Swami Ramanand Teerth Marathwada University, Nanded.

FACULTY OF SCIENCE

SYLLABUS

B. Sc. BIOPHYSICS FY
(SEMESTER I & II)

(June 2011 onwards)

B.Sc. I year Syllabus [Biophysics Optional] At a Glance

SEMESTER – I

Paper Code	*Name*	Max. Marks	Exam Duration	Teaching WL/Week
BP-I	**Molecular Biophysics**	60*	3 Hrs.	3 Hrs.
BP-II	Cellular Biophysics	60*	3 Hrs.	3 Hrs.
BPLAB-I#	Practical based on BP-I & BP-II	60*	4 Hrs.	4 Hrs.

*[50 External + 10 Internal]
#[Examined Annually]

SEMESTER – II

Paper Code	*Name*	Max. Marks	Exam Duration	Teaching WL/Week
BP-III	**Biostatistics & Computer Fundamentals**	60*	3 Hrs.	3 Hrs.
BP-IV	Basic Biophysical Techniques	60*	3 Hrs.	3 Hrs.
BPLAB-II#	Practical based on BP-I & BP-II	60*	4 Hrs.	4 Hrs.

*[50 External + 10 Internal]
#[Examined Annually]

Swami Ramanand Teerth Marathwada University,
Nanded.

B.Sc. I Year Semester 1 & 2 Syllabus [Biophysics Optional]

General Instructions

1. The subject Biophysics be included in Life Science stream and applied subject group within the pattern indicated in SRTM University circular No. **Academic/01/B.Sc.Sub.Combi.2008-2009/1924 dated 17/12/2008**

2. The rules indicated in the SRTM University circular **No. Academic/01/B.Sc. Sub. Combination 2008-2009 /1924 dated 17/12/2008** to be followed while opting for Biophysics as optional.

3. The Biophysics as optional in each of Semester 1 & 2 consists of
   Two Theory Papers each of 60 marks **[50 External + 10 Internal]** and
   One Practical paper of 60 marks **[50External + 10 Internal]**
   consolidating to180**[150 External +30 Internal]**marks per semester in B.Sc. First Year.

4. The total teaching days is 90 days [15 weeks] in every semester
   Every theory paper will have workload of 45 periods per semester each of 60 minutes duration. **(3 periods/wk/paper X 15 weeks=60)**.
   Every practical Paper will have workload of 60 periods each of 60 minutes duration. **(4 periods/wk X 15 weeks=60)**
   This workload is inclusive of test, tutorial to be conducted as mandatory UG activities as a part of internal assessment.

5. The weekly workload is
   [a] Each theory paper in every semester is 4 periods/wk each of 60 minutes
   [b] The practical paper in every semester is 3 periods/wk each of 60 minutes

6. It is essential to complete a minimum of **Ten** practical in practical paper of every semester

7. There should be **TWO** Tests per paper and **ONE** Tutorial per paper during each semester.

8. It is mandatory for students to have minimum **75% attendance** in each Semester.

9. The total number of students per batch during regular practical sessions be **15 students** per batch per practical during B.Sc. First year Semester 1 & 2

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 1 Syllabus [Biophysics Optional]

Paper BP-I: Molecular Biophysics

[Total Marks: 60](50Ext.+10 Int.) [Exam Duration: 3 hrs] [Total Workload:45 hrs]

Unit 1: Atomic & Molecular structure

Structure of atom-Models & theories, Quantum numbers, Schrödinger's theory , Pauli's exclusion principle , Hunds rule , Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, hybridization of orbitals, ó & π bonds, polar & non polar molecules; inductive effect; resonance. Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen, Electrostatic, Disulphide & peptide bonds, Van-der Waals forces Bond lengths & Bond energies , Bond angles, Bayer's strain , Structural isomerism; geometrical isomerism; optical isomerism & optical activity.

