



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

B.SC. BIOCHEMISTRY
NEP 2020

2023 ONWARDS



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER I

Subject Code	Subject title	Credit
MJ01BCH	INTRODUCTION TO BIOCHEMISTRY AND BIOMOLECULES	3

Unit I :

Introduction to Biochemistry (Definition, Historical background (Pasteur, Buckner Expt, Crebs discovery, EM), Importance of the study etc.), Scopes and future prospects of Biochemistry in academic as well as industrial aspects (Just mentioning the scope). Origin of life, types of organisms, prokaryotes, eukaryotes, unicellular, multicellular, compartmentation of functions in lower and higher organisms, endosymbiotic theory and common physiological events of organisms, chemical composition of living organisms, sub-cellular organelles: Structure, function and interrelationship (brief idea). SI units, mass, volume, temperature, amount, length and time. An overview on the metric system, atomic weight, molecular weight, equivalent weight, basicity of acids, acidity of bases, Avogadro's number, molarity, normality, molality, Dalton concept, mole concept, concentration, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significances.

Unit II :

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars - hemiacetals or hemiketals, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives (N-acetyl- β -D-glucosamine, N-acetylmuramic acid), oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids. (Definition, structure, functions, examples only) Carbohydrates as informational molecules, working with carbohydrates (applications of carbohydrate, carbohydrates are significant for energy production, energy source). Brief outline of Glucose utilization and ATP production in human body (only outline of digestion, absorption and metabolism i.e. schemes of glycolysis, TCA cycle, oxidative phosphorylation, gluconeogenesis, glycogenesis and glycogenolysis).



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit III :

Definition, classification and structures of amino acids, uncommon amino acids (4-hydroxyproline, 5-hydroxylysine, gamma carboxyglutamate, selenocysteine-occurrence in proteins). Molecular asymmetry/Chirality of amino acids, Physico-chemical properties of amino acids (amphoteric molecules, ionization, zwitterions, pK values, isoelectric point, Lambert-Beer's law, optical density, absorption spectra), alkali titration of amino acids (alanine, glutamic acid, lysine), Formol titration of glycine (only reaction and principle), reaction of amino acids: ninhydrin and fluorescamine, separation and analysis of amino acids by paper & thin layer chromatography.

Unit IV :

Peptide bond: Definition, structure and geometry of peptide bond, peptide bond lengths and configuration, dihedral angles, psi and phi helices, beta-sheets and turns, Ramachandran plot (Preliminary Concept). Nature of stabilizing bonds in protein— covalent and non-covalent forces. Proteins: Definition of structure, primary, secondary, tertiary and quaternary structure (definition and example), structure of globular protein (albumin, globulin, haemoglobin & myoglobin – Structure, function and occurrence in brief) and fibrous protein (keratin, collagen - role of Vitamin C in hydroxylation, elastin- Structure, function and occurrence in brief). Forces that stabilize structure of proteins. Different types of conjugated proteins (lipoproteins, metalloproteins, glycoprotein, phosphoprotein, hemoprotein, flavoprotein with one example each) Tests for protein (Biuret and FolinLowry test). Biologically important peptides – Biologically important peptides hormones (insulin, oxytocin), antibiotics (penicillin, gramicidin S) and growth factors (EGF, PDGF) (Sources and functions).

Unit V :

Building blocks of lipids – fatty acids, glycerol, ceramide. Storage lipids – triacyl glycerol and waxes. Structural lipids in membranes – Phospholipids, glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids as signal molecules (phosphatidyl inositols and sphingosine derivatives), cofactors (vitamin E and K) and pigments (conjugated dienes-preliminary ideas only).



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit VI:

Nucleotides – structure and properties. Nucleic acid structure--- Watson-Crick model of DNA. Forms of DNA (A, B and Z DNA), Structure and function of major species of RNA – mRNA, tRNA and rRNA. Basic concept of central dogma (Schemes of Replication, transcription and translation), Nucleic acid chemistry – DNA UV absorption, effect of acid and alkali on DNA and RNA. DNA melting, T_m value of DNA, hyperchromic shift of A_{260} of dsDNA during denaturation. Other functions of nucleotides – source of energy (nucleoside triphosphates), component of coenzymes (FAD, NAD⁺), second messengers (cAMP, cGMP).

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-3414-8.
2. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
3. Harper's Illustrated Biochemistry (27th edition), ISBN-13:978-0071253017
4. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1- 4292-2936-4



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL01 BCH	INTRODUCTION TO BIOCHEMISTRY AND BIOMOLECULES –LAB	1

PRACTICALS:

1. Separation of amino acids by thin layer chromatography.
2. Qualitative test for carbohydrate.
3. Qualitative test for lipid.
4. Qualitative test for amino acids & proteins.
5. Assay of proteins using Lowry method, standard curve preparation.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER II

Subject Code	Subject title	Credit
MJ02BCH	TOOLS AND TECHNIQUES IN BIOCHEMISTRY	3

Unit I:

Safety practices in the laboratory, preparation and storage of solutions, concepts of solution concentration and storing solutions: Standard solutions, molar, normal, molal, formal and percent strengths, quantitative transfer of liquids. Special chemical requirement of biomolecules, factors affecting analyte structure and stability, pH, temperature and solvent polarity, buffering systems used in biochemistry, concept of colligative properties (no derivations), osmolarity, diffusion of solutes in solution. Basic Instruments and techniques: Working principles, basic operation and application of weighing balance, pH meter, autoclave, laminar air flow, Water Baths, CO₂ Incubators, Shaking Incubators, Hot Air Ovens, Bio-Safety Hoods. Pipettes and MilliQ water system. Principle of asepsis and sterilization technique.

Unit II:

Microscopy – Working principles, basic operation and application of Light and phase contrast microscope. Principle and working of SEM, TEM,STEM.

Unit III:

Centrifugation techniques: Sedimentation (Sedimentation coefficient, Svedberg unit), Centrifugation: Working principles, basic operation and application of micro-centrifuge, ultracentrifuge and density gradient centrifugation, applications (isolation of cell components).

Unit IV:

Different Biophysical Techniques Theories of light (wave-particle duality), the electromagnetic spectrum, UV/visible absorption spectroscopy, physical basis, Beer Lambert's law, deviations of Beer Lambert's law, transitions, applications of UV-visible spectroscopy, UV-visible spectroscopy of proteins and nucleic acids



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Reference Books

- Biological instrumentation and methodology by Dr. P.K. Bajpai→
- Techniques and methods in Biology by K.L. Ghatak→
- Experimental procedures in Life Sciences by S. Rajan and R. Selvi Christy→
- Methodology of Biological Science by R. Bakkappa→
- Principles and techniques of Biochemistry and Molecular Biology by Wilson and→ Walker
- Tools and techniques in Biological Science by Dev, Vats and Chaturvedi→
- A Book on Biological techniques by Pawar and Desai→



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL02 BCH	TOOLS AND TECHNIQUES IN BIOCHEMISTRY –LAB	1

1. Safety measure in laboratories, use and calibration of pipettes
2. Preparation of normal, molar and percent solutions
3. Standardization of NaOH and acetic acid solutions
4. Concept of pH and preparation of buffers, pH metric titration of a weak acid with a strong base.
5. Determination of extinction coefficient of different BSA solutions by spectrophotometer.

Reference Books:

- Physical Chemistry - P. C. Rakshit→
- Lehninger Principles of Biochemistry - Nelson→ & Cox
- Text Book of Physical Chemistry - K. L. Kapoor Physical Chemistry-Hrishikesh Chatterjee→
- Techniques and Methods in Biology - K. L. Ghatak→
- Physical Biochemistry: Principles and Applications - D. Sheehan,→
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology – D.→ Freifelder
- An Introduction to Practical Biochemistry – D. T. Plummer→
- Molecular Spectroscopy - C. N.→ Banwell&McCash Organic Spectroscopy - William Kemp



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER II

Subject Code	Subject title	Credit
MJ03BCH	GENERAL AND ORGANIC CHEMISTRY	3

Unit I:

Atomic Structure (briefly) Concept of atomic orbital, shapes of s, p and d orbitals, radial and angular probability of s, p and d orbitals (qualitative idea). Many electron atoms, Pauli Exclusion Principle, Hund's rule of maximum multiplicity, exchange energy, Aufbau (building up) principle and its limitations, electronic energy levels and electronic configurations of hydrogen like and polyelectronic atoms and ions (concept only), Ground state term symbols of atoms and ions (concept only).

Unit II:

a. Ionic bonding Size effects- radius ratio rules and their limitations. Packing of ions in crystals, Lattice energy (concept only), Born-Landé equation (derivation not required) and its applications; Born-Haber cycle (derivation not required) and its application. Preliminary ideas of solvent energy, polarizing power and polarisability, ionic potential and Fajan's rules.

b. Covalent bonding Lewis structures, formal charge, Preliminary idea of Valence Shell Electron Pair Repulsion (VSEPR) Theory, shapes of molecules and ions containing lone pairs and bond pairs. Partial ionic character of covalent bonds, bond moment and dipole moment, Partial ionic character from dipole moment values and electro negativity differences, Preliminary idea of valence Bond Theory (Heitler-London approach). Directional character of covalent bonds, hybridization, equivalent and non-equivalent hybrid orbital, Bent's rule; Concept of resonance, resonance energy, resonance structures, bonding, nonbonding, antibonding molecular orbitals (concept only) elementary pictorial approach of H₂ and O₂ molecular orbitals, sigma and pi bonds, multiple bonding. Concept of Bond order, bond length, bond strength, bond energy.

c. Weak Chemical Forces Van-der Waal's forces, ion-dipole, dipole-dipole interactions, London forces, Hydrogen bonding; Effect of chemical forces on physical properties



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

d. Co-ordination compounds Double salts and complex salts, Werner's theory, ambidentate and polydentate ligands, chelate complexes, Naming of co-ordination compounds (up to two metal centres). Isomerism of co-ordination compounds: Constitutional, geometrical and optical isomerism in respect co-ordination numbers 4 and 6. Determination of configuration of cis-, trans- isomers by chemical methods.

