M. Sc. (Biophysics)
Centre for Interdisciplinary Research in Basic Sciences
Jamia Millia Islamia

S. No	Title of paper	Paper code	Credit		
			L	T	P
Semester I					
1.	General Biochemistry	MBP101	3	0	1
2.	Basics of Programming	MBP102	3	0	1
3.	Cell and Molecular Biology	MBP103	3	0	1
4.	Mathematical and Statistical Techniques	MBP104	3	1	0
5.*	**Choice Based course**		**4**		
Semester II					
1.	Structural Biology	MBP201	3	0	1
2.	Thermodynamics and Kinetics	MBP202	3	0	1
3.	Biophysical Techniques	MBP203	3	0	1
4.	Quantum Physics & Chemistry	MBP204	3	1	0
5.*	**Skill Development Course**		**4**		
6.*	**Choice Based Course**		**4**		
Semester III					
1.	Radiation Biophysics	MBP301	3	0	1
2.	Microbiology, Genetics and Immunology	MBP302	3	0	1
3.	Membrane Biophysics	MBP303	3	1	0
4.	Systems Biology	MBP304	3	1	0
5.*	**Ability Enhancement Course**		**4**		
6.*	**Choice Based Course**		**4**		
Semester IV					
1.	Dissertation and Viva–Voce	MBP401	16		
2.*	**Choice Based Course**		**4**		
Total credit			**88**		

Total Theory classes per course: **48 [1 credit= 1clock hr]**
Practical/Tutorial classes per course: **32 [1 credit= 2clock hr]**
Total classes per course: **----------**
80 clock hrs

Dissertation (Extensive Lab Work): **32 [16 credits = 16×2]/ week.**

*** Paper code will be given by the concern department from where the CBCS is offered.**

M. Sc. (Biophysics)
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Semester I: MBP101: General Biochemistry

UNIT-I **[12L]**

Some important properties of water, dissociation of water and its ion product, K_w, buffer and buffering capacity pH, Bronsted acids, ionization of weak acids and bases, Henderson Hasselbalch equation, Titration curves and buffering action, Goods buffer, water and intermolecular forces, thermodynamics in biochemistry, law of thermodynamics, Gibb's free energy and biomolecules in water.

Unit-II **[12L]**

Amino Acids: Structure, properties, classification, function, ionization and characterization, naturally occurring modifications of amino acids in proteins, non-protein amino acids, structure of proteins: primary, Secondary (α-helix, β-Plated and random coils), peptide bond, Ramachandran plots and collagen structure, protein sequencing, protease mapping, characterization of peptides, tertiary and quaternary structures of proteins/enzymes.

Unit-III **[12L]**

Carbohydrates: introduction, classification, types, optical isomerism, muta-rotation, basic structure and functions of monosaccharides, oligosaccharides, polysaccharides, energy storage molecules-starch, glycogen, building blocks-cellulose, hemicellulose, and chitin. lipids: classification, structure, properties and function of fatty acids, triglycerides, phospholipids, glycolipids, sphingolipids, sterols, cerebrosides, steroids, prostaglandins, glycolipids and proteoglycans, carbohydrate metabolism, brief overview of glycolysis and Krebs cycle.

Unit-IV **[12L]**

Nucleic acids: nucleosides and nucleotides, primary structure of nucleic acids, structure, properties and functions of DNA and RNA, secondary and tertiary level organization, different DNA forms, conformation, super coiling, stereochemistry: nucleoside, torsion angles, sugar conformation, NMR study, DNA structure: different types of DNA and their structure, DNA motifs, DNA repeats and their significance, function and stability, spectroscopic study of DNA: dye binding, interaction, denaturation, and renaturation of DNA, thermal denaturation and T_m value, vitamins, coenzymes and other small molecules.

Suggested Books

1. Textbook of Biochemistry with Clinical Correlations, Thomas M. Devlin, Publisher Wiley, 2010, ISBN0470281731, 9780470281734.
2. Biochemistry: Jeremy M. Berg, John L. Tymoczko, LubertStryer, ISBN:9780716746843
3. Lehninger Principles of Biochemistry, David Lee Nelson, Michael M. Cox. Published by: W.H. Freeman, 2013, ISBN: 1464109621, 9781464109621
4. Principles of Biochemistry, Donald Voet, Charl Judith G. Voet–PublisherWiley, 2013 , ISBN 1118092449, 9781118092446

1. 5. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon, Matthew P. Scott, Publisher W.H. Freeman, 2012, ISBN 142923413X, 9781429234139.