Unit 2 : Physico-chemical Foundations

Biophysics of Water: Physicochemical properties of water, Molecular structure, Association of water through H- bonding, Nature of hydrophobic interactions, Water as a Liquid and Solvent:Water Structure, Small-Molecule Solutes: Hydrophiles, Small-Molecule Solutes: Hydrophobes, Large Hydrophobic Solutes and Surfaces , The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces , Aqueous Environment of the Cell,State of water in bio-structures & its significance, Protein Hydration-Nonspecific Effects, The Hydration Shell, Dynamics

Acid & Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, weak acids, Ampholyte, pH, Calculations of pH from H & OH concentrations , measurements of pH , Henderson–Hasselbatch equation , Titration curve & pK values, Buffers & Stability of their pH , numerical problems

Redox potential : Oxidation –Reduction , Equivalence of electrical & chemical energy, Electrochemical cell, contact potentials, galvanic cell, potential of half cell, redox potentials & its calculations by Nernst equation, examples of redox potential in biological system standard electrode potentials & its determination , its relationship with emf, Types of electrodes, pH electrodes, ion selective electrodes, oxygen electrodes

Unit 3 : Physical Foundations of Biophysics

Thermodynamics of Biological system: First and second laws of thermodynamics, activity coefficients and phase equilibrium, activation energy. Biological systems as open, non-equilibrium systems, failure of classical (closed, equilibrium) thermodynamics

in describing biological processes. Concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, Enthalpy, Entropy, free energy as applicable to biological systems. Energy yielding and energy requiring reactions, calculations of equilibrium concentrations, oxidation reduction reactions. Concepts of thermodynamics flux and forces, constitutive equations, onsager reciprocal relations, prigogines principles, priogogine – curie law. Cells as non equilibrium stationary states, stability of non-equilibrium stationary states, non-equilibrium thermodynamics of passive and active transport, glycolytic oscillations, biological clocks.

Bioenergetics: Concept of energy coupling in biological processors, thermodynamics of coupled biochemical reactions, Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. thermodynamic analysis of TCA cycle and oxidative phosphorylation. Stoichiometry and energetic analysis of cell growth and product formation

Unit 4. Biomolecules as molecular alphabets of life

Nucleic acids: Purine and Pyrimidine bases, nucleosides, nucleotides, basic differences in structure and function of RNA and DNA

Amino acids & Proteins: types and reactions of amino acids, Structure of Proteins - primary, secondary, tertiany and quarternary , General reactions of Proteins, N-terminal and C- terminal amino acid determination.

Carbohydrates : Structure and function of mono, di ,oligo and polysaccharides, Reducing & non -reducing sugar, deoxy sugars, reactions of monosaccharides. Structure of D-glucose & D-fructose; formation of glucosides & the cyclic structure of D- glucose; D-ribose & D-deoxyribose; Structure and conformation of diasacharides and polysaccharides- cellulose, amylose, amylopectin & glycogen,Chitin, carbohydrate conjugates,

Lipids : major classes of lipids, Types of lipids; Triglycerides , fatty acids, Fats & oils ,Phospholopids, Glycolipids; lipoproteins, Structure, Function and Localization

Vitamins & hormones: Structure, classification & function

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 1 Syllabus [Biophysics Optional]

Paper BP-II: Cellular Biophysics

[Total Marks: 60] (50Ext.+10 Int.) *[Exam Duration: 3 hrs]* *[Total Workload 45 hrs]*

Unit1:Cell Organization

Cell as the basic structural unit, Origin & organization of Prokaryotic and Eukaryotic cell, Cell size & shape, Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell), Internal architecture of cells, cell organelles, compartment & assemblies membrane system, Ribosome, Polysomes, Lysosomes & Peroxisomes, Connection between cell & its environment, Glycocalyx, Extracellular Matrix.

Unit 2:Cell Cycle & Growth

Kinetics of cell growth, The Cell Cycle, Interphase-G1,S,G2,M molecular events at different cell cycle phases, A cytoplasmic clock times, cell cycle in early embryogenesis, Polypeptide Growth Factors & Control of cell proliferation, Mitosis & Cell division-Molecular mechanism , Events in mitosis, Role of mitotic apparatus, Meiosis & Sexual reproduction, Molecular mechanism of meiosis, significance of meiosis.

Unit 3.Cell differentiation & Cell-Cell Interactions

General characteristics of cell differentiation, Localization of cytoplasmic determinants, Molecular mechanism of cell differentiation, Morphological movements & the shaping of body plains, Cell memory, Concept of positional values, maintenance of differentiated state, Tissue with permanent cells, neuronal networks & centre of the lens of adult eye.
Connection between the cell and its environment, Glycocalyx, Extracellular Matrix, collagen, Elastin, Fibronectin, Lamin, Proteoglycans, Integrins, Cell Junctions, Desmosomes, Gap junction, Tight Junctions, Plasmodesmata .