Unit III:

Laws of radioactivity, Radioactive decay, decay constant, average life of radio elements and its relation with half-life, radioactive equilibrium, properties of α , β & γ radiations, radiation damage, radiation protection and safety aspects, units of radioactivity, radioactive carbon dating, Fundamental particles of atomic nucleus, atomic number and its significance, nucleus stability, neutron proton ratio and different modes of decay, nuclear binding energy, nuclear forces. Examples of radio isotopes (^{14}C , ^3H , ^{32}P , ^{35}S , ^2H) and their uses in biological systems. Basic principles of liquid scintillation counter. Radiation absorption, Radiation therapy in cancer (examples only).

Reference Books:

1. General & Inorganic Chemistry-R.P.Sarkar
2. Inorganic Chemistry-R.L.Dutta
3. New Concise Inorganic Chemistry -J.D.Lee
4. Inorganic Chemistry, Principles of Structure and Reactivity-J.E.Huheey, E.A. Keiter, & R.L. Keiter
5. Fundamental Concepts of inorganic Chemistry-A.K.Das



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL03 BCH	GENERAL ORGANIC CHEMISTRY (PRACTICAL)	1

- I. Physical characteristics (colour, odour, texture)
- II. Solubility and classification (Solvents: H₂O, 5% HCl, 5% NaHCO₃, 5% NaOH)
- III. Detection of special elements (N, Cl, S) by Lassaigne's tests.
- IV. Detection of the following functional groups by systematic chemical tests: (aromatic amino (– NH₂), aromatic nitro (– NO₂), Amido (– CONH₂, including imide), Phenolic –OH, Carboxylic acid (– COOH), Carbonyl (>C=O); only one test for each functional group is to be reported)

Reference Books:

- (i) Advanced Practical Chemistry–Subhas Ch. Das
- (ii) Handbook of Practical Chemistry– University of Calcutta



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER III

Subject Code	Subject title	Credit
MJ04BCH	MYCOLOGY AND PHYTOPATHOLOGY	3

Subject Name: Protein Purification Techniques

Unit I:

Protein Isolation- Methods of solubilisation of proteins from their cellular and extracellular locations- cytosolic, integral and peripheral membrane protein. Brief outline of the use of simple grinding methods, homogenization, ultra sonication, French press and centrifugation, sedimentation coefficient, stabilization of proteins during purification.

Unit II:

Solubility of Proteins based on Protein Purification- Salting in and salting out (Ammonium sulphate fractionation), solvent fractionation, Isoelectric precipitation), lyophilization, Dialysis, Ultrafiltration (Principle and application), Ultracentrifugation

Unit III:

Chromatographic Separation: partition coefficient, phase systems, liquid and gas chromatography, performance parameters: retention, resolution, basis of peak broadening, peak symmetry, Principle, Application, Advantages and Disadvantages, limitation for different modes of chromatography- Partition Chromatography (Paper Chromatography, hydrophobic interaction/ reverse phase chromatography), Adsorption Chromatography ;Thin Layer Chromatography, Gel filtration chromatography, affinity chromatography, Ion-exchange chromatography, Demonstration of High Performance Liquid Chromatography (HPLC), brief concept of FPLC.

Unit IV:

Electrophoresis Techniques: Brief concept of Paper electrophoresis, Principle and application of different types of Gel Electrophoresis (PAGE- horizontal and vertical, SDS-PAGE and molecular weight determination, Isoelectric Focusing (IEF) and 2-D gel electrophoresis, Capillary Electrophoresis (CE).



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit V :

Determination of purity, specific activity, extinction coefficient of enzymes / proteins. Mass Spectrometry (Principle and application only).

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1- 4292-3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN: 978-1180-25024.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL04 BCH	PROTEIN PURIFICATION TECHNIQUES- LAB	1

PRACTICALS:

1. Assay of enzyme activity and specific activity of Alkanine Phosphatases
2. Determination of Molecular weight of protein from SDS-PAGE (kit based)
3. Column chromatography (size exclusion) by teaching kit (Determination of Void volume)



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER III

Subject Code	Subject title	Credit
MJ05BCH	ENZYMOLGY	3

Unit I:

Enzyme and Enzyme Catalysis a. Definition of enzymes, Nature of enzymes, protein and non-protein (ribozyme), apoenzyme and holoenzyme, differences between biocatalysts and chemical catalysts. b. Cofactors: metal ions (Zn^{+2} , Mg^{+2} , Fe^{2+}) [one example of enzyme using metal ion with reaction], coenzymes, (NAD^+ , $NADP^+$, HSCoA, FH_4 , cobalamin), prosthetic groups (FAD, TPP, PALPO, biotin) [structures not needed, vitamin precursors, two examples of enzymes for each with reactions showing proper equation] , co-substrate (NAD^+)- one example with reaction. c. IUBMB Classification of enzymes, Name & two examples of each class with reaction d. Concept of active site, Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. proximity and orientation effect (orbital steering hypothesis to be mentioned), strain and distortion theory (example of Lysozyme/RNase catalyzed reaction). e. Catalytic power and specificity of enzymes (stereospecificity and geometric specificity) f. Mechanism of enzyme catalysis (basic concepts) i) acid- base catalysis (example- RNase A) ii) Metal ion catalysis: Metal activated enzymes (e.g., hexokinase) and metalloenzymes (e.g., carbonic anhydrase) iii) covalent catalysis (example- chymotrypsin)

Unit III:

Enzyme kinetics a. Parameters for spontaneous chemical reactions (Concept of ΔG , ΔH , ΔS , K_{eq}), concept of Activation Energy, energy profile diagram for uncatalyzed and enzyme-catalyzed reactions, Definition of Transition state, rate-determining step of a reaction, multistep reactions with energy profile diagram, binding energy, transition state analogs. b. Concepts of rate, rate constant and order of a reaction (first order reaction- derivation not needed, rate equation and graph needed), half-life period and its significance. 17 c. Concept of pre steady state and steady state, initial rate, maximum velocity (V_{max}), Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions, association and dissociation constant, Michaelis-Menten equation (derivation and



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

graphical representation), Lineweaver- Burk plot, Eadie-Hofstee and Hanes plot. K_m and V_{max} , K_{cat} and turnover number, K_{cat}/K_m , enzyme activity, specific activity, katal, International Unit of enzyme activity. Numerical problems on Enzyme kinetics. d. Factors on which enzyme catalyzed reactions depend: Substrate concentration, enzyme concentration, pH, temperature, time, metal ions on the activity of enzyme (Cu^{2+} , As^{2+} , Hg^{2+} , Pb^{2+} : one example of each). e. Bisubstrate reactions: Sequential reactions (Ordered and Random reactions with definition and example), Ping-pong reactions (definition and example of transamination reactions), differences between sequential and ping-pong reactions.

Unit III:

Enzyme Inhibition and Regulation of Enzyme Activity a. Reversible inhibition (competitive, uncompetitive, non-competitive, mixed – one example of each, Michaelis-Menten equation in the presence of respective inhibitor and effect of each inhibitor on K_M and V_{max} values.) b. Irreversible inhibition- Mechanism based inhibitors (suicide substrate or suicide inhibitor), example of an antibiotic that acts as an inhibitor (Penicillin) c. Control of activities of single enzymes: feedback inhibition d. Properties of Allosteric enzyme (Aspartate transcarbamoylase) and its regulation, definition of M and K enzymes, Sequential and Symmetry Model. e. Reversible covalent modification: phosphorylation and dephosphorylation (glycogen phosphorylase and glycogen synthase). f. Proteolytic cleavage- zymogen (chymotrypsinogen and trypsinogen). g. Isoenzymes - properties and physiological and clinical significance (lactate dehydrogenase and creatine kinase).

REFERENCE BOOKS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10: 1-4292-3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN: 978-1180-25024. 18
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN: 0 19 850229 X.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL05 BCH	ENZYMOLGY – Lab	1

PRACTICALS:

- Standard curve of p-nitrophenol.
- Assay of enzyme activity and specific activity of Alkanine Phosphatase.→
- Effect of pH on the enzyme activity.→
- Effect of temperature on the enzyme activity.→
- Determination of Km and Vmax using Lineweaver-Burk graph.→
- Enzyme inhibition - calculation of Ki for competitive inhibition.→



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER IV

Subject Code	Subject title	Credit
MJ06BCH	METABOLISM OF CARBOHYDRATES AND BIOENERGETICS	3

Unit I :

Basic design of metabolism Autotrophs and heterotrophs, Metabolic pathways, catabolism and anabolism, ATP as energy currency, Reducing power of the cell.

Unit II:

Glycolysis, Gluconeogenesis, pentose phosphate pathway and Glycogen metabolism Glycolysis - a universal pathway, reactions of glycolysis and role of the enzymes involved, net number of ATP molecules formed, fates of pyruvate, fermentation (homolactic and alcoholic), substrate cycling (one example), feeder pathways for glycolysis (fructose, mannose, galactose), galactosemia. Synthesis of glucose from non-carbohydrate sources, Steps in Gluconeogenesis(not exact reversal of glycolysis), role of the enzymes: Pyruvate Carboxylase and PEPCK, Glucose6-phosphatase, Fructose bisphosphatase, Reciprocal regulation of glycolysis and gluconeogenesis Pentose phosphate pathway: pathway, role of enzymes, significance, control of the pathway and Glucose-6-phosphate dehydrogenase deficiency. Glycogenesis and glycogenolysis : pathways, regulation of glycogen metabolism, glycogen storage diseases.

