DEPARTMENT OF BIOCHEMISTRY

PATNA UNIVERSITY

SYLLABUS

OF

M. Sc. COURSE

(SEMESTER SYSTEM)

2015

BIOLOGY BLOCK II
PATNA SCIENCE COLLEGE CAMPUS
PATNA 800005

BREAK UP OF SYLLABUS (SEMESTER SYSTEM)
M. Sc. BIOCHEMISTRY COURSE

Semester I

Paper I	**Organic and Biophysical Chemistry**
Paper II	**Cell and Molecular Biology**
Paper III	**Tool & Techniques, Biostatistics, Basic Computer Skill and Research Methodologies**
Paper IV	**Practical - General Biochemistry**

Semester II

Paper I -	**Bioenergetics & Bio molecules**
Paper II-	**Plant Biochemistry**
Paper III	**Human Physiology**
Paper IV	**Practical - Hematology & Biochemistry**

Semester III

Paper I	**Dissertation / Mini Project**
Paper II	**Enzymology**
Paper III	**Immunology & Immunochemistry**
Paper IV	**Practical - Analytical chemistry, Immunology & Enzymology**

Semester IV

Paper I -	**Biotechnology & Bioinformatics**
Paper II-	**Elective I Microbial Biochemistry**
Paper III	**Elective II Clinical Biochemistry**
Paper IV	**Practical - Both Elective papers**

SEMESTER I					
Code	**Subject**	**Credit**	**Internal Assessment**	**End Semester Exam.**	**Total**
BCH - 101	Organic and Biophysical Chemistry	4	30	70	100
BCH - 102	Cell and Molecular Biology	7	30	70	100
BCH - 103	Tools & Techniques, Biostatistics, Basic Computer skill &Research Methodologies	4	30	70	100
BCH - 104	Practical – General Biochemistry	5	30	70	100
	Total	**20**	120	280	**400**
SEMESTER II					
BCH - 201	Bioenergetics & Biomolecules	7	30	70	100
BCH - 202	Plant Biochemistry	4	30	70	100
BCH - 203	Human Physiology	4	30	70	100
BCH - 204	Practical-Hematology& Biochemistry	5	30	70	100
	Total	**20**	120	280	**400**
SEMESTER III					
BCH - 301	Dissertation /Project	6	30	70	100
BCH - 302	Enzymology	4	30	70	100
BCH - 303	Immunology & Immunochemistry	5	30	70	100
BCH - 304	Practical- Analytical Chemistry	5	30	70	100
	Total	**20**	120	280	**400**
SEMESTER IV					
BCH - 401	Biotechnology & Bioinformatics	5	30	70	100
BCH - 402	Elective I- Microbial Biochemistry	4	30	70	100
BCH - 403	Elective II- Clinical Biochemistry	4	30	70	100
BCH - 404	Practical- Both Elective Papers	7	30	70	100
	Total	**20**	120	280	**400**

SEMESTER I

PAPER- BCH-101

ORGANIC AND BIOPHYSICAL CHEMISTRY

The question paper will be divided in three parts A, B, & C.
PART A: Ten Questions, two questions from each unit (No choice) : 10x2 = 20 marks
PART B: Five Questions, one question from each group (Four to be answered) : 5x4 = 20 marks
PART C: Five Questions, one question from each group (Three to be answered) : 3x10= 30 marks

UNIT I (ORGANIC CHEMISTRY I)

Electronic Theory of valency: Valence Bond theory, Tetravalency of Carbon, Hybridization & Shapes of Molecules , Molecular orbital theory, Ionisation Potential, Electron affinity, Electronegativity, Dipole moments, Resonance, Hydrogen Bond, Vanderwaal's force, Electronic displacements in a molecule: Inductive effect, Mesomeric effect , Electronic effect, Inductomeric effect, Hyperconjugation, Steric effect.

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UNIT II (ORGANIC CHEMISTRY II)

Types of Organic Reactions: Substitution, addition, elimination, rearrangement, condensation and polymerization.

Mechanism of substitution in the Benzene Ring: o-, p- and m-directing groups, The concept of resonance with reference to Benzene derivatives, Direct influence of substituents-electronic interpretation.