M. Sc. (Biophysics)
Centre for Interdisciplinary Research in Basic Sciences
Jamia Millia Islamia

Semester I: MBP102: Basics of Programming

Unit-I: C Programming Basics [12L]

Basic concepts of programming languages: High-level and Low-level Languages, Language translators: Assemblers, Compilers, Interpreter and Editor; Concepts of flowcharting, algorithm development. Program Compilation, Running of a Program; Header files, Basic elements: Identifiers, keywords, Variables and Constants, Variables/Identifiers declaration; Expressions, Statements, Basic data types of C.

Unit-II: Operators and Control Structures [12L]

Operators and Expressions: Arithmetic Operators, Unary Operators, Relational Operator and Logical Operators, Assignment Operators, Conditional Operator, Expression Evaluation (Precedence of Operators); Data Input/Output statements. Control Structures: Branching- if, if else, switch-case, Looping-for, while, do-while; break, continue.

Unit-III: Functions and Arrays [12L]

A Brief Overview, Library Functions, User defined functions, declaration, definition & scope, Accessing a Function, Function Prototypes, Passing Arguments to a Function: call by value, call by reference. Defining an Array, Processing an Array, Passing Arrays to Functions, Multidimensional Arrays, Strings, String Handling functions.

Unit-IV: MATLAB [12L]

MATLAB Windows: A first Program, display commands, Expressions, Constants, Variables and assignment statement, arrays, Graph Plots: Basic Plotting, Procedures and Functions, Built in functions, Arguments and return values, M-files, function M-file, Formatted console input-output. Application to biological systems.

Reference Books:

1. Deitel and Deitel: How to Program C, Addison Wesley, Pearson Education Asia, Seventh Edition
2. Bryon Gottfried, Programming with C, McGraw Hill International.
3. "Getting Started: Graphics" in MATLAB Help.
4. "Getting Started: Scripts and Functions" in MATLAB Help.
5. MATLAB Online Manual: Creating Graphical User Interfaces

Semester I:MPB103: Cell and Molecular Biology

UNIT-I [12L]

Cell biology: Organization and structure of prokaryotes and eukaryotes, plasma membrane, nucleus, nuclear pore complex, mitochondria, chloroplast, endoplasmic reticulum, golgi complex,

lysozomes, glyoxysomes, peroxisomes, cyto-skeleton. Chromatin, chromosomes, human karyotype, condensation of chromatin into chromosomes. Cell cycle (G1, G2, S and M phases), cell division: mitosis.

Unit-II **[12L]**

Cell-cell communication: strategies of cell signalling: cell to cell contact, via signalling molecules (endocrine, paracrine and autocrine). Signalling mediated by intracellular receptors: G protein coupled receptors, receptor tyrosine kinases, non-receptor tyrosine kinases. Signalling pathways: cAMP pathway and glycogen metabolism, PI3 kinase/Akt pathway. Programmed cell death, caspases, mitochondrial pathway of apoptosis. Cancer biology, stages of tumour development, oncogenes and tumour suppressor genes.

Unit-III **[12L]**

Molecular biology: central dogma, genetic code, gene, Structure of nucleoside and nucleotide and nucleic acids-The nature of chemical bonds; Nomenclature system to designate nucleoside and nucleotides. Polymerisation of nucleotides, structure of DNA and RNA, Deviations in DNA structure and their significance, DNA as a genetic material of bacteria (Avery-MacLeod-McCarty experiment), Virus (Hershey-Chase experiment); DNA Polymerases and Replication of DNA in prokaryotic system, RNA transcription and an overview of Protein translation.

Unit-IV **[12L]**

Chromosomal and Plasmid DNA isolation from *E. coli*; Nucleic acid separation techniques: Agarose gel electrophoresis of DNA. Basic principle of cloning, Vectors: Basic requirements for a suitable cloning vector. Recombinant DNA. Competent cell preparation and transformation protocols. Cloning and selection transformants and recombinants. Characterization of recombinant clone. Blottings: Southern and Northern blotting techniques. Nucleic acid amplification protocols; DNA sequencing. Restriction endonucleases and restriction digestion.