Unit 4: Basics of Cell Signaling

Synapse and synaptic vesicles, Cell Signaling, General principle of cell signaling, Paracrine, Autocrine, Endocrine &synaptic signaling, Heat Shock Proteins, G-Protein structure and role in signaling, Intracellular Cyclic AMP, Role Ca^{++} in cell signaling, CAM Kinases, (Calmodulin/Ca^{++} dependent protein kinases), Interaction between cyclic AMP & Ca^{++}. Role of Methylation in adaptation & bacterial chemotaxis.

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 1 Syllabus [Biophysics Optional]

Paper BPLAB-I: Practicals Based on BP-I & BP-II

[Total Marks: 60]](50Ext.+10 Int.) [Exam Duration:4 hrs] [Total Workload 60 hrs]

Practicals based on BP-I : Molecular Biophysics

1. Preparation of buffers (acetate, phosphate, citrate, borate buffers).Preparation of Normal, molar and standard solutions,serial dilutions
2. To study the principle of spectrophotometer. To verify the Lambert Beer's law.
3. To determine the beer's limit and measurement of molar and percent extinction coefficient.
4. To estimate the percent purities of dyes and inorganic compounds.
5. To establish the absorption spectrum and determine the absorption maxima of p-Nitro phenol.
6. To plot absorption spectrum of DNA and protein(BSA/Egg Albumin) and find λ_{max}
7. Estimation of ascorbic acid in lemon juice by titration with 2,6 DichlorophenolIndophenol
8. Estimation of Glycine or any other by formal titration method.
9. Estimation of Glucose by ortho-Toludine method
10. Estimation of DNA by DPA method
11. Estimation of RNA by Orcinal method.
12. Estimation of reducing sugars by Benedict's Method.

13. To estimate proteins by Biuret assay, Folin's-Lowry method
14. Spot test for carbohydrates.
15. Qualitative tests for Glucose, Fructose, Ribose ,Maltose
16. Spot tests for Amino Acids.
17. Test for cholesterol.
18. To Isolate of Casein from milk
19. To isolate the Phospholipids from Egg Yolk
20. Estimation of protein from animal and plant sources.
21. Isolation of Starch from potato
22. Acid – Base titration using pH meter and Determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base..
23. To determine the pH titration curve of amino acids & calculate the pKa values.
24. To determine the pH titration curve of Proteins & calculate the pI values
25. To study the biomolecular structures by using ball & stick models
26. To construct the structures of biomolecules using balls & sticks.
27. To Study the simple molecular structures using DTMM or other basic molecular modeling software.

Practicals based on BP-II : Cellular biophysics

1. To learn a) use of microscope b) principles of fixation and staining; To familarize with bright field, phase contrast, fluorescence & polarizing microscopes. and micrometry.
2. Microscopic observation of bacteria, microalgae, fungi, lichen and protists; Cell staining – Staining of Plant cell (onion epidermal cell), Animal cell (Squamous epithelial cell), Blood cell, Microbial cells (Bacteria & Yeast).
3. To study cell structure from onion leaf peels ; Shape and size of the cell–simple & differential staining
4. Cell division- Examination of various stages of mitosis and meiosis -mitosis (Onion root tip)& Meiosis (Tradescantia flower buds / grasshopper testes)
5. Polytene chromosome (chironomous larvae)
6. Separation of chloroplast & flower pigments by paper chromatography
7. Microbiological Techniques:
   1. Preparation of Media(Media preparation : Nutrient agar and Nutrient broth), Cotton Plugging and Sterilization, Pure culture and maintenance of culture, Dilution and pour plate techniques. Standard plate count, Gram staining, other staining methods
   2 .Bacterial growth curve- To raise the culture of E. coli and estimate the culture density by turbidity method. Draw a growth curve from the available data. determination of generation time
8. Study of different types of eggs; Study of egg of hen and vital staining of embryo;Culture of chick embryo fibroblast –Demonstration,Study of frog development, observation of frog embryo different developmental stages; Study of different types of sperms by smear preparation

9. To study Permanent slides :
    - Cytochemical staining of DNA-Feulgen.
    - Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
    - Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
    - Cytochemical staining of Total proteins- Bromophenol blue.
    - Cytochemical staining of Histones -Fast Green
10. To study the histochemical localization of Alkaline & Acid Phosphatase, Glycogen & Lipids in the tissue
11. To study the cytochemical distribution of nucleic acids and muco-polysaccharides with in cells/tissues from permanent slides.
12. To demonstrate the presence of mitochondria in striated muscle cells using vital stain Janus Green B from permanent slides
13. Identification and study of cancer cells –Slides/ photomicrographs
14. Blood analysis: Estimation of RBC count, WBC count, Differential count, Hb%, Packed cell volume, E.S.R.