Isomerism: Structural Isomerism, Stereoisomerism: Geometrical isomerism (E&Z nomenclature), Optical isomerism**:** Optical activity, specific rotation, chirality, chiral centre, enantiomers, diastereomers, meso-compounds, DL & RS Nomenclature, Configuration and Conformation, dihedral angles, Conformational analysis of ethane, n-butane, cyclohexane, mono & di-substituted cyclohexane, boat and chair forms, eclipsed, gauche and staggered conformations, axial and equatorial bonds. Monosaccharides, Anomers , mutarotation, glycoside, epimers, glucopyranose, fructopyranose, periodic acid oxidation of sugars.

Heterocyclic Systems occurring in living system: Numbering of the ring and properties of pyran, furan thiozole, indole, pyridine, pyrimidine, quinone, purine, piperidine.

UNIT III (THERMODYNAMIC STUDIES IN BIOLOGICAL SYSTYEM)

Open, closed and isolated system; First law of thermodynamics, Enthalpy of formation, Bond Enthalpy and Enthalpy of a reaction , Hess Law, Internal Energy, Enthalpy; second law of thermodynamics, entropy, Helmholtz and Gibbs free energy, Criteria of Spontaneity; Third law of thermodynamics and calculation of entropy; application of first and second law of thermodynamics in understanding energies in living cells, chemical potential, Order & Molecularity of a reaction, Law of Mass action, equilibrium constant, Le Chatelier's Principle.

UNIT IV (IONIC EQUILIBRIUM IN SOLUTION)

Physical properties and structure of water, ionization of water, pH scale, acid & bases, buffer, Handerson equation, ionization behaviour of amino acids and proteins, titration curve, buffer solution and their action.

UNIT V (FREE RADICALS & RADIOCHEMICAL ISOTOPE IN MODERN BIOLOGY)

Free Radicals in Biological Systems: Oxygen as a free radical in the auto-oxidation of fats, Antioxidants (free radical inhibitors in the cell such as vitamin A, vitamin E, vitamin C, Se etc)

Nature of radio- activity, properties of α, β, and γ rays, measurement of radioactivity, use of radioactivity in research. In vivo and In vitro labelling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay & autoradiography.

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PAPER- BCH-102

CELL AND MOLECULAR BIOLOGY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions, two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group (Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group (Three to be answered): 3x10= 30 marks

CELL BIOLOGY

UNIT I:- Cell: Cell wall, nucleus, mitochondria, ribosome, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility. Eukaryotic and prokaryotic cells.

UNIT II:- Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Cancer: Biochemistry of cancer, concept of proto-oncogenes and tumour suppressor genes. Microenvironment of a cancer cell, cancer as a multistep process. Role of carcinogens, Treatment of cancer, Apoptosis

UNIT III: - Membrane Biology:-

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes (membrane potential), transport of macromolecules across plasma membrane.

Cell communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, cell junction/gap junctions, extracellular matrix, integrins.
Signal transduction: Cell surface receptor, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, bacterial chemotaxis and quorum sensing.

UNIT IV: - Molecular Biology I

Genetic material in eukaryotes and prokaryotes, a brief account of Mendelian genetics, population Genetics and Mutation.
DNA replication: Semi conservative nature of replication, Replication fork and the origin of replication. DNA polymerases and other enzymes involved in replication. Mechanism of replication, regulation of replication. Inhibitors of DNA replication.

DNA Repair: Mechanisms of DNA repair.

Transcription: - Transcription in prokaryotes and eukaryotes. RNA polymerase, promoters, initiation, elongation and termination of RNA synthesis, inhibitors of transcription, post transcriptional processing of RNA in eukaryotes**,** RNA editing, RNA interference

UNIT V: - Molecular Biology II
Genetic code: Basic features, biological significance of degeneracy, Wobble hypothesis and overlapping genes**.**

Translation: Ribosome structure, A and P sites, charged tRNA, f-met-tRNA, initiator codon, Shine-Dalgarno sequence, Formation of 70S initiation complex. Role of initiation factors, elongation factors and termination factors, Inhibitors of protein synthesis.