Suggested Books

1. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp, PublisherJohn Wiley & Sons, 2009, ISBN 0470483377, 9780470483374.
2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, Taylor & Francis, 2014, ISBN 0815344643, 9780815344643.
3. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon, Matthew P. Scott, Publisher W. H. Freeman, 2012, ISBN 142923413X, 9781429234139.
4. Essential Cell Biology, Fourth Edition, Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, PublisherGarland Science, 2013, ISBN 1317806271, 9781317806271.
5. Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers, Lisa Starr, Cengage Learning, 2008, ISBN 0495557986, 9780495557982.
6. Molecular Biology: Genes to Proteins, Burton E. Tropp, PublisherJones & Bartlett Publishers, 2012, ISBN: 0763786632, 9780763786632.

Semester I:MBP104: Mathematical and Statistical Techniques

UNIT-I **[12L]**

Vectors: Cross and Dot products, Vector fields: General expression for gradient, divergence, curl and Laplace operators in orthogonal curvilinear coordinates and their explicit forms in cylindrical and spherical polar coordinates, multiple integrals, Gauss theorem, Stokes theorem.
Matrix theory: Different types of matrices, rank and its application to solutions of linear equations, eigenvalues and eigenvectors,Cayley-Hamilton theorem, diagonalization of symmetric matrices by orthogonal matrices and Hermitian matrices by unitary matrices.

UNIT-II **[12L]**

Differential equation and applications: pure time differential equations and autonomous differential equations, methods of solutions and applications, series solutions, ordinary and singular points, Frobenius method of solving second order linear differential.

UNIT-III **[12L]**

Fourier series and transform: parseval and convolution theorems, FFT concept, gamma and beta functions, properties of these functions, correlation and regression analysis, interpolation and extrapolation, probability theory-events, additions, multiplication and Bayes theorems, Binomial, Poisson and Gaussian and normal distributions.

UNIT-IV **[12L]**

Classification and diagrammatic representation of statistical data, frequency distribution, measures of central tendency, measures of dispersion including standard error,
Sampling theory, sample size and sampling methods, concept of statistical inference- parametric tests (Z-test, unpaired t-test, paired t-test, one way analysis of variance and two way analysis of variance), non-parametric tests (Wilcoxen rank sums test, Wilcoxan sign rank test, KruscalWalli's test, Friedman test), chi-square test,p-test, p-values.

References

1. E. Kreyszig, Advanced engineering mathematics, 10th ed. Hoboken, NJ: John Wiley, 2011.
2. G. B. Arfken, Mathematical methods for physicists: a comprehensive guide, 7th ed. Amsterdam ; Boston: Elsevier, 2013.
3. J. B. Fraleigh, A first course in abstract algebra, 7th ed. Boston: Addison-Wesley, 2003.
4. D. C. Lay, Linear algebra and its applications, 4th ed. Boston: Addison-Wesley, 2012.
5. B.Rosner, Fundamentals of biostatistics,7th ed. Boston: Brooks/Cole, Cengage Learning, 20

Semester I: List of Practical

[Any ten experiments from the list will be conducted]

1. To determine the concentration of Glucose in the given sample by Anthrone's/ Fehling's solution Method.
2. Estimation of Cholesterol in the given sample.
3. To determine total Lipid Profile from Human Serum.
4. To determine the saponification value of Mustard Oil

5. To determine the activity of acid phosphatase and alkine phosphatase.
6. To carry out Vitamin C titration.
7. Write a program to swap the values of two integers using a function.
8. Write a program to find mean of two integer values using a friend function.
9. To learn sequence search using various tool such BLAST, FASTA and to determine similarity scoring BLOSUM, SYMCOM and etc.
10. Plasmid DNA isolation
11. Restriction digestion of plasmid DNA
12. Agarose gel electrophoresis
13. Representation and determination of statistical parameter of data in excel and other statistical package such as SAS, SPSS.
14. To solve differential equation, integrals, equations using muPad in MATLAB and other mathematical equations solver such as MATHEMATICA etc.
15. Learn direct command in MATLAB to determine Eigen values and Eigen Vectors and other matrices related characteristics.