Unit III:

Citric acid cycle Production of acetyl CoA (Role of PDC: steps and reactions), Reactions of citric acid cycle : role of enzymes and net ATP count, Amphibolic nature of TCA cycle, Regulation of citric acid cycle, Glyoxylate cycle.

Unit IV:

Bioenergetics Introduction to bioenergetics ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Universal electron carriers. Oxidative phosphorylation Mitochondria: Anatomy, Electron transport chain - its organization and function. Metabolite transporters in mitochondria, Inhibitors of ETC and P/O ratio: experimental



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

layouts. Peter Mitchell's chemiosmotic hypothesis. Proton motive force ATP synthase: structure and mechanism of ATP synthesis. Uncouplers and mechanism of hormonally induced uncoupling (Thermogenesis) Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms.

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN: 10:1-4292-2936-5, ISBN: 13:978-1-4292-2936-4
4. Biochemistry Book edited by Hiren Das



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL06 BCH	METABOLISM OF CARBOHYDRATES AND BIOENERGETICS – LAB	1

PRACTICALS:

1. Estimation of blood plasma glucose by GOD-POD method.
2. Estimation of glycosylated hemoglobin (Demonstration)
3. Estimation of serum amylase activity by kinetic method
4. Estimation of serum creatinine



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER IV

Subject Code	Subject title	Credit
MJ07BCH	CLINICAL BIOCHEMISTRY	3

Unit I:

Introduction to Clinical Biochemistry Definition of Clinical Biochemistry and significance of diagnosing a disease with specific biological sample (serum, plasma, CSF, urine and faeces), Collection and preservation of serum, plasma and urine, Use of anticoagulants, Instrumentation (colorimeter, spectrophotometer) – automation (auto analyzer and semi-autoanalyzer), significance of calibration, precision, accuracy, specificity, sensitivity, quality control

Unit II:

Assessment of glucose metabolism in blood – clinical significance in variation of blood glucose, glucose tolerance test (OGTT, EGTT), Diabetes Mellitus – types, cause, symptoms, treatment, HbA1c, Lactose intolerance.

Unit III:

Lipid profile – composition and function of lipoproteins, clinical significance of elevated lipoproteins (atherosclerosis, hypertension, blood pressure – normal range and factors leading to high blood pressure)

Unit IV:

Liver function test – function of liver, tests to assess liver function – serum bilirubin (total, conjugated, unconjugated), urine – bile pigments, bile salts, urobilinogen, liver enzyme tests – ALT, AST, ALP, GGT, plasma protein, serum albumin, globulin, A/G ratio, prothrombin time, blood ammonia, tests based on liver's part in carbohydrate metabolism (glucose tolerance test, galactose tolerance test), tests based on detoxicating functions of liver (hippuric acid test), Jaundice and its classification (haemolytic, hepatic, obstructive, neonatal)

Unit V:

Renal function test – function of kidney, classification of renal function test – complete urine analysis, plasma urea, creatinine and electrolytes, GFR and its markers (creatinine clearance test, urea clearance test, inulin clearance test), tubular function test (concentration test, dilution test,



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

urinary acidification), use of urine strip / dip stick method of urine analysis, normal and abnormal constituents of urine

Reference books

1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests → Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests → Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL07 BCH	CLINICAL BIOCHEMISTRY-LAB	1

PRACTICALS:

1. Clinical Biochemistry laboratory practices and biosafety
2. Estimation of serum alkaline phosphatase
3. Estimation of lipid profile – i) cholesterol ii) triglyceride iii) HDL cholesterol (demonstration only) iv) LDL cholesterol (calculation using Friedwald equation)
4. Estimation of serum LDH activity (Demonstration)



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER IV

Subject Code	Subject title	Credit
MJ08BCH	PHYSICAL CHEMISTRY	3

Unit I:

Principles of Thermodynamics Definition of systems, surroundings and types of systems (isolated, closed and open). extensive properties and intensive properties, concept of thermodynamic equilibrium, concept of temperature, concept of heat and work, reversible work, irreversible work and maximum work. First law of Thermodynamics, internal energy as a state function, properties of a state function, definition of isothermal and adiabatic processes, Joule's experiment and its consequences, Joule-Thomson experiment and enthalpy as a state function, calculation of work done, heat changes for isothermal and adiabatic changes involving ideal gas. Concept of thermochemistry, laws of thermochemistry, Kirchhoff's equation, Change in enthalpy in different reactions. Statement of Second law of Thermodynamics and their equivalence, Carnot's cycle and Carnot's theorem, absolute scale of temperature, concept of entropy as a state function, entropy changes in various physical processes. Clausius inequality, condition of reversibility and irreversibility of a process, auxiliary state function Helmholtz free energy and Gibbs free energy and their simple applications.

Unit II:

Chemical Equilibrium State of equilibrium and thermodynamic condition of equilibrium (condition of Minimum Gibbs' potential), Van't Hoff's reaction isotherm (deduction using chemical potential), temperature dependence of equilibrium constant (brief introduction), preliminary idea of chemical equilibrium, equilibrium constants, Le Chatelier's principle and its simple applications. Homogeneous equilibrium: Use of different standard states to define K_p , K_c , K_x and their interrelations, examples of homogenous equilibrium. Ionic equilibrium in solution: Hydrolysis of weak acids and bases, pK_a , pK_b , pH , pOH , acid-base neutralization curves, concept of a buffer, buffer action definition, Henderson-Hasselbalch equation and preparation of buffers, buffer capacity, Good's buffers. Buffers used in living system. Colloidal State: Types and properties of colloids, electrokinetic phenomena, concept of Zeta potential,



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

stability of colloids, mechanism of coagulation, Brownian motion, Gibbs adsorption isotherm (statement and significance), surfactant, micelle formation, critical packing parameter.

Unit III:

Electrochemistry Flow of electrical charge, electrical conductance, cell constant, specific conductance and equivalent conductance, variation of equivalent conductance of strong and weak electrolytes with dilution, Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility, equivalent conductance at infinite dilution for weak electrolytes and determination of dissociation constants of weak electrolytes from conductance measurements, conductometric titrations. Basic concepts of electrochemical cell and cell reactions, EMF of cell, Nernst equation, its use in measuring thermodynamic properties (brief introduction) types of electrodes, glass electrode, determination of pH of a solution, working of a pH meter. Concepts of activity and activity coefficient with special reference to electrolyte solutions, statement of Debye-Huckel limiting law and its applications.

Reference Books:

- Physical Chemistry-P. C.Rakshit→
- Lehninger Principles of Biochemistry-Nelson→ &Cox
- Text Book of Physical Chemistry-K. L.Kapoor→
- Physical Chemistry-Hrishikesh Chatterjee→



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL08 BCH	PHYSICAL CHEMISTRY-LAB	1

PRACTICALS:

1. Determination of specific rotation of a given optically active compound and percentage composition of its aqueous solution using Polari meter.
2. Formol titration (acidic, basic, neutral amino acid).
3. Conduct metric titration: weak acid vs strong base.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER - V

Subject Code	Subject title	Credit
MJ09BCH	CELL BIOLOGY AND CELL SIGNALING	3

Unit I:

Introduction to cell biology: Prokaryotic (Archaea and Eubacteria) and eukaryotic cell (Animal and Plant cells), Cells as experimental models. Structure and functions of different cell organelles: Schematic diagram & brief functions of eukaryotic cell structure, cell membrane (membrane composition, fluid mosaic model & its validity). Nucleus, Structure of nuclear envelope, nuclear pore complex, ER structure, Organization of Golgi apparatus, Lysosome, Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome. Cytoskeletal proteins: Structure and organization of actin and tubulin filaments. Intermediate filament proteins. Assembly, organization and movement of cilia and flagella (schematic representation).

Unit II:

Prokaryotic cell wall and Cell wall in Plant, cell matrix proteins (concept & examples). Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. (Schematically representation and fundamental ideas). Cell-Cell Interactions and CellMatrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components.

Unit III:

Protein transport: Selective transport of proteins from cytosynthesis to the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER (only mechanism). Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion (Schematic explanation)

Unit IV:

Cell cycle: Definition and phases of Eukaryotic cell cycle, importance of cell cycle restriction point and checkpoints. Cell division- a basic understanding of mitosis and meiosis (Schematic description). Cell signalling (Preliminary concept) Fundamental theme of a generalized cell



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

signalling pathway (Schematic description), Classification of cell signalling components) Receptors-extracellular and intracellular. G protein coupled receptors, G proteins, Role of second messengers in signalling cascade- cAMP, cGMP, IP₃, DAG, Ca²⁺, NO. Signal transduction (Flow diagram) and importance of signal attenuation, Effector systems- adenylyl cyclase, guanylyl cyclase, PDE, PLC. Regulation of cell signalling by phosphorylation and dephosphorylation (Concept only)

Reference Books:

- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press— & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley— & Sons. Inc.
- Alberts, B., Johnson, A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 5th ed.,— Garland Science (Princeton),
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012.— Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York),
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th— edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.— Freeman & Company (New York), ISBN: 13: 978-1-4292-3414-6 / ISBN: 10-14641-0962-1.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL09 BCH	CELL BIOLOGY AND CELL SIGNALING -LAB	1

PRACTICALS:

1. Study of cell and its organelles with the help of electron micrographs.
2. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
3. Study the phenomenon of plasmolysis and deplasmolysis.
4. Study the effect of organic solvent and temperature on membrane permeability.
5. Study different stages of mitosis and meiosis.
6. Meiosis through temporary squash preparation.
7. Mendel's laws through seed ratios. Laboratory exercises in probability and chi- square.
8. Chromosome mapping using point test cross data.
9. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
10. Incomplete dominance and gene interaction through seed ratios. (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
11. Blood Typing: ABO groups & Rh factor.
12. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
13. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
14. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, rolling of tongue, Hitchhiker's thumb and Attached ear lobe.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER V

Subject Code	Subject title	Credit
MJ10 BCH	LIPID METABOLISM AND MEMBRANE BIOLOGY	3

Unit I:

Fatty acid oxidation Fatty acid activation, fatty acid transport to mitochondria, β -oxidation of saturated, unsaturated, odd chain and even chain fatty acids, regulation of fatty acid oxidation, peroxisomal β -oxidation, differences with mitochondrial β -oxidation, α -oxidation, ω -oxidation, metabolism of ketone bodies, ketoacidosis and ketosis. Fatty acid biosynthesis Rate-determining step in fatty acid synthesis, Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids, fatty acid elongation, desaturation, regulation of fatty acid synthesis.