Regulation of gene expression in prokaryotes and eukaryotes: Operon concept, Lac operon, Trp operon, transcriptional level control, translational level control and post-translational level control of gene expression. Role of chromatin modifications in gene regulation.

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PAPER- BCH-103

TOOLS, BIOCHEMICAL TECHNIQUES, BIOSTATISTICS, BASIC COMPUTER SKILL & RESEARCH METHODOLOGIES

The question paper will be divided in three parts A, B, & C.
PART A: Ten Questions, two questions from each unit (No choice): 10x2 = 20 marks
PART B: Five Questions, one question from each group (Four to be answered): 5x4 = 20 marks
PART C: Five Questions, one question from each group (Three to be answered): 3x10= 30 marks

UNIT I: TOOLS, BIOCHEMICAL TECHNIQUES (PART I)

Viscosity: viscosity of macromolecules, relationship with conformational changes

Centrifugation: Principles of centrifugation, concepts of RCF**,** Sedimentation of macromolecules, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights of biomolecules and other applications, Sub cellular-fractionation.
Electrophoretic techniques: Principles of electrophoretic separation**,** Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose and gel (Polyacrylamide and agarose), pulse field gel electrophoresis and isoelectric focusing
Chromatography: Principles of partition chromatography, Paper, Thin layer, Ion-exchange, Adsorption, Reverse phase, Gel Filtration & Affinity chromatography, Gas liquid chromatography, HPLC (High performance liquid chromatography) and FPLC (Fast protein liquid chromatography)

UNIT II: TOOLS, BIOCHEMICAL TECHNIQUES (PART II)

Spectroscopy: Concepts of spectroscopy, Laws of photometry, Beer-Lambert's law, Principles and applications of colorimetry**,** applications of X-ray diffraction, NMR, ESR, Visible, UV, IR, Fluorescence, Raman, Mass spectroscopy in structure determination of organic and Biomolecules, CD and ORD.
Microscopy: Light, Electron (scanning and transmission), Phase contrast, Fluorescence microscopy (FRET, FLAP, FRAP, FISH techniques) & specific staining of cells and cell organelles.
Flourimetry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and application.

UNIT III:-BIOSTATISTICS

Definition, Scope and Limitation; Frequency Distribution-Discrete and Continuous; Measures of Central Tendency – A.M., Median and Mode; Measures of Dispersion- Range, Quartile Deviation, Mean deviation, Standard deviation, Co-efficient of variation; Simple Correlation – Scatter diagram, Computation of r , properties of r ;Simple Regression – Regressive lines of y on x and x on y. Properties of regression co-efficient ; Probability – Definitions of probability and terms used in probability theory ; Addition and Multiplication theorem and problems based on them ; Probability distribution – Binomial and Poisson, Normal probability curve and its properties; Tests of Significance – Large sample tests of Population mean, Equality of two population means, Population proportion, Difference of two population proportion. ; Tests based on chi-square statistics and t statistics; Analysis of variance (One way).

UNIT IV: - **BASIC COMPUTER SKILL**

Computer peripherals with application: Introduction**,** MS Windows basics, MS-office including MS-Word, MS-Excel, and MS-PowerPoint, Internet and E-mail.
Logic development: Generations of programming languages, emulation of common DOS commands using C and C^{++}, data structures in C, objects and classes, pointers, arrays (One & two dimensional) normal string and file handling in C^{++}

UNIT V: - RESEARCH METHODOLOGIES

Collection and review of research literature, source of literature and their evaluation, Designing research methodologies, General strategies for preparation of research proposals, Data representation in technical reports, posters presentation in scientific conference and workshops,

Preparation of manuscripts for publication in national and international journals, Yardsticks employed in evaluation of manuscripts for publications.