M. Sc. (Biophysics)
Centre for Interdisciplinary Research in Basic Sciences
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Semester II: MBP201: Structural Biology

UNIT- I **[12L]**

Introduction to Protein Structure: the chemical nature of polypeptides and forces determining protein structure. Structural properties of proteins: Secondary structure elements, classification of tertiary structure; protein families and databases for structure classification: SCOP & CATH. Sequence and structure relationship, structural implications of the peptide bond; allowed and disallowed conformations; Ramachandran plot; conformationally constrained amino acids and their importance, determinants of secondary structure, experimental evaluation of structural stability, structure of nucleic acids and other biologically important molecules and molecular assemblies like ribosomes, nucleosomes, functional significance of structure.

UNIT- IV **[12L]**

Expression of protein for crystallization in Escherichia coli, yeast and insect cells. Post-translational modifications, protein purification for structural studies, preparation of high quality protein for crystallization, methods for characterization of protein for crystallization, basic concept of crystallization, factors affecting protein crystallization, crystallization techniques: Hanging drop, suiting drop, microdialysis, seeding, etc. buffer system and precipitating agents used for crystallization.

Unit III **[12L]**

Elements of crystal symmetry and the basis of crystallographic theory, Bravais lattices, basic ideas of symmetry: symmetry in chiral molecules, X-ray generation, detection and properties of X-rays, synchrotron radiation, X-ray diffraction, Bragg's law of diffraction, diffraction of macromolecules: molecular replacement method and direct method, theory of diffraction by helical structures and application to alpha-helix and DNA, validation of X-ray structure, ASTM index, analysis of structures and its correctness, submission of data to PDB: atomic coordinates and electron density maps.

Unit IV **[12L]**

Basic principle of Nuclear Magnetic Resonance (NMR) Spectroscopy, typical nuclei, NMR observables and parameters for structure determination, selection rules, spectral density functions and relaxation, Nuclear Overhauser Effect (NOE), analysis of high-resolution NMR spectra, two-dimensional NMR, 2D NMR COSY, assignment of peptides and proteins by proton NMR, 3D structure of proteins and nucleic acids, constitution, conformation and dynamics of small molecules, chemical exchange, ligand binding, applications to chemistry, biology and medicine.

References

1. Creighton, T. E. Ed.: Protein Structure: A Practical Approach. 1989.
2. Creighton, T.E.: Proteins: Structure And Molecular Properties. Second Edition. New York. W. H. Freeman And Company, 1993.
3. Creighton,T.: Protein Folding, 1992.

4. Sternberg, M.J.E.: Protein structure prediction: a practical approach, 1996
5. Pain, R.G.: Mechanisms of protein folding, 1994
6. Leach.A.R: Molecular modelling: principles and applications.
7. NMR spectroscopy of large molecules and multimolecular assemblies in solution. Wider, WüthrichCurr. Op. Struct. Biol. (1999) 9, 594-601.
8. Multidimensional NMR in liquids - Basic principles and experimental methods van de Ven, VCH (1995).
9. Protein NMR spectroscopy – Principles and Practice. Cavanagh, Fairbrother, PalmerIII, Skelton. Academic Press (1996).

Semester II:MBP202: Thermodynamics and Kinetics

Unit-I **[12L]**

Fundamental principles of the thermodynamics: surroundings, intensive and extensive properties, thermodynamic processes, state and path functions. First law of thermodynamics: internal energy, reversible work of expansion, heat change at constant volume and constant pressure, enthalpy, exothermic and endothermic reactions, energy as a function of T and V, enthalpy as a function of T and P, heat capacities, relation between Cp and Cv, spontaneous process, concept of entropy and second law of thermodynamics.

Unit-II **[12L]**

Concept of free energy, Gibbs-Helmholtz equation, ΔA and ΔG of the system and ΔS of universe, Relationship between standard free energy change and equilibrium constant, variation of equilibrium constant with temperature and pressure, standard free energy changes, oxidation-reduction potential, Nernst equation, reduction potential differences types of half-cells and their reactions, calculation of cell e.m.f., thermodynamic quantities of cell reactions (ΔG, ΔH, and ΔS), Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.