Unit II:

Triacylglycerols, Eicosanoids, steroids and isoprenoids Biosynthesis and physiological importance of triacylglycerol (Triacylglycerol cycle). Precursor and physiological importance of prostaglandins, leukotrienes and thromboxanes. Rate-determining step in cholesterol biosynthesis and regulation of cholesterol biosynthesis. Precursor and physiological importance of isoprenoids. Lipid storage diseases- GM1Gangliosidosis, Tay–Sachs disease, Gaucher’s disease, Niemann–Pick disease, Fabry’s disease (Enzyme Deficiency, principal storage substance, major symptoms)

Unit III:

Introduction to biomembranes Composition of bio membranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins and their significance (lipid-anchored, integral, peripheral and auxiliary membrane protein), Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.

Unit IV:

Membrane structures and dynamics (Preliminary concept only) Polymorphic structures of amphiphilic molecules in aqueous solutions – micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Precursor, and physiological importance of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, Precursor and



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

physiological importance of plasmalogens, sphingolipids and glycolipids, Membrane skeleton, lipid rafts, RBC membrane architecture (diagram only) 24 Lateral, transverse and rotational motion of lipids and proteins, Techniques used to study membrane dynamics – FRAP (Example with experiments), Transition studies of lipid bilayer, transition temperature, Membrane fluidity, factors affecting membrane fluidity, Hydropathy plot (Concept only).

Unit V:

Membrane transport (Definition & concept only) Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters (Preliminary concept only)- lactose permease, Na⁺-glucose symporter. ABC family of transporters - MDR, CFTR. Ion channels - voltage-gated ion channels (Na⁺/K⁺ voltage-gated channel), ligand gated ion channels (acetyl choline receptor), aquaporins, and bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Reference Books

- Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
- Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN: 13:978-1-4641-0981-2.
- Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL10 BCH	LIPID METABOLISM AND MEMBRANE BIOLOGY-LAB	1

PRACTICALS:

1. Estimation of serum cholesterol by CHOD-PAP method
2. Determination of CMC of detergents by conduct meter
3. RBC ghost cell preparation.
4. Determination of phosphate from crude phospholipid (Lecithin/Cephalic)[Demo only]



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJ11 BCH	NUTRITIONAL BIOCHEMISTRY	3

Unit I:

Introduction to Nutrition and Energy Metabolism: Defining Nutrition, role of nutrients, unit of energy, biological oxidation of foodstuff, measurement of energy content of food, physiological energy value of foods, SDA, measurement of energy expenditure, direct and indirect calorimetry, factors affecting thermogenesis, energy utilization by cells, energy output – basal and resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance, energy expenditure in man. estimating energy requirements, BMR factors, recommended nutrient intakes (RNI) and recommended dietary allowances (RDA) for different age groups. Dietary carbohydrates, lipids, proteins and health RDA, sources and functions and storage of carbohydrates, proteins and lipids in human health, essential and non-essential amino acids and fatty acids, excess, toxicity, imbalance and deficiency of amino acids and fatty acids, dietary importance/implications of MUFA, PUFA, SFA, omega fatty acids with omega3/omega 6 ratio, phospholipids, cholesterol, triglycerides, saturated fats and oils, combined ratios of n6 and n3, lipotropic factors, amino acid supplementation, amino acid pool, amino acid availability, antagonism, NPU, BV, nitrogen balance, nitrogen cycle, protein calorie malnutrition - Kwashiorkar and Marasmus.

Unit II:

Vitamins RDA, sources, storage, adsorption, distribution, metabolism and excretion (ADME) of fat- and watersoluble vitamins, functional role of vitamins (vitamin A as an antioxidant, in visual cycle, dermatology and immunity, vitamin B6 in pyridoxal phosphate formation, niacin-metabolic interrelation between tryptophan, niacin and NAD/ NADP, vitamin C as cofactor in amino acid modifications, extra-skeletal role of Vitamin D and its effect on bone physiology, vitamin E as an antioxidant, vitamin K in gamma carboxylation and blood coagulation, hypervitaminosis and deficiency of vitamins with deficiency symptoms and treatment. A correlation of Vitamin B12 and folate mentioning dietary source, RDA, absorption, metabolic role and biochemical basis for deficiency symptoms.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit III:

Minerals RDA, sources, storage, digestion, absorption, utilization, transport, excretion, balance, deficiency and distribution in human body for calcium, phosphorus, iron, iodine, fluoride, Mg, Cu, Zn, Se, manganese, 26 chromium, molybdenum, calcium: phosphorus ratio, role of iron in prevention of anemia, iodine cycle, toxicity of minerals with special reference to arsenic.

Unit IV:

Assessment of Nutritional status BMI, biochemical assessment, basal and comprehensive metabolic panel, CBC, urine analyses, assessment of anemia, ROS assessment, GTT and glycosylated Hb, differential diagnosis of B12 and folate. Food and drug interactions and Nutraceuticals Definition and functional importance of nutraceuticals, interactive effects of alcohol, tobacco, antidepressants and psychoactive drugs on (1) nutrient metabolism and assimilation, (2) appetite changes, (3) nutrient deficiency and malnutrition.

Reference Books

- Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley—& Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- Nutrition for health, fitness and sport (2013); Williams.M.H, Anderson, D.E, Rawson, E.S.— McGraw Hill international edition. ISBN-978-0-07-131816-7.
- Krause's Food and Nutrition Care process. (2012); Mahan, L.K Strings, S.E, Raymond, J.— Elsevier's Publications. ISBN- 978-1-4377-2233-8.
- The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's— Publications. ISBN-13- 978-0-12- 183493-7.—



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL11 BCH	NUTRITIONAL BIOCHEMISTRY-LAB	1

PRACTICALS:

1. Estimation of Vit-C from fruit juice.
2. Estimation of calcium from milk.
3. Estimation of total phenolic content from black-Tea.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER V

Subject Code	Subject title	Credit
SIP	INTERNSHIP/PROJECT WORK	4

Overall Internship/ Project may be evaluated under the following heads:

1. Motivation for the choice of topic
2. Project dissertation design
3. Methodology and Content depth
4. Results and Discussion
5. Future Scope &References
6. Presentation style
7. Viva-voce

Internship/ Project Each student has to submit two copies of the Internship/ Project work duly forwarded by the HOD of Department concerned. The forwarded copies will be submitted in the Department of Biochemistry, RKDF University, for evaluation (Seven days before the seminar).

The paper will consist of

- (a) Field work/Lab work related to the project.
- (b) Preparation of dissertation based on the work undertaken.
- (c) Presentation of project work in the seminar on the assigned topic in the U.G. Department of Biochemistry, RKDF University, Ranchi & open viva thereon. Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular Intervals.

OR

Paper presentation on 'Topic Provided' and group discussion



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER VI

Subject Code	Subject title	Credit
MJ 12 BCH	METABOLISM OF AMINO ACIDS AND NUCLEOTIDES	3

Unit I:

Amino acid Metabolism: Transamination: [Reaction (Mechanism not needed) Role of pyridoxal phosphate, glucose-alanine cycle.], Oxidative deamination [reaction, role of enzyme, regulation, related disorder], Other deamination reactions (Amino acid oxidases), Urea cycle and inherited defects of urea cycle, Kreb's bicycle. Glucogenic and ketogenic amino acids. Amino acid decarboxylation: Glu, Trp, His, Tyr. Precursor functions of amino acids, Creatine, polyamines (putresine, spermine, spermidine), Catabolism of amino acids Phe, Glu, Gly. Disorders of amino acids metabolism: phenylketonuria, alkaptonuria, albinism. Biosynthesis of amino acids: Gly Glu, Gln, Regulation of enzyme: Glutamine synthetase

Unit II:

Porphyrin Metabolism: Heme Biosynthesis, Heme Catabolism, Disorders related to heme metabolism: Porphyrias, Jaundice.

Unit III:

Nucleotide Metabolism: Denovo biosynthesis of purine and pyrimidine nucleotides and regulation, Salvage pathways: reactions and enzymes involved.c. Precursor of deoxyribonucleotides: role of Ribonucleotide, reductase and its regulation.Coenzyme nucleotides: Precursor only.Degradation of purine and pyrimidine nucleotides, Biosynthesis of Thymine (concept of suicide inhibition.)Antifolates : anticancer agents.Disorders of purine and pyrimidine metabolism –Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency, orotic aciduria.Metabolism of one carbon units.