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PRACTICAL PAPER- BCH-104

GENERAL BIOCHEMISTRY

1. Introduction to laboratory safety precautions, personal hygiene, Glass wares, Instruments etc. (Centrifuge, pH meter, Colorimeter, Spectrophotometer, UV & VIS Spectrophotometer, Flame Photometer, Ultra Centrifuge, Electronic Balance, Chemical Analyzer& Elisa Reader etc.
2. Verification of Beer-Lambert's Law.
3. **pH , Buffer Solutions and Titration**
   a) Preparation of Standard Solution and Buffer Solution
   b) Determination pH of the given sample.
   c) Titration of a mixture of a strong and weak acid
   d) Titration of a strong acid with a strong base
   e) Titration of a weak acid with a strong base
   f) Titration of a polybasic acid with a strong base
   g) Titration of a Amino acid (Neutral) with a strong base and acid
4. **Qualitative test for Unknown Carbohydrate**:-
   Molisch's test, Benedict's test, Barfoed's test / Bradford's method etc.
5. **Qualitative test for Unknown Protein**:-
   Biuret test, Ninhydrin test, Heller's Nitric Acid test etc.
6. **Qualitative test for Unknown Lipid**:-
   Salkowski's test ,Emulsification, Saponification, etc.
7. **Study of Urine Examination(Urinalysis)**:-
   a) Physical examination
   b) Chemical examination:
      i) Normal constituents
      ii) Abnormal constituents
   c) Microscopic examination
8. **Study of Fecal Material (Stool Examination)**:- Physical, Chemical & Microscopic
9. **Chromatography:-** Separation of sugars and amino acids using Paper chromatography
10. DNA Isolation.

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SEMESTER II

PAPER- BCH-201

BIOENERGETICS & BIOMOLECULES

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

UNIT I: - BIOENERGETICS

A:- Introduction- Energy transformation, Biological oxidations, Oxygenases, hydroxylases, dehydrogenases, free energy on hydrolysis of ATP, standard free energy change of ATP hydrolysis, electrochemical potential, photons energy inter conversions, ionophores and shuttle systems.

B:- The mitochondiral respiratory chain- order and organization of carriers. The Q cycle, chemiosmotic theory and oxidative phosphorylation, P/O and H/P ratios, respiratory quotient, uncouplers and inhibitors of electron transport chain. Fractionation and reconstitution of respiratory chain complexes and ATP – synthase complex.

UNIT II: BIOMOLECULE: STRUCTURE & METABOLISM (PART I)

Carbohydrate:- Classification, Structure, General Properties and function of Monosaccharides, Polysaccharides and complex carbohydrate (Amino sugar, proteoglycans and glycoprotein), Stereoisomerism and optical isomerism of sugar, reactions of aldehyde and ketone groups, ring structure and anomeric forms, mutarotation, reaction of sugar due to hydroxyl group.

Glycolysis, TCA cycle, Alternate pathways of carbohydrate metabolism (Gluconeogenesis, Glyoxalate cycle, pentose phosphate pathway, biosynthesis of starch and cellulose, glycogen metabolism); Regulation of Blood glucose, Homeostasis, hormonal regulation of carbohydrate metabolism.

UNIT III:- BIOMOLECULE: STRUCTURE & METABOLISM (PART II)

Lipid:- Introduction, Classification, Nomenclature, Structure and Properties of Saturated and Unsaturated fatty acids
Triacyl glycerol**:** Nomenclature and properties
Characterization of fat hydrolysis, saponification value, rancidity of fats, Reichert-Meissel number and reaction of glycerol.
Properties and Functions of Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidyl serine, phosphatidyl inositol, plasmalogens), Sphingomyelins, Glycolipids (cerebrosides and Gangliosides), Phospholipid, Isoprenoids and Sterols.
Fatty acid Biosynthesis: Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase. Fatty acid oxidation:α, β, ω oxidation and lipo-oxidation. Lipid Biosynthesis: Biosynthesis of triacyglycerols, phosphoglycerides and sphingolipids, Biosynthetic pathways for terpenes, steroids

and prostaglandins. Ketone bodies: Formation and utilization. Metabolism of circulating lipids: chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.

