of surface tension of biological fluid and its relevance to physiology	2
BP-LBC 303	**Lab Course III** 1. To study the characteristics of GM tube and determination of its operating voltage. 2. To verify inverse square law of gamma/ alpha/beta/UV rays 3. To study the nuclear counting statistics 4. To determine linear and mass attenuation co-efficient using gamma source for aluminium, lead and copper. 5. Estimation of efficacy of the GM detector for gamma and beta source 6. To study Beta particle range and maximum energy 7. To measure short half life of radiation source 8. To measurement of UV radiation dose by chemical and physical methods 9. To determine gamma radiation dose using Fricke Dosimeter. 10. Effect of UV/gamma radiation on bacterial /mammalian cell survival.	2
BP-LBC 304	**Lab course IV: Research Project /Literature Review**	2

SEMESTER IV

Theory Papers

SEMESTER IV

Paper I : Medical Biophysics

Course Code	UNIT	TOPIC HEADINGS	Lectures	Credits
PB-CCT 401	I	Biophysical Aspects of Radiotherapy	15	04
	II	Physics of Radiotherapy, Nuclear Medicine and Diagnostic Radiology	15	
	III	Introduction to Nuclear Medicine	15	
	IV	Basic Radiation Protection	15	
		Total	60	04

Paper II: Nanobiophysics & Nanomedicine

Course Code	UNIT	TOPIC HEADINGS	Lectures	Credits
PB-CCT 402	I	Introduction	15	04
	II	Biosynthesis and Characterization of nanomaterials	15	
	III	Nanotoxicology	15	
	IV	Applications of nanomaterials in biology & Medicine	15	
		Total	60	04

Paper III: Environmental Biophysics

Course Code	UNIT	TOPIC HEADINGS	Lectures	Credits
BP-CCT 403	I	Introduction	15	04
	II	Conductance of heat and mass transfer	15	
	III	Animal plants and their environment	15	
	IV	Electromagnetic radiation and gravity in living system	15	
		Total	60	04

Paper IV: Elements of Bioinformatics, Molecular Modelling & Drug design

Course Code	UNIT	TOPIC HEADINGS	Lectures	Credits
BP-CCT 404	I	Introduction	15	04
	II	Phylogenetics and structural bioinformatics	15	
	III	Molecular mechanics and conformational analysis	15	
	IV	De novo ligand design and 3D –QSAR	15	
		Total	60	04

Practical Papers

Course code	Paper title	Credits
BP-LAB-101	Lab Course I	02

BP-LBC 402	Lab Course II	02
BP-LBC 403	Lab Course III	02
BP-LBC 404	Research Project	02

Syllabus details

SEMESTER IV

Paper I: MEDICAL BIOPHYSICS : PB-CCT 401

Course code	Title	Credit:04
BP-CCT 401	MEDICAL BIOPHYSICS	Lectures: 60

Unit I: Biophysical Aspects of Radiotherapy: **15 lectures**

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

Unit II: Physics of Radiotherapy, Nuclear Medicine and Diagnostic Radiology: **15lectures**

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.

Unit III: ***Introduction to Nuclear Medicine:*** **15 lectures**

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.

Unit IV: Basic Radiation Protection : **15 lecture**

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.

Course code	Title	Credits: 04
BP-CCT 402	**Nanobiophysics and Nanomedicine**	Total Lectures:60

Unit I: ***Introduction***: **15 lectures.**

Origins of nanotechnology, nanoscience, the unit nanometer, Types of nanomaterials: Silver, gold, zinc oxide, quantum dots, dendrimers, nanotubes, nanocrystals, Gadonium based nanoaprticles, semiconductor based Nanobiomaterials, silica based, nanocomosite, etc. Biological nanobiomaterials like lipoprotein based, peptide NPs, Biologically direct and self assembled Physico-chemical properties of nanomaterials, Nanomotors in biological system: ATP synthase, flagellar motor in bacteria, etc.