Unit-III **[12L]**

Overview of bioenergetics, role of vitamins, minerals and co-enzymes in bioenergetics, thermodynamic control of metabolic pathways, high energy compounds and their nature of energy, ATP as universal currency of free energy in biological systems, ATP hydrolysis and equilibrium of coupled reactions, phosphates as the 'energy currency' of the cell, phosphocreatine, nucleoside triphosphates, coenzyme A, biological aspects of Nernst equation, electron carriers like NAD+ and FAD, experimental approaches to study bioenergetics, thermodynamics of transport, structural basis of the high group transfer potential of ATP.

Unit-IV **[12L]**

Methods of determining rate laws, order of reaction, effect of temperature and pH on reaction rate, simple chemical reactions: zero order, first order, second order, pseudo order, and their half-life expressions, Arrhenius equation, transition state theory, elementary and complex reactions, collision theory of reaction rates, treatment of unimolecular reactions, theory of absolute reaction

rates, comparison of results with Eyring and Arrhenius equations, homogeneous catalysis, heterogeneous catalysis, kinetics of enzyme catalyzed reactions.

References

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R. R. Mishra. Principles of Physical Chemistry, S. H. Maron and C. F. Prutton.
1. New Era of Bioenergetics, by Yasuo Mukohata, Publisher Academic Press, 2012, ISBN 0323140297, 9780323140294.
2. Principles of Bioenergetics: Authors, Vladimir P. Skulachev, Alexander V. Bogachev, Felix O. Kasparinsky, Publisher Springer Science & Business Media, 2012, ISBN 364233430X, 9783642334306.
3. Bioenergetics, Authors: David G. Nicholls, Stuart J. Ferguson, Publisher Academic Press, 2014, ISBN 1483214206, 9781483214207

Semester II:MBP203: Biophysical Techniques

Unit-I **[12L]**

Reflection, absorption, emission, scattering in spectroscopy, UV-Visible absorption, fluorescence and phosphorescence spectroscopy, Circular Dichroism, dynamic light scattering, rotational and vibrational spectroscopy, study of diatomic vibrations and rotational modes, advantages of Raman spectroscopy, applications, advantages and disadvantages of these techniques to biology.

Unit-II **[12L]**

General principles of NMR spectroscopy, resonance condition, relaxation phenomena and measurements, chemical shifts, coupling constants, proton decoupling (broad band), NOE effects, 1H, 13C, solid state NMR, Basic principle and application of ESR, spin-labeling. Basic principle of mass spectroscopy, analysis and its application, importance and principle of MALDI-TOF spectroscopy and its applications.

Unit-III **[12L]**

General principles of electrophoresis, Factors affecting electrophoresis, Electrophoresis of proteins, SDS-PAGE, Support media for SDS-PAGE, Native gel, Gradient gel, Isoelectric focussing gel, Molecular mass determination by electrophoresis, Two-dimentional electrophoresis, Detection of proteins in gel, Wester Blotting, Electrophoresis of nucleic acid, Agarose gel electrophoresis, Support media for agarose gel electrophoresis, Electrophoresis of RNA, Capillary electrophoresis, Microchip electrophoresis, application of electrophoresis.

Unit-IV **[12L]**

Basic principles of chromatography, paper chromatography, TLC, column chromatography, gas, liquid chromatography, ion exchange chromatography, exclusion chromatography, affinity chromatography, high performance liquid chromatography, fast protein liquid chromatography, their applications to macromolecules.