UNIT IV:- BIOMOLECULE: STRUCTURE & METABOLISM (PART III)

Protein and Amino acids:- Polypeptide chain. Primary (Peptide confirmation, N- and C-terminal, Peptide cleavage), Secondary (α helix, β pleated sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of Proteins, stability of protein structure, Biosynthesis, degradation and regulation of important amino acids. Protein sequencing, Urea cycle and its regulation.

UNIT V:- BIOMOLECULE: STRUCTURE & METABOLISM (PART IV)

Nucleic Acids:-. DNA: Structure, physical and chemical properties, DNA topology (Supercoil forms of DNA, Linking number), Types of DNA -A, B, Z, forms of DNA, Satellite DNA, Centromeric DNA,.
RNA: Structure, physical and chemical properties of RNA and types (mRNA, tRNA, rRNA, hnRNA, snRNA)

Biosynthesis, Degradation and Regulation of Purines and Pyrimidines.

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SEMESTER II

PAPER- BCH-202

PLANT BIOCHEMISTRY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

Unit I Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

Unit II Photosynthesis Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO_2 fixation- C_3, C_4 and CAM pathways. Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

UNIT II: **Biological nitrogen fixation and ammonia assimilation-** Nitrate and ammonium assimilation; amino acid biosynthesis.

UNIT III: **Secondary metabolites** - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles

UNIT IV: **Plant hormones** – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Biochemistry of seed development and fruit ripening.

UNIT V: Environmental Biochemistry
Air pollution – Particulate matter, compounds of carbon, sulphur, nitrogen and their interactions, methods of their estimation, their effect on atmosphere.
Water pollution – Types of water bodies and their general characteristics, major pollutants in domestic, agricultural and industrial wastes, methods of their estimation effects of pollutants on plants and animals, brief account on treatment and management of domestic waste, industrial wastes and solid wastes .

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SEMESTER II

PAPER- BCH-203

HUMAN PHYSIOLOGY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

UNIT I

Nutritional Biochemistry: Nutrition & Dietary habits, Balanced diet, Recommended dietary allowances for average Indians, Role of WHO, Nutritive and Caloric value of food. Role of minerals and vitamins.

Digestive system: Composition, functions and regulation of saliva, Gastric, pancreatic, intestinal and bile secretions – digestion and absorption of carbohydrates, lipids, proteins, nucleic acids.

UNIT II

Muscle System – Type of muscles-skeletal, cardiac and smooth muscles, Ultrastructure and molecular mechanism of contraction of skeletal muscles and its regulation, Role of energy rich compounds, skeletal muscle diseases and Muscle hypertrophy and hyperplasia.

Circulatory system – Cardiovascular and lymphatic vascular system. Blood vessels, Heart, Route of blood, lymphatic vessels, Blood composition and function of Plasma, formed elements – Erythrocytes, Leukocytes, Platelets, including Hb, Plasma proteins in health diseases.

UNIT III

Blood homeostasis- Blood coagulation , Hydrogen ion homeostasis – Factors regulating blood pH – buffers, respiratory and renal regulation, Acid bases balance, metabolic and respiratory acidosis and alkalosis. transfer of blood gases – oxygen and carbon dioxide, Role of 2, 3 DPG, Bohr effect and chloride shift.

UNIT IV

Endocrine system – Brief outline of various endocrine glands and their physiological roles; storage and secretion of hormones; Feedback regulation of hormone secretion, hormone-receptors and their activation, mechanism and extracellular and intracellular hormone action.

Excretory system: Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.

Nervous system – Organization of the system, nerve cells, nerve impulses and neurotransmission, synapses, Chemical and electrical synapses, functional properties of nerve fiber, action potential, the reflex action and reflex arc.

UNIT V

Excretory System – Structure and its organization, Functions of glomerular membrane and glomerular filtration rate (GFR), structural and functional characteristics of tables, selective reabsorption and secretion, active and passive transport of various substances (Sugars, amino acids, urea and creatinine), antiport capabilities of various tubule segments, role of aldosterone and anti diuretic hormones and mechanisms of urine formation.