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 2 Syllabus [Biophysics Optional]

Paper BP-III: Biostatistics & Computer Fundamentals

[Total Marks: 60](50Ext.+10 Int.) [Exam Duration: 3 hrs] [Total Workload 45 hrs]

Unit 1 -Biostatistics, Statistical Terms and Collection of Data, Classification of Data, Frequency Distribution and Presentation of Data

Statistics,Biostatistics and Biometry,Descriptive and Inferential Biostatistics,Sample and test Biostatistics,Statistical Terms,Limitations of Statistical Methods,Aims of Biostatistics, Applications of Biostatistics.Census and Sampling Methods of Data Collection,Necessity of Sampling,Types of Sampling Methods Random or Probability Sampling–Nonrandom or Non Probability Sampling. Data, Data collection, Data Processing ,Data Summarization, Classification of Data Methods of classification of Data,Difference s Between Classification and Tabulation, Formation of Frequency Distribution.Tabular Representation of Data, Graphic Representation of Data,Line Diagram,Histogram,Frequency Polygon,Frequency Curve, Cumulative Frequency Curve or Ogive, Scatter or Dot Diagram,Bar Diagram, pie diagram, Pictogram, Cartogram.

Unit 2-Measures of Central Tendency, Dispersion, Correlation & regression

Average, Objectives of Averages, Characteristics of an Ideal Measure of Central Tendency Types of Averages, Mean, Median, Mode, Meaning of Dispersion,Measures of Dispersion, Range, Standard Deviation, Coefficient of Variation, Standard Error. Correlation, Types of Correlation, Measures of Simple Correlation, Rank Correlation. Regression, Simple Regression, Regression Equation,Regression Coefficients.

Unit 3- Probability, Test of Hypothesis and Tests of Significance

Important Terms and Concepts, Sample point, Sample space, Trial and Event; Classical Definition of Probability, Frequency Definition of Probability,Rules of Probability (Addition Rule and Multiplication Rule) Random variable and Probability Distribution,Binomial Distribution, Poisson Distribution and Normal Distribution. Statistical Inference, Test of Significance, Procedure for Carrying out test of Significance, Computation of Test of Significance, Test for the mean of a Normal Population, chi-square test,`t' test, F-test and their significance, analysis of variance(ANOVA)

Unit 4: Computer Fundamentals

Computer system at a glance processor (CPU, ALU) Memory (ROM, RAM, CACHE data and address bus) Storage, Input & Output devices, Computer peripherals, Binary code and binary system, Algorithms and Flow charts, Software & Hardware, Operating systems (Dos, Windows) Application software's (MS-office) Super computer, Mainframe computers, Mini computers, Micro computers, Workstation, Concept of multimedia and its applications. Network concepts (LAN, WAN, MODEM, Fibre-Optics Network) and its topology, Network media and hardware. Design and application of modern data communication over telephone lines and Digital telephone lines. Internet protocols HTML, XML, WWW (World wide webs) Internet connectivity, search engines.

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 2 Syllabus [Biophysics Optional]

Paper BP-IV: Basic Biophysical Techniques

[Total Marks: 60](50 Ext. + 10 Int.) *[Exam Duration: 3 hrs]* *[Total Workload 45 hrs]*

Unit 1.Optical Techniques :

Light wave-Geometric, wave, quantum optics, Reflection ,Refraction, Diffraction, Interference phenomena, **Refractometry**: Refraction of light and snell's law, refractive index , principle ,design, working and application of Abbe's refractometer, **Light microscopy:** Simple ,compound optical microscope, Phase contrast and interference contrast microscope, inverted microscope, Fluorescence and polarizing microscope principle, design magnification, resolution, numerical aperture, care and maintenance of microscopes, micrometry **Polarimetry**: Polarization of light, stereoisomers, optical activity and its measurement, specific rotation, molar rotation, optical activity of some biomolecules and its significance.