Unit IV:

Integration of metabolism Integration of carbohydrate, lipid and amino acid metabolic pathways.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN: 10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN: 13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL12 BCH	METABOLISM OF AMINO ACIDS AND NUCLEOTIDES –LAB	1

PRACTICALS:

1. Assay of serum transaminases – SGOT and SGPT.
2. Estimation of total protein and albumin in serum.
3. Estimation of serum uric acid.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJ 13 BCH	BASIC MICROBIOLOGY	3

Unit I:

Introduction: Basic Concepts of Microbiology. Evolution of micro-organisms-Millers' Experiment, Spontaneous generation (abiogenesis), Biogenesis; Germ Theory of Disease, Koch's Postulates, Scope of Microbiology. Microorganisms in biological world: Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaeobacteria (major difference within Eubacteria). Staining techniques: Definition of auxochrome; Chromophores; Acidic and Basic dyes; Mordant; Classification of stains; Simple and differential staining: theories of staining, Gram staining; acid fast staining; endospore staining; mechanism of gram staining Morphology and subcellular structures: Size and shape of bacteria (examples of Bacillus, Coccus, Spirillum); Bacterial cell wall structure, Slime layer, Mycelial morphology: Actinomycetes, Capsule, Ribosome, Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic); Exospores & Cysts: types & structure; Endospore, Flagella, Pilus, Fimbriae (structure, composition and functions). Concept of Ribotyping.

Unit II:

Microbial Nutrition: Nutritional types (definition and example) - Photoautotrophs, Photo-organotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemoorganotrophs Bacterial Growth and its regulation: Growth phases - Generation time. Kinetics of growth, Batch culture. Continuous culture. Synchronous culture (definition and brief description). Bacteriological media: nutrient broth (liquid media) and nutrient agar (solid media), complex media and synthetic media (mention only). Techniques of pure culture. Physical Factors influencing bacterial growth: pH, temperature, oxygen, osmotic pressure, salt concentration, water activity. Basic Principle of storage of bacteria: idea of slant, stab cultures, short- and long-term storage of bacteria.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit III:

Control of micro-organisms: Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent (definition, application & examples); Physical method of disinfection and sterilization - dry heat, moist heat, filtration, radiation (mode of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents (mode of action, applications). Chemotherapeutic agents - sulphonamides, antibiotics, (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism. Basic concept of probiotic therapy.

Reference Books:

- Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.→
- Pelczar. M., et al., Microbiology, 5th ed.,2000, Tata-McGraw Hill→
- Atlas, RM., Principles of Microbiology, 2nd ed.,1997, McGraw-Hill→
- Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,1999, Tata- McGraw Hill→
- Prescott, LM., Microbiology, 6th ed. 2005, McGraw-Hill.→



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL13 BCH	BASIC MICROBIOLOGY - LAB	1

PRACTICALS:

1. Basic Microbiological Laboratory Practices and Biosafety.
2. Study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation (both broth and solid media).
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs
5. Gram staining
6. Isolation of pure cultures of bacteria: Streaking method, Spread plate technique and Pour plate method.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER VI

Subject Code	Subject title	Credit
MJ 14 BCH	HUMAN PHYSIOLOGY	3

Unit I:

Circulatory system Definition and composition of intracellular, extracellular and interstitial fluids, lymph, components of blood (plasma & formed elements, serum proteins), cascade and factors controlling blood coagulation, anticoagulants, definition of homeostasis and types & factors controlling homeostasis, causes and types of anemia, polycythemia, haemophilia, thrombosis and fibrinolysis.

Cardiovascular system Basic structure of heart, heart valves and cardiac circulation, cardiac conduction system and electrocardiogram, cardiac cycle, cardiac output, cardiovascular diseases (CAD, MI, cardiac arrest, heart failure). Respiratory system Basic structure of respiratory organs, mechanism of breathing, respiratory volumes and capacities, exchange and transport of oxygen and carbon di oxide, control of respiration, pulmonary circulation, disorders of respiratory system (COPD, emphysema, bronchitis, asthma)

Unit II:

Digestive system Basic structure of GI tract and accessory digestive organs, mechanisms of digestion and absorption of carbohydrates, protein, lipids in different parts of GI tract, hepatic circulation. Excretory system Basic structure of kidneys, blood supply of kidneys, nephrons, urine formation (GF, GFR, regulation of GFR, tubular reabsorption and secretion), role of kidney in acid-base balance (acidosis, alkalosis) and water-electrolyte balance, renin-angiotensin mechanism.

Unit III:

Nervous system Basic structure of neurons, synapses, synthesis and functions of excitatory and inhibitory neurotransmitters (Glutamic acid, GABA, dopamine, serotonin, acetylcholine), neurotransmitterreceptor binding, IPSP, EPSP, action potentials, neurodegenerative diseases (Parkinson's, Alzheimer's, Schizophrenia, Dementia).



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit IV:

Introduction to endocrinology Definition of endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms, classification of hormones, circulation, transport, clearance and half-lives of hormones. Biochemical synthesis and physiological functions of hormones Hypothalamus (RH), anterior pituitary (TSH, LH, FSH, POMC, GH, PRL), posterior pituitary (oxytocin, vasopressin/ADH), pineal (melatonin), thyroid (T3, T4, calcitonin), parathyroid (PTH), adrenal (glucocorticoids, mineralocorticoids/aldosterone, epinephrin/adrenalin, nor-epinephrin/nor-adrenalin) glands, GI tract (insulin, glucagon, gastrin, secretin, CCK, GIP, adiponectin, leptin and ghrelin) and gonads (androgen, testosterone, progesterone, estrogen). Secondary endocrine organs Liver, kidney, heart (definition of secondary endocrine organs, biochemical functions of the hormones secreted from these organs) Regulation of endocrine secretion Feedback cycle and hypothalamic-pituitary axes. Endocrine disorders Hypo- and hyper-functioning of endocrine organs with mention to gigantism, acromegaly, dwarfism, pigmies, diabetes mellitus, diabetes insipidus, iodine-deficiency goitre, Hashimoto's disease, thyroiditis, Grave's disease/exophthalmic goitre, Addison's disease, Cushing's syndrome, prolactinoma. Introduction to HRT as a therapy.

Reference Books

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H.→ Freeman & Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10-14641-0962-1.
- Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T.→ McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
- Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New→ Delhi), Inc. ISBN: 978-81-317-2610-5.
- The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM→ Press & Sunderland, (Washington DC), Sinauer Associates. (MA). 42 ISBN: 978-0- 87893- 300-6. Human Physiology by C. C. Chatterjee



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL14 BCH	HUMAN PHYSIOLOGY -LAB	1

PRACTICALS

1. Quantitative estimation of haemoglobin from blood
2. Estimation of serum proteins and determination of ratio of albumin and globulin 32
3. Estimation of normal and abnormal constituents of urine
4. Estimation of serum phosphorus and calcium



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJ15BCH	GENE AND GENE EXPRESSION	3

Unit I:

Structure of DNA DNA structure, features of the double helix, various forms of DNA, denaturation and renaturation of DNA. Genes and genomic organization Definition of a gene, organization of genes in viruses, bacteria, eukaryotes. DNA Supercoiling (Linking Number, Twist number, Writhe number), DNA Topoisomerase role in supercoiling, Nucleosome structure and packaging of DNA into higher order structures.

Unit II:

Replication of DNA The chemistry of DNA synthesis, DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, Meselson and Stahl experiment, stages of replication of E. coli chromosome, Rolling circle replication (Concept only), Inhibitors of DNA replication and applications in medicine. Transposition of DNA Transposition, three classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

Unit III:

Molecular basis of mutations Importance of mutations in evolution of species. Types of mutations - transition, trans versions, silent, nonsense, leaky mutation, missense, frame shift mutations, Gene mutations: Induced versus Spontaneous mutations, back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Ames test. Various modes of DNA repair Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, SOS Repair.

Unit IV:

Biosynthesis of RNA in prokaryotes Bacterial RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA foot printing, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

independent termination. Inhibitors of transcription and applications as anti- microbial drugs.

Concept of Central Dogma, One gene–one polypeptide hypothesis by Beadle and Tatum.

Unit V:

Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code. Biosynthesis of proteins Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine. Mendel's principles & chromosomal basis of heredity and Extensions of Mendelism Genetics: Basic principles of Mendelian genetics (monohybrid and dihybrid, test and back crosses).

Reference Books

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.→ Freeman & Company (New York), ISBN: 13: 978-1-4292-3414-6 / ISBN: 10-14641-0962-1
- Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A.,→ Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321- 50781-5.
- Lewin's GENES→ Text Book of Molecular Biology by SivaramaSastri, G Padmanavan and C. Subramanyam→ Stryer's Biochemistry



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL15 BCH	Gene and Gene Expression-Lab	1

PRACTICALS

1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of E.coli.
2. Extraction of total nucleic acids (genomic DNA) from bacterial cells and quantitative estimation of DNA using spectrophotometer (A260 measurement) and assessment of purity (A260/A280). Agarose gel electrophoresis.
3. Concept of standard curve and estimation of unknown DNA concentration.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER VII

Subject Code	Subject title	Credit
MJ16BCH	RECOMBINANT DNA TECHNOLOGY AND GENETIC ENGINEERING	3

Unit I:

Introduction to recombinant DNA technology Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, Taq polymerase, Kinases), separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.

Unit II:

Cloning vectors for prokaryotes and eukaryotes Plasmids, classification, copy number and its regulation, incompatibility and curing, Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene. Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides (Concept of primers), synthesis and use.

Unit III:

Introduction of DNA into cells and selection for recombinant clones Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants, Sequence dependent and independent screening, southern, northern, western and southwestern blot; colony and plaque hybridization - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Expression of cloned genes Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Challenges in producing recombinant protein in E. coli.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit IV:

Polymerase chain reaction Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products, Reverse transcription PCR, Quantitative Real time PCR (Principle), Diagnostic use of PCR. 35 Analysis of DNA in forensic science and archaeology. Applications of DNA finger printing, Techniques of chromosome analysis. Application of genetic test. Karyotyping, chromosome banding and fluorescence In-situ hybridization techniques.