References

1. Fundamentals of Molecular Spectroscopy, 5th Edn, McGraw Hill, ISBN-10 1259062597, ISBN-13 9781259062599, 2013 May
2. Introductory Raman Spectroscopy by John R. Ferraro, Kazuo Nakamoto and Chris W. Brown, Second Edition, ISBN: 978-0-12-254105-63, Elsevier Science Publishing, 2003
3. Infrared and Raman Spectroscopy; Principles and Spectral Interpretation, by Peter Larkin, Elsevier Science Publishing Co Inc (13 July 2011), ISBN-10: 0123869846, ISBN-13: 978-0123869845
4. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQRby D.N. Sathyanarayana (Second Edition), I K Int. Publ. House; Second Edition ISBN-10: 9382332529, ISBN-13: 978-93823325278 Nov 2013
5. Physical Biochemistry, D. Freifelder, W.H. Freeman & Co. San Francisco, 1976
6. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, Wiley India Pvt Ltd; Second edition ISBN-10: 8126528443, ISBN-13: 978-8126528448, 12 October 2010
7. Biomolecular NMR Spectroscopy, by Jeremy N. S. Evans, OUP Oxford (11 May 1995)
1. ISBN-10: 0198547668, ISBN-13: 978-0198547662
8. Govil G. & Hosur R. V. NMR – Conformation of Biological Molecules, Springer- Verlag.
9. Modern Optical Spectroscopy: With Exercises and Examples from Biophysics and Biochemistry, by William W. Parson, Springer; 2007 edition (12 December 2006), ISBN-10: 354037535X, ISBN-13: 978-3540375357
10. Handbook of Fluorescence Spectroscopy and Imaging: From Single Molecules to Ensembles, Prof. Dr. Markus Sauer, Prof. Dr. Johan Hofkens, Dr. Jörg Enderlein,
2. 2011 Wiley-VCH Verlag GmbH & Co. KGaA, Print ISBN: 9783527316694
11. Principles of Fluorescence Spectroscopy, Lakowicz, Joseph R. 5rd ed. 2006, XXVI, Springer, ISBN-10: 0387312781, ISBN-13: 978-0387312781, June 2010
12. Electrospray and MALDI Mass Spectrometry: Fundamentals, Instrumentation, Practicalities, and Biological Applications, by Richard B. Cole (Editor), Wiley-Blackwell; 2nd Edition edition
3. ISBN-10: 0471741078, ISBN-13: 978-0471741077, 18 May 2010
13. Friefelder D. Physical biochemistry W.H. Freeman & Co.
14. Stout G.H. & Jensen L.H. X-ray structure determination, Macmillan.
15. Slayter E.M. Optical methods in Biology, John Wiley
16. Blundell T. L. and Johnson L.N. Protein crystallography, Academic Press.
17. Wuthrich K. NMR of proteins and nucleic Acids, Wiley Interscience, Publications.

Semester II: MBP204: Quantum Physics and Chemistry

Unit-I **[12L]**

de Broglie's wavelength, Bohr atom, Physical basis of quantum mechanics, Schrodinger equation (1D), Physical interpretation and conditions on the wave function, Stationary states and energy spectra, Particle in a square well potential, Tunnelling through potential barrier, Bound and unbound state.

Unit-II **[12L]**

Spherically symmetric potentials in 3-dimensions, Hydrogen atom, Helium atom; singlet and triplet states, Observables, Quantum operators; position, momentum, energy and parity, Spectroscopic notations, L-S coupling, J-J coupling, Commutators; linear and angular momentum, Uncertainty principle, Zeeman and Stark effect, Linear harmonic oscillator

Unit-III **[12L]**

Diatomic molecules, Molecular orbitals of the homo and heteronuclear diatomic molecules, Valance bond treatment of heteronuclear diatomic molecules, Molecular orbital and valence bond methods for the hydrogen molecule, charge distribution in molecular hydrogen, Born-Oppenheimer approximation and its breakdown, LCAO approximation, Vibrational and rotational energy levels in diatomic molecules

Unit-IV **[12L]**

Chemical bond, Bonding and anti-bonding regions-formation of bonds, Polyatomic molecules, Directed valance (Introduction), Hybridization and geometry, Simple Huckel theory of the linear conjugated systems, Examples of simple Huckel calculations: Butadiene, Simple Huckel theory for the cyclic conjugated systems and aromaticity.