Unit 2.Hydrodyanamic Techniques :

Centrifugation:Concept of sedimentation Basic principles, Forces involved, RCF, partial specific volume Centrifugation techniques-Differential centrifugation, principle, design, types and applications of different Centrifuges.**Viscometry:**General features of fluid flow (streamlined and turbulent) nature of viscous drag for streamlined motion. Definition of viscosity coefficient. Origin of viscosity of gases and liquids, temperature dependence of viscosity coefficient of gases and liquids. Stroke's law and terminal velocity. Determination of viscosity coefficient of liquids, diffusion of gases and solute in solution, Fick's law, viscometric measurements, determination of coefficient of viscosity, Stokes law, Oswald's viscometer, relative, specific and intrinsic viscosity, factors affecting viscosity, applications of viscometry in bimolecular structure determination.

Unit 3. Physico-chemical & Electroanalytical techniques : :

Chromatography : Adsorption, Partition, Partition coefficient, Basic principles of Adsorption & Partition Chromatography, Principle Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods-chromatography using paper, thin layer, Column (gel filtration, ion exchange, affinity), gas(GC,GLC) **Electrophoresis :** Principle, Electrophoretic mobility(EPM) estimation,

factors affecting EPM , Methodology & Applications of Free & Zone Electrophoresis techniques, micro-electrophoresis principles and applications of paper, Cellulose acetate , agarose gel ,polyacrylamide gel (native and SDS) electrophoresis., Principle, Experimental set-up, Methodology & Applications isoelectric focusing

Potentiometry & voltametry,pH meter–principle, design, and working of pH meter, care & maintainance of pH electrodes,Ion selective electrode-design, use, Conductimetry-conductivity of ionic solutions,cellconstants,specific conductance,conductance measurement, Conductometric titrations.

Unit 4. Absorption & Fluorescence Spectroscopy:

Electromagnetic spectrum, properties of electromagnetic radiations, concept and types of spectroscopy, absorption spectrum, energy characteristics of spectrum, fundamental laws of photometry, Beer's law and its deviation ,concept of $\lambda_{max,}$ chromophoric shifts, Photometric analysis, Principles of fluorescence and fluorimetry; Colorimeter, spectrophotometer & Spectrofluoriphotometer-design,working,care, maintenance and applications.

Swami Ramanand Teerth Marathwada University, Nanded

B.Sc. Semester 2 Syllabus [Biophysics Optional]

Paper BPLAB-II: Practicals Based on BP-III & BP-IV

[Total Marks: 60]](50Ext.+10 Int.) [Exam Duration: 4 hrs] [Total Workload 60 hrs]

Practicals based on BP-III : Biostatistics & Computer Fundamentals

1. Presentation of Statistical data by Histogram, Ogive curves, Pie diagram. frequency tables, graphs (5 assignments)
2. Measurement of central tendencies: - Arithmetic & Geometric mean, Mode and Median. (5 assignments)
3. To calculate the measures of dispersion.:(6 assignments)
   Mean deviation. Quartile deviation ,Standard deviation and Coefficient of variation.
4. Test of Significance. (6 assignments):Chi-Square test, t- test.
5. Calculating the Correlation coefficients.
6. Finding Regression coefficients and Regression lines
7. Basic operating procedures of computer.Basic commands – File creation, Copying and deleting in Linux and Windows
8. To create File, Folder, Directories. (2 assignments)
9. Familiarity with the Basic operations of MS-office. (7 assignments)
10. Familiarity with use of Internet, Search engines, Web sites, Surfing, Browsing websites such as NCBI,EMB,DBT,DDBJ, Ethics in Internet surfing, Downloading text and Graphics. (4 assignments)
11. Creating Email account, Using Email, Sending and Receiving mails.

Practicals based on BP-IV : Basic Biophysical techniques

1.Refractometry

(i)Use of Refractometer and determine RI of biofluids, biomolecular solutions

(ii)To obtain relation between concentration & Refractive Index for solutions of proteins and sugars and estimation of specific refraction increment for proteins

(iii)Determine refractive index of a given liquid as a criterion for its purity (Benzene i.e. commercial benzene + A.R. acetone)

2.Polarimetry

(i)Use of polarimeter and determination of observed rotation α ,specific rotation[α] and molar rotation [m'] for amino acids and sugars

(ii)Determination of the percentage composition of optically active solution.