Reference Books

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley- Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1- 4051-3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed.,
4. Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581- 498-4 (HC).
5. Recombinant DNA Technology by Watson



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL16 BCH	RECOMBINANT DNA TECHNOLOGY AND GENETIC ENGINEERING -LAB	1

Practical:

1. Isolation of plasmid DNA from E. coli cells.
2. Digestion of plasmid DNA with restriction enzymes and size estimation of fragments by gel electrophoresis.
3. Preparation of competent cells, transformation and estimation of transformation efficiency.
4. Primer designing (in silico) using any one webtool



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B.Sc. Biochemistry

SEMESTER VII

Subject Code	Subject title	Credit
MJ 17 BCH	IMMUNOLOGY	3

Unit I:

Cells and organs of the immune system Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Mononuclear cells, Granulocytic cells, Mast cells, Dendritic cells- brief characteristics and functions. Innate and adaptive immunity Innate immunity- definition, characteristics, components, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), cell types of adaptive immunity, characteristics of adaptive immunity, connections between innate and adaptive immunity, cell adhesion molecules, Cytokines (definition, examples and functions) Antigens Chemical nature, antigenicity, immunogenicity, hapten, epitopes, Adjuvant (definition, examples, function), B and T cell epitopes. Immunoglobulins Isotypes- definition, basic and fine structures, general characteristics and functions; effector functions of antibody, antigenic determinants on Ig and Ig super family, Monoclonal (basic procedure of synthesis) and polyclonal antibody (definition and characteristics)

Unit II:

Biology of the B and T lymphocyte Antigen independent phase of B cell maturation and selection, humoral response– T- dependent and T-independent response, anatomical distribution of B cell populations. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC). Antigen-antibody interaction Precipitation reactions-Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions- Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition. MHC complex and antigen presentation General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of



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B.Sc. Biochemistry

antigen processing and presentation, Complement systems 37 Three pathways of complement activation and their biological consequences.

Unit III:

Tolerance, autoimmunity and hypersensitivity Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, Immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. Vaccines Active and passive immunization (definition, brief characteristics, examples and functions); Attenuated and inactivated viral or bacterial vaccines (definition, brief characteristics, functions, examples)

Reference Books

- Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A.,— W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 / ISBN: 10:0-7617— 8590-0.
- Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley—& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
- Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver,C.T., Garland— Science (London & New York), ISBN: 978-0-8153-4243-4.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL17BCH	IMMUNOLOGY –LAB	1

Practical:

1. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
2. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) & Single radial immune diffusion (SRID) (Mancini method).
3. Immuno electrophoresis.
4. Enzyme linked immune-sorbent assay (ELISA) (Demonstration only).



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B.Sc. Biochemistry

SEMESTER VII

Subject Code	Subject title	Credit
MJ 18 BCH	MOLECULAR DIAGNOSTICS	3

Unit I:

Introduction To Biochemical Diagnostics Inborn errors of metabolism Inborn error of metabolism (phenylketonuria, alkaptonuria, albinism, MSUD, glycogen storage disease, lipid storage disease, GM1 gangliosidosis, Tay Sachs disease, Fabry's disease, Gauchers disease, Niemann pick disease – cause) Diagnostic Enzymes Diagnostic enzymes – clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase, lactate dehydrogenase), tests for determination of myocardial infarction (enzymes, troponin, myoglobin), enzymes of pancreatic origin and biliary tract.

Unit II:

Immunodiagnosics Introduction, antigen-antibody binding and assays; Immunoassays –types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry-principle and techniques. Immunodiagnosics for detection of infectious agents, cancer, and autoimmune diseases; Immunosensors. Molecular Diagnostics Introduction to DNA based diagnostic techniques; Polymerase chain reaction in diagnostics and analysis; Analysis of DNA in forensic science and archaeology. Applications of DNA finger printing, Techniques of chromosome analysis. Application of genetic test. Karyotyping, chromosome banding and fluorescence In-situ hybridization techniques. Disease identification and Genetic tests for following disorders Thalassemia, Sickle Cell anemia, Down Syndrome, Sex-linked inherited disorders, Allelic susceptibility test for multifactorial disorders (Male infertility).

Reference Books

- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic→
- Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New→ Delhi). ISBN:9780070076594 / ISBN:9780070076631
- Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd.→ (Philadelphia), ISBN:0-7234-3341-0.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL18 BCH	MOLECULAR DIAGNOSTICS -LAB	1

PRACTICALS:

1. Estimation of Surface antigen of Hepatitis B & Hepatitis C virus.
2. Lipid profile: triglycerides and total cholesterol.
3. Permanent slides (histology/cytology) for different types of cancer and comparison with slides from normal tissues
4. Permanent slides of pathogens: Plasmodium vivax and P. falciparum
5. Estimation of serum Alkaline phosphatase and Acid phosphatase.



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B.Sc. Biochemistry

SEMESTER VII

Subject Code	Subject title	Credit
MJ 19 BCH	MOLECULAR BASIS OF INFECTIOUS DISEASE	3

Unit I:

Molecular basis of Infectious Diseases Classification of infectious agents (brief introduction) Bacteria, Viruses, protozoa and fungi. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion. Epidemiology and Public health Science of Epidemiology, Disease outbreak, Disease transmission, Diagnosis of Infectious diseases, Disease prevention

Unit II:

Overview of diseases caused by infectious agents (brief introduction) Bacterial: Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Cholera, Typhoid, Diphtheria, Pertussis, Tetanus and Pneumonia. (Mode of action of Diphtheria toxin, Tetanustoxin, Cholera toxin) Viral: Viral diseases including AIDS, hepatitis (A, B, C), influenza and polio: causative agents, Pathogenesis; Dengue & chikungunya. Parasitic: Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including Leishmaniasis, Amoebiasis. Fungal: Aspergillosis (brief introduction)

Reference Books

- Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., – Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007 126727.
- Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, – Volume, 2. Churchill Livingstone Elsevier.
- Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. – George Ray, Publisher: McGraw-Hill



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B.Sc. Biochemistry

- Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier→ Health Sciences



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL19BCH	MOLECULAR BASIS OF INFECTIOUS DISEASE-LAB	1

1. Identification of bacterial contamination (CFU) from water, soil
2. Antibiotic assay by i) Cup plate method ii) Serial dilution method (Determination of MIC)
3. PCR based diagnosis (Demo & tutorial only)
4. Dot Blot & ELISA based diagnosis (Demo & tutorial only)



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER VIII

Subject Code	Subject title	Credit
MJ20BCH	MICROBIAL GENETICS AND BIOSTATISTICS	3

Unit I:

Genome Organization and Mutations Genome organization: E. coli, Saccharomyces, Tetrahymena Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes Plasmids: Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Unit II:

Mechanisms of Genetic Exchange Transformation: Discovery of Transformation, Competence, Regulation of competence in B. subtilis, Experimental evidence for models of natural transformation, Plasmid transformation and phage transfection of naturally competent bacteria, Role of natural transformation, Importance of natural transformation for forward and reverse genetics, artificially induced competence. 42 Conjugation: Classification of self-transmissible plasmids, Mechanism of DNA transfer during conjugation in Gram negative bacteria, Chromosome transfer by plasmids, Formation of Hfr strains, Transfer of chromosomal DNA by integrated plasmids, Chromosome mapping of genes by interrupted mating.

Unit III:

Transduction: Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers Phage Genetics Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda Transposable elements: Prokaryotic transposable elements – Insertion Sequences, composite and noncomposite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic



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B.Sc. Biochemistry

transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds)

Uses of transposons and transposition

Unit IV:

Biostatistics Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, difference between parametric and non-parametric statistics; Statistical evaluation of results-mean, mode, median calculation, standard deviation calculation, Correlation and regression, student t-test, correlation coefficient, Chi-square tests with examples of different problems.

Reference Books:

- Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.—
- Pelczar. M., et al., Microbiology, 5th ed.,2000, Tata-McGraw Hill—
- Atlas, RM., Principles of Microbiology, 2nd ed.,1997, McGraw-Hill— Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,1999, Tata- McGraw Hill—
- Prescott, LM., Microbiology, 6th ed. 2005, McGraw-Hill.—
- Biostatistics: A Foundation for Analysis in the Health Sciences (2009) 9th ed., Daniel W.W.,— John Wiley and Sons Inc.
- Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. and Doerge,— R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57-7.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MJL 20 BCH	MICROBIAL GENETICS AND BIOSTATISTICS -LAB	1

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Demonstration of Bacterial Conjugation
5. Demonstration of bacterial transformation and transduction 8. Demonstration of AMES test



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJ01BCH	ADVANCED CELL BIOLOGY	3

Unit I:

Nuclear transport Transport across nuclear envelope, regulation of nuclear protein import and export
2. Cell Signaling Molecular mechanisms of signal transduction, receptor tyrosine kinase and tyrosine kinase based signaling, insulin signal transduction, MAP kinase signaling cascade, JAK STAT pathway, signaling in microorganisms and plants, sensory transduction in vision, olfaction and gustation. Hormone mediated signalling Intracellular and extracellular receptors, hormone-receptor binding, scatchard analyses, mechanism of functions of secondary messengers (GPCR, cAMP, cGMP, IP3, DAG, Ca²⁺, NO), effector systems (AC, GC, PDE, PLC).

Unit II:

Cell, Cell Cycle and Cell Death Overview of cell cycle, regulation of cell cycle by protein kinase-cyclin. Types of cell death, apoptosis, features and pathways of apoptosis, Bcl2 family proteins, necrosis, causes of necrosis, mechanism of necrosis, Stem cells and maintenance of adult tissues, hematopoiesis, embryonic stem cells and therapeutic cloning.

Unit III:

Cancer Biology Transformation of cells, characteristics of neoplastic cells, hallmarks of cancer, stages of cancer, causes of cancer, cell cycle abnormalities and cancer, cancer causing mutations, gain-of function mutation, lossof function mutation, tumour viruses, cancer metastasis, molecular approach to cancer treatment.