Unit II: ***Biosynthesis and characterization of Nanomaterials***: **15 lectures**

Concept of bottom- up approach, Top-down approach. Principles of gas, liquid & phase synthesis of nanoparticles. Physical, chemical and biological methods of synthesis of nanoparticles. Synthesis of various nanomaterials from bacteria, fungi, plants, algae, DNA & protein templates etc. Characterization techniques for nanomaterials using spectroscopic and microscopic techniques (UV visible, light scattering, fluorescence, Force microscopy, Scanning electron microscopy, High resolution Transmission Electron Microscopy, Ellipsometry, surface tensiometry etc)

Unit III: ***Nanotoxicolgy*** **15 Lectures**

Introduction a general view, physicochemical properties of NPs influencing their toxic effects on biological system, cell, tissue and organs, mechanism related to nanotoxicity. Interaction of nanoparticles with biological system like cell, cell membranes, tissues, organ, protein DNA, RNA and enzymes. Pharmaceutical development based on cytotoxicity of nanomateirals super molecular strategies and study of biological interactions, Nanomaterials and immune system, biocompatibility and stability. Health effects of nanomaterials.

Unit IV: ***Applications of nanomaterials in biology & Medicine***: **15 Lectures**

Surface modification and functionalization of nanoparticles, nanoparticles for biosensors, nanoparticles for drug delivery, nanoprobes for diagnostics, nanocomposite in tissue engineering. Nanoparticles for gene delivery system and targeted drug delivery, nanomaterials as antibacterial, antiviral and antifungal agents, nanomaterials for neurodegenerative disorder.. Nanomaterials for implants, prostheses, biodefence. Peptide based Nanofibers: self assembly of peptides, types, biomedical applications for peptide amphiphils; tissue regenerative applications, Direct cellular signalling.

Course code	Title	Credits: 04
BP-CCT 403	**Environmental Biophysics**	Total Lectures:60

Unit I Introduction: **15 Lecture**

Introduction to environment, microenvironment, energy exchange, mass and momentum transport, conservation of energy and mass, continuity in the biosphere.

'ater 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

Unit II Conductance of heat and mass transfer **15 Lecture**

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.

Unit III **15 Lecture**

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 eriergetic, 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.

Unit IV Electromagnetic radiation & gravity in living system **15 lecture**

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.

Paper III : BP-CCT 403 : Elements of Bioinformatics, Molecular docking & drug design

Course code	Title	Credits: 04
BP-CCT 403	**Elements of Bioinformatics, Molecular docking & drug design**	Total Lectures:60

Unit I Introduction: **15 Lecture**

Introduction to bioinformatics and Biological databases, major bioinformatics resources, Types of databases, sequence databases, formats, organisation and query system, nucleotide sequence database and protein sequence database, Information & retrieval form biological databases. Database search algorithms- FASTA & BLAST

Gene prediction: Gene prediction programs in prokaryotes and eukaryotes.

Promoter & Regulatory Elements Prediction: Program for promoter and regulatory elements prediction in prokaryotes and eukaryotes.

Unit II Phylogenetics & Structural Bioinformatics: **15 Lecture**

Terminology, forms of tree representation, gene phylogeny vs species phylogeny. Molecular phylogeny Methods – distance based, character based; programs for construction of phylogenetic trees.

Structural Bioinformatics: Pair-wise and multiple sequence alignment, sequence alignment algorithms, pairwise alignment algorithms (global & local), multiple sequence alignment, sequence identity, similarity and homology concept, scoring matrices, scoring functions, algorithms, profiles and HMMs, prediction of protein motifs and protein domains, derived databases; patterns, profiles, motif and domain. Prediction of secondary and tertiary structure of proteins, homology modelling, threading, ab initio prediction.

Unit III: Molecular mechanics & conformational analysis: **15 Lecture**

Molecular Mechanics and the forcefield. General form of a generic force field, force field parametrization. Comparison between the different forcefields in existence at present time

Conformational analysis: Systematic search, Monte Carlo simulations, Molecular dynamics simulations, distance geometry, strengths and limitations of each method

Molecular docking & Energy minimization: Docking by energy minimization, superimposition, molecular dynamics, Metropolis Monte Carlo, genetic algorithms, build-up approach. Different types of scoring function, e.gs of successful application of docking

Energy minimization: Steepest descents, conjugate gradients, Newton Raphson method, advantages and limitations of each method.

Unit IV de novo ligand design & 3D –QSAR: 15 Lecture

Classes of de novo ligand design – active site analysis methods, whole-molecule methods, connection methods, random connection and disconnection methods, e.g of successful application of *de novo* ligand design. Fragment based drug design, Self. Study – Successful applications of de novo drug design.