3. Conductometry

(i)Determination of cell constant

(ii)Determination of specific and equivalent conductance of electrolyte (NaCl and HCl) and Bio-fluids

4.Absoption & Fluorescence Spectroscopy

(i) To study the principle of colorimeter and spectrophotometer and determine suitable filter for light absorption studies of inorganic salts. Verify Beer-Lambert law. Determine molar Extinction coefficient

(ii)To plot absorption spectrum of DNA and protein and find λ_{max}.

(iii)Effect of different solvents on UV absorption spectra of proteins

(iv)Study of structural changes of proteins at different pH using UV Spectrophotometry

(v)Study of structural changes of proteins at different temperature using UVSpectrophotometry.

(vi)Differentiate single stranded DNA from double stranded DNA

(vii) Quantitative estimation of DNA/RNA using spectroscopy.

(viii) Fluorescence spectrum of protein and Nucleic acids

5.Viscometry

(i) Use of Ostwald viscometer. & Determination of coefficient of viscosity η of biofluids.

(ii) Determination of relative viscosity of a macromolecule (Protein & DNA) in native and altered state of the biomolecule.

6.Electrophoresis

Separation of Biomolecules (amino acids, proteins) by paper electrophoresis.

7. pH meter

(i) Use of pH meter and measuring the pH of the buffer solutions

(ii) Acid base titration of HCl vs. NaOH

(iii) To obtain pH titration curve for amino acids and estimate their pKvalue

(iv) Determination of ionization of a weak acid (CH3COOH)

8.Chromatography

(i)Separation of amino acids and sugars using paper and Thin layer chromatography. Estimate their Rf value

(ii)Fractionation of mixture of amino acids and sugars using Paper & TLC

ANNEXURE: - Recommended Books and Journals.

1. Ackerman E.A. Ellis, L.E.E. & Williams L.E. (1979), Biophysical Science, Prentice-Hall Inc.
2. Barrow. C. (1974), Physical Chemistry For Life Sciences, McGraw-Hill.
3. Berns M.W. (1982), Cells, Holt Sounders International Editors.
4. Bloomfield V.A. and Harrington R.E. (1975), Biophysical chemistry, W.A.Freeman and CO.
5. Cantor C.R. and Schimmel P.R. (1980), Biophysical chemistry, W.A.Fremman and Co.
6. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west press.
7. De Robertis E.D.P. and De Robertis E.M.P. (1981), Essentials of cell and molecular Biology, Holt sounders International Editions.
8. Dugas H. and Penney C. (1981), Bioorganic chemistry, Springer-Verlag.
9. Haschemyer R.N. and Haschemyer A.E.B.V. (1973), Proteins**,** John willey and sons.
10. Hughes W. (1979), Aspects of Biophysics, John willey and sons.
11. Lehninger A. (1981), Biochemistry, Butter Worth Publication.
12. Pesce A.J., Rosen C.G and Pasty T.L., Fluorescence Spectroscopy: An introduction for Biology and Medicine, Marcel Dekkar.
13. Pullman B. (1978), Molecular Association in Biology, Academic Press.
14. Saenge W. (1984), Principles of Nucleic acid structure, Springer-Verlag.
15. Schule G.E. and schirmer R.H. (1984), Principles of protein structure, Springer-Verlag.
16. Setlow R.B. and pollard E.L. (1962), Molecular Biophysics, Pergamon Press.
17. Sheelk P. and Birch D.E. (1983), Cell Biology Structure, Biochemistry and function, John willey and sons.
18. Spragg S.E. (1980), Physical Behavior of macromolecules with biological functions, John willey and sons.
19. Stanford J.R. (1975), Foundation of Biophysics Academic press.
20. Stryer L. (1981), Biochemistry, W.A. Freeman and Co.
21. Szekely M. (1984), From DNA to protein, Macmillan.
22. Volkenstein M.V. (1977), Molecular Biophysics, Mir Publication.
23. Basar E. (1976), Biophysical and physiological system Analysis, Addition-Wesley.
24. Guyton A.C. (1981), Textbook of Medical Physiology, Sounders co.
25. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance. (1995), Principles of Biochemistry, Wm.c.Brown Publishers.
26. Sambrook and Russell (2001), Molecular cloning (A laboratory Manual) cold spring Harbor Laboratory Press.
27. Henry B. Bull (1971), An Introduction to physical biochemistry, F.A.Devis Co.
28. Gerald Karp (1996), Cell and Molecular biology concepts and experiments, John willey and sons, Inc.
29. Loewy Sickevitz, Menninger, Gallant (1991), Cell structure and function, Sounders college pub.