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PRACTICAL PAPER- BCH-204

HEMATOLOGY AND BIOCHEMISTRY

1. Method of collection of blood

A. Study of blood: -

a) Total count of WBC
b) Total count of RBC
c) Differential count of WBC
d) Estimation of Hemoglobin percentage
e) ESR, BT & CT
g) Platelets Count

B:- Laboratory Diagnosis of Kala-azar

C:- Screening for sickle-cell anemia

2. Quantitative Estimation of Biomolecules (manual method/ Colorimetric method) :

1. Glucose (Sugar),
2. Blood Urea,
3. Creatinine,
4. Cholesterol,
5. Uric acid,
6. Bilirubin
7. Total Protein, Albumin & A/G ratio
8. Iodine value, Acid value and saponification value in oil or fats.

3. Qualitative test for Unknown Secondary metabolites in plants(Alkaloids, terpenoids, flavonoids etc.)

4. Water Analysis:-

a) Estimation of dissolved oxygen in water.
b) Chemical oxygen demand
c) Biological oxygen demand
d) Estimation of nitrate, pH, temperature, TDS, TSS, Total Hardness.
e) Bacterial and Chemical Analysis of domestic and industrial effluents

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SEMESTER III

PAPER- BCH-301
DISSERTATION / PROJECT
(ON TOPICS RELATED TO SYLLABUS)

PAPER- BCH-302

ENZYMOLOGY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group (Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group (Three to be answered): 3x10= 30 marks

ENZYMOLOGY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

UNIT I: - Enzymes: General Account

Nomenclature and Classification of Enzymes
Characteristics of Enzymes
Three dimensional structure of Enzymes- RNase
Biological role of Enzymes

UNIT II: - Multi enzyme system: Structure and Dynamics

Occurrence, Isolation and their properties
Polygenic nature of multienzyme system
Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complex
Immobilized multi enzyme system and their application

UNIT III: - Enzyme Kinetics

Concept of ES complex, Active site, Derivation of Michaelis-Menten equation for uni substrate reaction, Different plots for the determination K_m and V_{max} and their significance, Significance and evaluation of energy of activation, Collision state theories and transition

Kinetics of zero and first order reaction, methods for measuring Kinetic and rate constants of enzymic reactions & their magnitude
Factors affecting the rate of enzyme -catalyzed reaction
Kinetics of multi substrate reactions, Derivation of the rate of expression for ping pong, random and ordered bi-bi mechanism, use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism.

UNIT IV: - Mechanism of Enzyme Action

Acid Base catalysis, Covalent catalysis, proximity, orientation effect, Strain and Distortion theory
Chemical modification of active site groups
Mechanism of enzymatic action of Lysozyme, Glyceraldehydes, 3 Phosphate dehydrogenase, aldolase, triose phosphate isomerase & Alcohol dehydrogenase.
Water soluble vitamins and their coenzymes, Mechanism of catalysis of serine, proteases, Ribonuclease.

UNIT V: - Enzyme Regulation

General mechanism of enzyme regulation
Reversible and irreversible covalent modification of enzymes
Monocyclic and Multicyclic cascade system with specific examples
Feedback inhibition and feed forward stimulation, Enzyme repression, induction and degradation
Allosteric enzymes, concerted/symmetric and sequential model for their action and significance
Competitive, non competitive, uncompetitive, linear mixed type inhibition and their kinetics, Suicide inhibitor
Protein-ligand binding measurement, analysis of binding isotherm, Co-operativity phenomenon with special reference to aspirate transcarbamoylase & phosphofructo kinase, Hill & scatchard plot

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PAPER- BCH-303

IMMUNOLOGY AND IMMUNOCHEMISTRY

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group (Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group (Three to be answered): 3x10= 30 marks

Unit I : Concept of Immune System

Concept of innate and acquired immunity.
Structure and function of primary and secondary lymphoid organs.
Cells involved in the immune system- Hematopoiesis; mononuclear phagocytic cells, granulocytes, mast cells,dendritic cells, Natural killer cells, lymphoid cells B lymphocytes and T lymphocytes.
Lymphocyte trafficking
Mechanism of innate immune system (phagocytosis and inflammation)
Mechanism of humoral and cell mediated immunity