Reference Books:

- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press— & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley— & Sons. Inc.
- Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 5th ed.,— Garland Science (Princeton),



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B.Sc. Biochemistry

- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012. → Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York),
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th → edition. Pearson Benjamin Cummings Publishing, San Francisco.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJL01BCH	ADVANCED CELL BIOLOGY –LAB	1

PRACTICALS:

1. Cell count of RBC/Yeast cell by haemocytometer.
2. Study of morphology of cancer cells (photomicrographs)
3. Biopsy for diagnosis of cancer (demonstration)
4. Mitosis study in onion root tip
5. Microscopic measurement of bacterial / yeast cell (micrometry)
6. Study of cell viability/death assay by use of trypan blue
7. Study of apoptosis through analysis of DNA fragmentation assay (ladder assay) (demonstration)



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJ02BCH	ADVANCED BIOCHEMISTRY	3

Unit I:

Protein Structure and Protein Folding Ramachandran Diagram and its significance in Protein Structure. Protein domain, subunit interactions. Three-dimensional structure of Myoglobin, quaternary structure of Hemoglobin, Oxygen binding curves, influence of 2, 3-BPG, CO₂ and Cl⁻. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders. Protein folding, Denaturation and renaturation of protein-Ribonuclease A. Protein folding monitoring by circular dichroism (CD) spectroscopy, pulsed HD exchange followed by 2D-NMR spectroscopy or mass spectrometry and fluorescence resonance energy transfer (FRET). Protein folding events-burst phase, hydrophobic collapse, molten globule. Assisted folding by molecular chaperones (Hsp 70, Hsp40), chaperonins (GroEL, GroES) and PDI. Defects in protein folding and diseases –Alzheimer's and Prion based. Proteostasis, Autophagy.

Unit II:

Different types of biomolecular interactions Molecular interaction mechanisms and forces between molecules: selectivity, affinity, kinetics and thermodynamics. Various types of biomolecular interactions: protein ligand (Hb-O₂, Mb-O₂, steroid hormone receptor), protein-protein (Hb subunit interactions, protease-inhibitor complex), DNA-protein (DNA-Transcription factors-Lac repressor). Techniques to study biomolecular interaction for DNA-small molecule, DNA-protein, protein-protein interactions by absorption spectroscopy, fluorescence spectroscopy, FRET, SPR, ITC, Thermal melting, DNA footprinting, CHIP assay, Co-IP, pull down assay.

Unit III:

Drug discovery and development Modern method and principles of drug discovery and development. Computational techniques used in drug development. Brief introduction of discovery, development & molecular mechanism of action of few drugs: salicylates, jasmonates, penicillin and insulin. Brief introduction of classical targets in drug discovery: protein, enzymes,



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

g-protein-coupled receptors (GPCRs), ligand-gated channels. Brief introduction to pharmacophore, QSAR, chirality in drug selection, drug-drug interaction, bioavailability of drug, Basics of clinical trials: phase I, phase II, phase III and phase IV trials.

Reference books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1/ISBN: 10:1-4292-3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN: 978-1180-25024
3. Principles and Techniques of Biochemistry and Molecular Biology (Seventh edition), edited by Keith Wilson and John Walker. Basic Principles of Drug Discovery and Development –by Benjamin Blass–



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJL02BCH	ADVANCED BIOCHEMISTRY –LAB	1

PRACTICALS:

1. Spectrophotometric quantitation of protein (Lowry) and preparation of standard curve.
2. Study of DNA-small molecule interaction by absorbance spectroscopy.
3. Analysis of protein-ligand interactions by Molecular docking/Pymol software.
4. In silico visualization of interaction of a protein with a drug (say interaction of actin and Phalloidin OR tubulin with vinca alkaloids)



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJ03BCH	MOLECULAR BASIS OF NON- INFECTIOUS DISEASE	3

Unit I:

Definition of non-infectious diseases, classification of diseases, risk factors, genetic disorders and life style disorder, role of environmental factors.

Unit II:

Genetic disorder Causes, identification of gene, symptoms, diagnosis, management/ treatment for the following diseases – Huntington disease, Cystic Fibrosis, Albinism, Autism, Hemophilia, Myotonic dystrophy, Perkinson disease, Fragile X syndrome

Unit III:

Life style disorder Causes, symptom, diagnosis, treatment / management, Diabetes, Hypertension, Obesity, Hypothyroidism, Cardio vascular disease, Atherosclerosis, Irritable bowel syndrome

Unit IV:

Cancer Important aspects of biochemical and genetic features of cancerous cell, important properties of oncogenes and tumor suppressor genes, concepts of genetic instability, aneuploidy and angiogenesis, telomerase activity and cancer, p53 mutation and cancer, retinoblastoma, burkitts lymphoma, BCR-ABL genetic tests, use of tumor biomarkers for treatment and detection (PSA, AFP, calcitonin, CEA, β -HCG, monoclonal immunoglobulin, ER, PR, HER-2, BRCA1, BRCA2, EGFR, KRAS, CA-125)

Unit V:

Other diseases Age related diseases (osteoarthritis, COPD, Alzheimer disease, dementia), Prion disease.

Reference Books:

- Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 5th ed.,Garland Science (Princeton)
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012. Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York)



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B.Sc. Biochemistry

- Textbook of Biochemistry for Medical students, 7th Edition, DM Vasudevan, Sreekumari—
S, Kannan Vaidyanathan



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
AMJL03BCH	MOLECULAR BASIS OF NON-INFECTIOUS DISEASE –LAB	1

PRACTICALS:

1. Estimation of glycosylated Hb in human blood
2. Estimation of serum cholesterol
3. Estimation of Blood Urea by enzymatic method
4. Permanent slides of different types of cancer



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
RC01	RESEARCH METHODOLOGY	4

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process.

2. Problem Identification & Formulation - Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis. Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.

3. Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

4. Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

5. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurement Nominal, Ordinal, Interval, Ratio.

6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample Practical considerations in sampling and sample size.

7. Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of association.

8. Interpretation of Data and Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.



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B.Sc. Biochemistry

10. **Use of tools I techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/ Mendeley, Software for paper formatting like LaTeX/ MS Office, Software for detection of Plagiarism

Reference Books :

1. Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
2. Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology- C. R. Kothari
4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
6. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
RC02	RESEARCH PROPOSAL	4

Process of writing a research proposal.

That includes the following points:

1. TITLE.
2. INTRODUCTION
3. REVIEW OF LITERATURE (BACKGROUND AND RATIONALE)
4. RESEARCH QUESTION(S) ..
5. AIMS & OBJECTIVES
6. RESEARCH METHODOLOGY.
7. PLAN OF WORK
8. REFERENCE/BIBLIOGRAPHY.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
RC03	Research Report	4

A research report is a reliable source to recount details about conducted research. It is most often considered to be a true testimony of all the work done to garner specificities of research.

Research reports present the results of formal investigations into the properties, behavior, structures, and principles of material and conceptual entities. Almost any physical phenomenon or concept may be investigated in a research framework. The following are some key differences between formal research, and other less structured kinds of inquiry.

1. *Problem definition*: the rigorous reduction of the inquiry to a narrow question with a quantifiable answer. The most significant preliminary phase of research writing is that of effective problem definition. This process is one of identifying an interesting question and narrowing the research inquiry to a manageable size.
2. *Research approach*: the structuring of the research according to a methodology associated with a specialized field of inquiry. Specialized fields have research methodologies that are followed in investigating problems. These range from general methods of interviewing and literature researching to highly specialized procedures for using materials and mechanical devices to establish appropriate conditions for generating data. Adapting a sound research methodology to the investigation of your problem is a major milestone in the conduct of your inquiry.
3. *Research report*: the presentation of the research and its results in a rigorously formatted document that follows a conventional structure. In presenting your research, you pull all its elements together into a focused, coherent document. Research reports contain a standard set of elements that include.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

MINOR (I/ III/ V/ VII)

SEMESTER I

Subject Code	Subject title	Credit
MN01 BCH	BIOCHEMISTRY MINOR	3

Unit 1: Scope of Biochemistry and Units of measurement

Origin of life, types of organisms, prokaryotes, eukaryotes, unicellular, multicellular, compartmentation of functions in lower and higher organisms, and common physiological events of organisms, chemical composition of living organisms, subcellular organelles, SI units, mass, volume, temperature, amount, length and time. An overview on the metric system, atomic weight, molecular weight, equivalent weight, basicity of acids, acidity of bases, Avogadro's number, molarity, normality, molality, Dalton concept, mole concept, concentration, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significances.

Unit 2 : Atomic structure and Chemical bonds

Structure of an atom, electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L, M, N, O, P, and Q shells. Illustration of Pauli's exclusion principle, Aufbau principle, and Hund's rule, electron configuration, octet rule. Formation and properties of noncovalent and covalent bonds, hydrogen bonds, ionic bonds, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. Sigma, pi and co-ordinate bonds, back bonding

Unit 3: Buffers and Colligative properties

Acids, bases, Arrhenius concept, proton transfer theory, Lewis concept, Lowry and Bronsted concepts. Buffers, composition, pH, pH scale, Henderson Hasselbalch equation, titration curve of H₃PO₄, pK value, isoelectric pH, ionization of HCl, HNO₃, H₂SO₄. Colligative properties and anomalous colligative properties of solutions, structure of water, phase diagram of pure water, ionic product of water, special properties of water, buffers in animal system. Solutions and types, ionizable solutes, non-ionizable solutes, vapor pressure and its application in distillation, Vant Hoff law, Roults law, boiling point, freezing point, de-icing, osmosis and osmotic pressure determination, reverse osmosis, surface tension



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B.Sc. Biochemistry

Unit 4: Electrochemistry and Redox reactions

Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, primary and secondary batteries, electrodes, half-cell reaction, standard electrodes. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb's energy, free energy change, Lewis concept, ions, redox reactions, redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin, biological active forms of zinc, calcium, nickel, molybdenum, selenium, and cobalt, NAD^+/NADH , $\text{NADP}^+/\text{NADPH}$, FAD/FADH_2 , FMN/FMNH_2 . Molecularity and order of a reaction.