30. Jean Brachet (1985), Molecular cytology, Academic press.
31. Hans Netter (1969), Theoretical Biochemistry, Oliver and Boyd, Springer-verlag Press.
32. Carl Branden and John Tooze (1991), Introduction to protein structure, Garland publishing, Inc.
33. David Freifelder (1987), Molecular Biology, Narosa Publishing house.
34. Thomas E. Creighton (1994), Proteins: Structure and Molecular properties, W. A. Freeman and co.
35. M. Satake, Y.Hayashi, M.S. Sethi & S.A.Iqbal (1997), Biophysical chemistry, Discovery publishing house.
36. C.Edward Gasque (1992), A manual of lab. Experience in Cell biology, Universal stall.
37. F. Heinmets (1970), Quantitative Cellular Biology, Marcal Dekker, Inc.
38. Daniel L. Hartl (1995), Essential genetics, Jones and Barlett Publishers.
39. Bernard R. Glick and Jack J. Pastermak: (1994), Molecular Biotechnology Principles and Applications of Recombinant DNA.
40. Clearance H. Suelter (1985), A practical guide to enzymology, John willey and sons.
41. Robert K. Scopes (1994), Protein Purification Principles and practice, Narosa Pub. House.
42. Stanley R. Maloy (1983), Experimental techniques in bacterial genetics, John and Bartlett pub.
43. V. A. Bernstam (1997), V.YA. Alexandrov: Cells, Molecule and temperature, Springer-verlag.
44. H. H. Perkampus (1992), UV-VIS Spectroscopy and Its applications, Springer-Verlag.
45. Felix Franks (1985), Biophysics and Biochemistry at low temperature, Cambridge University Press.
100. Bernard Pullman (1978), Proteins in physicochemical Biology, Academic Press
101.R.Glaser, D. Gingell (1990), Biophysics of the cell surfaces, Springer-verlag.
102.J. B. C. Findlay and W. H. Evans (1987), Biological Membranes a practical approach, ORL press.
103.Darnell, Lodish, Baltimore (1986), Molecular cell biology, W.H.Freeman Press.
104.P. W. Arora, P.K. Malhan (2002), Biostatistics, Himalayas pub. House, Mumbai.
105.Vijaya D. Joshi (1995), Prep. Manuals for Physiology, B.I.Churchill living stone Pvt. ltd.
106.R. N. Roy (1998), Viva and Practical Physiology, Biochemistry and Biophysics, Books and allied Pvt. Ltd.
107..P. S. S. Surnder Rao and J. Richard (1996), An introduction to Biostatistics, Prentice Hall of India.
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109 .Manisha Dixit (2000), Internet an Introduction, Tata McGraw-Hill.
110.Timontry J. O'Leary, Linda I. O'Leary (1999), Microsoft windows 98, Tata McGraw Hill.
111.Timothy J. O'Leary, Linda I. O' Leary (2000), Microsoft office-2000, Tata

McGraw Hill.
112.Pitter Norton's (1999), Introduction to Computers, Tata McGraw Hill.
113..S.M.Khopkar (1984), Basic Concepts of Analytical chemistry, Willey eastern lit.
114.Campbell R.C. (1974), Statistics for biologist, Cambridge University Press.
115..Bliss C. I.K. (1967), Statistics in biology vol. 1 Mac-Graw Hill.
116..Wardlaw, A.C (1985), Practical Statistics for Experimental biologist.
117. Bailey, (2000), Statistical Method in biology.
118. Daniel Wayle W., Biostatistics (A foundations for analysis in health sciences).
119. Khan, Fundamental of Biostatistics.
120. Lachin, Biostatistical Method.
121. Friefelder D, Physical Biochemistry, W. H. Freeman and co.
122. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
123. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
124. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
125. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco
126. David Sheehan, Physical Biochemistry: Principles and Applications, 2nd Edition, John Wiley, 2009.
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