References

1. Elementary Quantum Chemistry, F. Pilar, McGraw Hill book company, New York, 1968
2. Quantum Chemistry, N.V. Riggs, Macmillan Company London, Oxford and IBH publishing, 1975
3. Molecular Orbital theory, A. Streitwiser, John Willey, New York, 1961
4. Quantum Chemistry, Ira N Levine, Fourth Edition, Prentice Hall of India, New Delhi, 1994
5. Quantum Mechanics Concepts and Applications Second Edition, NouredineZettili
a. Jacksonville State University, Jacksonville, USA
6. Concepts of Modern Physics, Arthur Beiser, McGraw Hill, 2003

Semester II: MBP205: Lab course: Practical's

[Any ten experiments from the list will be conducted]

1. Determination of molar absorption coefficient of the native proteins (RNase-A, α-lactalbumin and lysozyme) from the spectra of model compounds (Try and Trp).
2. Determination of no. of Tryptophan and Tyrosine residues in an unknown protein (Lysozyme) by Edelhoch's method.
3. Determination of conformational stability from the guanidine hydrochloride-induced denaturation of a protein.
4. Determination of thermal stability from heat-induced transition curves of a protein (RNase-A).
5. Determination of secondary structure elements of proteins (RNase-A, α-lactalbumin and lysozyme) from their CD spectra.
6. Calculation of acceleration due to gravity $'g'$ using simple pendulum.
7. Solar cell & diode characteristics – four different experiments
8. ECG- Experiments.
9. Minimum deviation of prism.

10. EMF of different leaf.
11. Determination of the binding constant for ligand-protein interaction using Stern-Volmer equation
12. Determination of the thermodynamic parameters for ligand-protein interaction using Van-Hoff's equation
13. Study of the separation of the orbits using Zeeman's effect.
14. Determination of the surface active parameters of amphiphilic molecules using Gibb's adsorption equation
15. Determination of root mean square and its deviation for drug-target interaction using GROMACS

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, 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, hazards of non-ionizing radiation and their control, medical application of radiation sources

Unit-III **[12L]**

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

Unit-IV **[12L]**

Biomedical imaging techniques and principles of working, analogue and digital imaging, Ultrasound imaging, nuclear magnetic resonance imaging, principles of X-ray diagnosis, 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

Semester III: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

Semester III: 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 byphosphotransferase 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.

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

Unit-II **[12L]**

Linear equation, system of linear equation, solution of these equations MATLAB, ODEs, Taylor's methods, Euler's method, modified Euler's method, Runge-Kutta methods, solution of system of ODEs, nth order differential equations and their programs in MATLAB, direct function for solving ODEs in MATLAB, Data fitting; Parameter estimation.

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 Modelling and Transport; probabilistic picture of molecular interactions: Gillespie's picture, master equation formalism of biochemical networks. 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:

1. S. Attaway, MATLAB: a practical introduction to programming and problem solving, Butterworth-Heinemann, Amsterdam ; Boston, 2009.
2. S.H. Strogatz, Nonlinear dynamics and Chaos: with applications to physics, biology, chemistry, and engineering, Addison-Wesley Pub, Reading, Mass, 1994.
3. C.F. Gerald, Wheatley, Patrick O, Applied numerical analysis, Pearson Educations Inc. : Dorling Kindersley, Boston, 2004.
4. C.P. Fall, Computational cell biology, Springer, New York, NY, 2005.

Semester III: List of Practical

[Any ten practical from the list will be conducted]

1. Enzyme-Linked Immunosorbent Assay (ELISA)
2. Bacterial culture and Growth curve
3. Polymerase Chain Reaction (PCR) amplification and analysis
4. Write basic programming in MATLAB such as use of loop, conditional statements, plotting curves etc.

i. To write program for determination of roots of polynomials and transcendental equations using various methods such as Netwton-Raphson method, Iteration etc.

5. To write program for determine the solution of system of equations using various methods such as Gauss elimination method, Jordan's modification, Jacobi methods of iteration methods, Gauss – Seidel methods of iteration etc.
6. Gel electrophoresis
7. Enzyme kinetics
8. Bacterial growth curve/kinetics
9. Bacterial staining and identification
10. LASER induced cell damage
11. Detection of glucose/cholesterol/pesticides using biosensors

i. Study of the hydrophobicity/hydrophilicity of the given surface using contact angle measurements.

12. Determination of the critical micelle concentration of amphiphilic molecules by conductivity method
13. Fluorescence based biosensors

Semester IV: MBP401: Dissertation and Viva-Voce

Dissertation and viva voce of experimental/ theoretical work on specific topic will be carried out under the supervision of a faculty member of the Centre. The CBCS courses remain as proposed.