Reference Books:

1. Advanced Inorganic Chemistry: A comprehensive Text, 1999, Cotton A and Geoffrey Wilkinson, 6th edition, Wiley publication
2. Inorganic Chemistry, 2014, Miessler GL, Paul Fischer PJ, and Tarr DA, 5th edition, Pearson Publication
3. Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication
4. Inorganic Chemistry, 2015, Overton, Rourke, Weller, Armstrong and Hagerman, Oxford Press



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MNL01 BCH	(PRACTICAL)	1

1. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions.
2. Calibration of volumetric glassware's (Burette, pipette).
3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methylorange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H₂SO₄ in the given solution (phenolphthalein).
5. Preparation of standard Oxalic acid. Standardization of KMnO₄ and estimation of H₂O₂ in the given solution.
6. Preparation of standard K₂Cr₂O₇. Standardization of Na₂S₂O₃ and estimation of CuSO₄ in the given solution.
7. Preparation of ZnSO₄. Standardization of EDTA and estimation of total hardness of water using Eriochrome-Black-T indicator.
8. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
9. Estimation of sulphuric acid and oxalic acid in a mixture using standard NaOH solution and standard KMnO₄ solution.
10. Preparation of standard Potassium dichromate and estimation of ferrous/ferric mixture using diphenylamine indicator (Demonstration).

References

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER III

Subject Code	Subject title	Credit
MN03 BCH	Biochemistry- II	3

Unit 1: Chemical Catalysis:

Definition, characteristics, types, intermolecular, multifunctional, theories of catalysis, properties, characteristics of enzyme catalysis, autocatalysis, industrial catalysis and their role in biological systems (brief). Colloids: true solutions, classification, peptisation, purification, ultrafiltration, Brownian movements, electric properties, coagulation, mutual, lyophilic sols, boiling, dialysis, electro and persistent dialysis, addition of electrolytes, colloids in daily life and applications. Emulsion, types, micelles with biomolecules and its biological applications.

Unit 2: Nomenclature of Organic Compounds:

Classification, naming- IUPAC nomenclature, compounds containing one, two functional groups with chains, homologous series. Stereochemistry, geometrical and structural Isomerism, conformation and free rotation. Optical isomerism, symmetry of elements, plane polarized light and optical purity. Nomenclature of enantiomers, epimers, racemic mixture, resolution. Fischer and Newman projection formulae, molecule with one and two chiral and achiral centers. Priority rules; E and Z (CIP rules), R and S, D and L notations, absolute (r and s) and relative (d and l) configuration. Role of stereochemistry in biological systems.

Unit 3: Organometallic Compounds:

Metal atom linked organic compounds. Preparation of Grignard reagents and structure, limitations, protonolysis and reactions. Organolithium compounds, preparation and reactions. Organozinc compounds. Organoboranes its mechanisms. Ferrocenes. Introduction to mineral and ores, classification, concentration, extraction, refining, uses of minerals and metals and its importance. Porphyrins and Metal ions: Role of metal ions in biological systems, Fe, Cu, Zn, structure and functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitable examples and their role in biological systems.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit 4: Inorganic Chemistry:

Nomenclature of inorganic molecules and coordination compounds, formula. IUPAC nomenclature. Central metal ion, ligand, coordination number, sphere, complex ion, oxidation number of central atom, homoleptic and heteroleptic complexes. Isomerism in complexes, structural, ionisation, solvate, linkage and coordination, Stereoisomerism, geometrical, optical isomerism with simple inorganic complexes. Applications of qualitative, quantitative analysis, photographic, metallurgy, medicine, catalysis and biosystems. Heavy Metal Poisons: Introduction, poisons, lead, mercury, aluminium, arsenic, corrosives, cyanide, irritants, phosphorus, CO₂, SO₂, SO₃, NO₂, halides and acid fumes, poisoning, sources, signs and symptoms. Free radicals: introduction, definition, generation and scavenger systems. Redox reactions, types, stock notations, change in oxidation number and combination. Endergonic and exergonic reactions with examples. The Importance in biological systems.

Reference Books:

1. Physical Chemistry 2006, Peter Atkins. 8th edition, W.H. Freeman and Company
2. Inorganic Chemistry: Principles of structure and Reactivity, 2006, Huheey JE, Keiter EA, Keiter RL, Pearson Education India
3. Stereochemistry: Conformation and Mechanism, 2009, Kalsi PS, New Age International Publications
4. Introduction to Stereochemistry 2012, Kurt Mislow, Dover Publications
5. A text book of Organic Chemistry 2016, Raj K Bansal, 6th edition, New Age International Publications



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Subject Code	Subject title	Credit
MNL03 BCH	(PRACTICAL)	3

1. Systematic Semi micro–Qualitative Analysis of Inorganic Salt Mixtures Systematic semi micro qualitative analysis of two acid and two basic radicals in the given inorganic salt mixture. The constituent ions in the mixture to be restricted to the following. (Any four binary mixtures shall be given) Anions: HCO^- , CO_3^{2-} , Cl^- , Br^- , NO_3^- , BO_3^{3-} , SO_4^{2-} and PO_4^{3-} . Cations: Pb^{2+} , Al^{3+} , Fe^{2+} , Fe^{3+} , Mn^{2+} , Zn^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+} , K^+ , Na^+ and NH_4^+ . Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
2. Determination of density and surface tension of the given liquid using specific gravity bottle and stalagnometer.
3. Determination of molecular weight of non-volatile solute by Walker-Lumsden method.
4. Determination of rate constant of decomposition of H_2O_2 using KMnO_4 by volumetric analysis method using ferric chloride as catalyst.
5. Determination of distribution coefficient of benzoic acid between water and benzene or iodine between water and carbon tetrachloride.
6. Separation of Two Components from given Binary Mixture of Organic Compounds Qualitatively. (Types of binary mixtures- Solid – Solid, Solid – Liquid, Liquid – Liquid)

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata McGraw Hill



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

SEMESTER V

Subject Code	Subject title	Credit
MN05BCH	INTERMEDIARY METABOLISM	3

Unit 1:

1. Basic concepts and design of metabolism the nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.
2. Glycolysis and gluconeogenesis Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis.
3. The citric acid cycle Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway.
4. Oxidative phosphorylation The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

Unit 2 :

Photosynthesis, Calvin cycle and pentose phosphate pathway The light reaction, chlorophyll, accessory pigments, reaction centres, two photo systems, generation of proton gradient and NADPH, Calvin cycle, synthesis of glucose, starch, sucrose, regulation, C4 pathway. Pentose phosphate pathway, importance and regulation.

Glycogen metabolism Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

Fatty acid synthesis and degradation TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Biosynthesis of fatty acids - elongation and unsaturation of fatty acids. Regulation of fatty acid oxidation and synthesis.

Amino acid catabolism and anabolism Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.



RKDF UNIVERSITY RANCHI

B.Sc. Biochemistry

Unit 3:

Nucleotide metabolism Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by Feedback inhibition, degradation and excretion.

Integration of metabolism Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel To brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.

Reference Books:

1. Advanced Inorganic Chemistry: A comprehensive Text,1999, Cotton A and Geoffrey Wilkinson, 6th edition, Wiley publication
2. Inorganic Chemistry, 2014, Miessler GL, Paul Fischer PJ, and Tarr DA, 5th edition,Pearson Publication
3. Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication



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B.Sc. Biochemistry

SEMESTER V

Subject Code	Subject title	Credit
MN05LBCH	Practical	1

1. Alcohol fermentation by yeast.
2. H₂S production, indole production and ammonia production by bacteria.
3. Urea estimation.
4. Uric acid estimation.
5. Nitrogen fixation by cyanobacteria.

References

1. Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.



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B.Sc. Biochemistry

SEMESTER VII

Subject Code	Subject title	Credit
MN07BCH	VIROLOGY	3

Virology

Unit 1:

Introduction to Viruses

Properties of viruses; general nature and important features, Subviral particles; viroids, prions and their importance, Isolation and cultivation of viruses. Morphological characters: Capsid symmetry and different shapes of viruses with examples. Viral Multiplication Viral multiplication in the Cell: Lytic and lysogenic cycle. Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages. Description of important viruses Salient features of the viruses infecting different hosts -Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses).

Unit 2:

Role of Viruses in Disease and its prevention

Viruses as pathogens: Role of viruses in causing diseases. Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds. 47 Cultivation and assay of viruses Cultivation of viruses using experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA. Assay of viruses Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.), Infectivity Assays (Plaque and end-point) Genetic analysis of viruses by classical genetic methods.

Unit 3:

Pathogenesis of Viruses



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B.Sc. Biochemistry

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses. Control of Viruses and Emerging Viruses Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus. Emerging viruses.

Reference Books:

1. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons, 1995.
2. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
3. Applied Virology. 1984. Edited by EdonardKurstak. Academic Press Inc.
4. Introduction to Modern Virology by Dimmock.
5. Prion diseases by Gaschup, M.H.
6. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A. Principles of Virology. 2000 by Edward Arnold.



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B.Sc. Biochemistry

Subject Code	Subject title	Credit
MNL07BCH	PRACTICAL	1

PRACTICALS:

1. One step growth curve for determination of virus titre.
2. Phage typing of E.coli bacteriophages.
3. Induction of lambda lysogen by UV radiations.
4. Studies on Specialized transduction
5. Isolation of lambda DNA and their characterization.
6. Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique (demo only).

Reference Books:

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C 1994.
2. Churchill Livingstone, London. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell– Scientific Publications. Oxford. 48
3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall,– Englewood Cliff, New Jersey.