3D-QSAR: CoMFA and CoMSIA. Mention of other 3D-QSAR techniques and introduction to the 4^{th}, 5^{th} and 6^{th} dimension in QSAR. 3D-QSAR methods other than CoMFA and CoMSIA.

Pharmacopore Modeling &Virtual screening:

Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches, incorporating additional geometric features into a 3D pharmacophore, use of a pharmacophore model in drug design.

Virtual Screening based on similarity, docking, pharmacophore maps and filters for drug-likeness and ADME.

Practical

BP-LBC 401	**Lab course I** 1. Synthesis of metallic nanoparticles using physical methods (Silver, gold, Zinc oxide, TiO2, Cd etc). 2. Synthesis of nanoparticles using chemical methods 3. Synthesis of nanoparticles using biological methods like Plants, organisms, proteins and DNA templates. 4. Characterization of nanoparticles using UV-Visible spectroscopy, Dynamic Light Scattering. 5. Characterization of nanoparticles using XRD, SEM & AFM etc (Demo) 6. To demonstrate interaction of nanoparticles with model biological systems. 7. Biofunctionlization / surface modification of nanoaprticles 8. Characterization of nanoparticle-bioconjugate using spectroscopy (Fluorescence, UV Visible, FTIR, DLS) techniques	02	
BP-LBC 402	**Lab course II** Preparation, observation and characterization of macromolecular crystals. Isolation of chloroplast and study of evolution of oxygen by DCPIP method. 3. Study of ligand binding interaction using Gel electrophoresis 4. Isolation of chlorophyll from plant and its absorption spectra. Separation of biological samples using paper chromatography 6. Study of membrane equilibria and ligand binding studies by dialysis method. 7. Study of protein characterization using scattering techniques (DLS/Raman) 8. Biological response under electromagnetic field/gravitation. 9. To synthesize polyacrylamide using free radical initiator and to characterize using	02	

	IR/Raman spectroscopy. 10. To study the rate of DNA polymerase reaction by Raman /IR spectroscopy.		
PSBPP403	**Lab course III** Database searches Database similarity searches & Pairwise sequence alignment Multiple sequence alignment & Motif Detection Phylogenetic analysis: Constructing & Refining a Multiple Sequence Alignment, Constructing a distance based phylogenetic tree, Constructing a Maximum parsimony tree, Constructing a Quartet Puzzling Tree, Constructing a maximum likelihood tree using genetic alogorithm, constructing a phylogenetic tree using Bayesian Inferance. Protein Structure prediction Gene & prometer prediction and gene annotation Construction of molecules using different tools Docking 2D & 3D QSAR.	02	
BP-LBC 404	**Lab course IV** **Research Project**	02	

References:

1. Fundamental and Radiobiology (1966) 2nd Edition Bacq Z.H. Alexander P., Pergammon Press, New York.
2. Radiation Biophysics (1990) Alpen E.L.Printice hall, Engel Wood.
3.Radiation Chemistry (1973) Hughes G. Clarendon Press,
4. Polymers as Biomaterials Ed. By Shalaby W., Shalaby W. Plaenum press, N, Y.(1984)
5. Introduction physics of nuclear medicine by Chandra, R.
6. Nuclear Medicine by Lelle, R.D.
7. Technology and interpretation of nuclear medicine procedures by Sodee. D.B. and Early, R.J
8. Nuclear Medicine by Wagnar, H.N.
9. Medical physic by Cameron J.R.
10. Radiation Biology, Alison P. Casserette
11.Radiation Biophysics by J.Kiefer
12. Radiobiology for Radiation Therapy, by Eric Hall
13.Radiobiological Basis of Radiotherapy G.G.Steel
14. Radiation Protection, Shapiro
15. The Physics of Radiation Therapy, Faiz M. Khan
16. Molecular Modelling – Principles and Applications, Leach A. R., Prentice Hall.
17. Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
18. 3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien ESCOM.
19. Molecular Modelling and Simulation -An Interdisciplinary Guide, Schlick T., Springer
20. Biomedical Nanotechnology, Neelina H. Malsch (2005), Taylor & Francis.
21. Nanochemistry, G B Sergeev,(2006), Elsevier.
22. Bioinformatics A Practical Approach, Shui Qing Ye (2008), Chappman & Hall/CRC.
23. Handbook of Biophotonics, Vol II, V. Tuchin, A. Chiou, S.tefan H, (2012) Wiley
24. Raman Spectroscopy, Fullerens & Nanotechnology, Maher S Amer (2010) RSC Publ.
25. Introductory Biophysics, James C & J Q Tran (2011), John & Bartlet India Pvt Ltd
26. Biophysics A Physiological Approach, Patric F Dillon (2012) Cambridge Univ. Press
27. Comprehensive Biophysics, Volume I-IX, Edward H Egelman (2012) Elsevier.
28. Text Book of Medical Biophysics, Eleventh Edition, Guyton & Hall, Elsevier
29. Physiology, Biophysics and Biomedical Engineering , Andrew W Wood (2012) CRC Press
30. Introduction to experimental Biophysics, Jay Nadeau (2012) CRC Press
31. Methods in Molecular Biophysics, Igor N Serdyuk,N R Zaccai, Joseph Z (2007), Cambridge University Press.
32. Biocalorimetry : applications of calorimetry in the biological sciences edited by John E. Ladbury and Babur Z. Chowdhry. New York : J. Wiley, 1998.
33. Introduction to Experimental Biophysics (Biological methods for physical scientist) Author: Jay Nadeau, CRC Press
34. Fundamental concepts in Biophysics, Volume 1, Author: Thomas Jue, Humana Press
35. Single Molecular biology, by Alex E. Knight, Academic Press
36. Techniques in Molecular Medicine by Friedhelm Hildebrandt, Springer
37. Adavanced Techniques in Biophysics by Jose Luis R. Arrondo, Springer
38. Hnadbook of Single-Molecule Biophysics by Peter Hinterdorfer, , springer
39. Mass Spectrometry in Structural Biology and Biophysics by AGOR A. KALTASHOV, wiley
40. Nanobiomaterials Handbook by Balaji Sitharaman, CRC Press
41. Environmental and pollution by Ian L. Pepper, Academic Press
42. Biophysical Chemistry of Proteins. An Introduction to Laboratory Methodsby Engelbert Haubnam, Spreitzer

43. Fundamentals Nanomaterials by Geckeler and Edward Rosenberg, ASP Publishers
44. Nanobiomaterials (Developments and applications) by Dong Kee Yi
45. Understanding Nanomaterials by Malkats J
46. Nanotoxicology (Methods and Protocols) by Joshua Reineke, Humana Press

Additional Books for reference

Annexure A

Access No.	Title of the Book	The Author's Name
1	Principal of biostatistics 2eld	Pagno
2	DNA Micro arrays : a molecular cloning manual	Browtell
3	Introduction to protein structure 2eld	Branden
4	Guidebook on molecular modeling in drug design	Cohen
5	Electrophoresis	Desai
6	Radioactive releases in the environment	Copper
7	An Introduction to biomechanics.	Humphrey
8	Biophysics : An Intro	Cotterill
9	Principal of fluorescence spectroscopy 3 eld	Lokowicz
10	Protein targeting transport and translocation	Dalbey
11	Practical protein crystallography 2eld	MC.Ree
12	Molecular genetics of bacteria 4eld	Dale
13	Biophysics	Pattabhi
14	Biophysical aspects pf transmembrane	Damjanovich
15	Drug discovery and development	Rang
16	Textbook of Biophysics	Roy
17	A short intro to biomedical engineering	Sarbadhikari
18	Practical capillary electrophoresis 2 eld.	Weinberger
19	Essential pf genomics and bioinformatics	sensen
20	Biophysics	subramaniam
21	Protein structure & predication	Tramontano
22	Bioinformatics of Genome Regulation and structure	Kolchanov
23	Essential bioinformatics	Xing
24	Introduction to Bioinformatics	Lesk
25	Introduction to Bioinformatics	Attwood
26	Functional Genomics	hunt
27	Bioinformatics Technologies	Chen
28	Micro array Bioinformatics	Stekel
29	Basic Biostatistics and its App.	Datta
30	Quanti Protein by mass Sep.Euro	Sechi
31	Vides Gene.Reg. and Met	Collada
32	Essential of biophysics	Narayanan
33	Micro for an integrative genomics	Kohane
34	Physical chemistry for the Biomedical science	Logan
35	Structural biology	Teng/Springer
36	Water and the cell	Pollack/springer
37	NMR-MPI USR & moss Bauer spectroscopies in molecular magnets	Lascialfari-Springer
38	Modeling in molecular biology	Cio banu-springer
39	Chemical Biophysics, Quantitative Analysis of cellular system	Beard