Unit II: Antigen and Antibody: Chemical nature and function

Antigencity vs Immunogenicity
Chemical nature of antigen, epitopes adjuvants, haptens, mitogens and super antigens.
Cross and fine structures of immunoglobulin, types and sub types.
Antibody mediated effectors functions

Unit III: Immune Effectors Mechanism

Kinetics of primary and secondary immune response
Complement activation and its biological significance
Cytokines
Antigen Processing and Presentation
Hypersensitivity (Type I, II, III, IV)
Assembly of antigen antibody interactions-agglutination, precipitation, opsonization, immune diffusion, immunoblotting, RIA, ELISA, ELISPOT
Immune tolerance and immune suppression
Hybridoma technology

Unit IV: Genetic Diversity of Immune System

Clonal selection theory
Concept of antigen specific receptor
Organization of immunoglobulin gene and generation of antibody diversity
T cell receptor diversity
Polymorphism of MHC gene and role of MHC antigen in immune responses.

Unit V: Immunological disorders: Prophylaxis and Therapy

Immunodefiency disorders
Autoimmune diseases
Immunological Basis of Cancer
Host immune response to protozoan and metazoan parasites, bacterial and viral diseases
Passive and Active Immunization and role of Vaccination in the prevention of diseases.

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PRACTICAL PAPER- BCH-304
ANALYTICAL BIOCHEMISTRY

1. Complete Blood Count (C.B.C) / Hemogram
2. Serological Tests :- VDRL/RPR, ASO Titer, CRP test, RA test, Widal test and Pregnancy test etc.
3. ELISA for any Hormone
4. ABO grouping and Rh typing
5. Quantitative Study of Biocatalyst (Assay of Enzymes):- SGPT, SGOT, Alkaline phosphatase, Amylase etc.
6. Identification of Food Adulterants':
    a) Test for dilution of milk with water

b) Test for starch in milk or milk products
c) Test for Argemone oil in Mustard oil
d) Test for common sugar in honey
e) Test for khesari Dal in Besan of other Dal
f) Test for coloured saw in turmeric powder

7. Detection of vitamin C in fruit juices.
8. Chemical Analysis of milk
9. Column Chromatography
10. Gel Electrophoresis

SEMESTER IV

PAPER- BCH- 401

BIOTECHOLOGY AND BIOINFORMATICS

The question paper will be divided in three parts A, B, & C.
PART A : Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B : Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C : Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

UNIT I: Recombinant DNA Technology (Part I)

History and Scope: Core Technique and essential enzymes, Restriction enzymes-types and cleavage pattern, DNA ligase- types and ligation of DNA molecule in vitro
Cloning vectors; Plasmids (pBR322, Ti plasmid vectors), cosmid, artificial chromosome vector
Passenger DNA: Different strategies used for isolation/synthesis of gene: Organo-chemical synthesis of gene; Construction of genomic and cDNA libraries.

UNIT II : Recombinant DNA Technology(Part II)

Construction of rDNA: Different strategies for construction of rDNA (use of restriction enzymes, linkers, adaptors, homopolymer tailing)
Method of DNA transfer in suitable host: Transformation, electroporation, micro-injection, particle gun method
Selection Strategies: Different methods for selection of clones (antibiotic resistant markers, colony hybridization, plaque hybridization, immune-screening)
Application of rDNA technology in medicine, agriculture, forensic and environment protection.
Various methods of DNA Sequencing.

UNIT III: Plant and Animal Cell Culture

Micropropagation, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation protoplast fusion, protoplast culture, genetic transformation, production of transgenic plants and animals, production of secondary metabolites, primary & transferred cell-culture, differentiated cells in culture, applications.

UNIT IV: Fermentation Technology

Primary & secondary metabolites in biotechnology, continuous & batch type culture techniques, principle type of fermentors, general design of fermentor, fermentation process – brewing, manufacture of Penicillin, production of single cell proteins, production strategies for other antibiotics and other organic compounds.

UNIT V: Bioinformatics

1. Introduction: Basic concepts, objective & its application in modern Biology

2. Bioinformatics databases: Introduction & Type of databases

Nucleotide sequence databases

Primary nucleotide sequence databases

NCBI/ Gene Bank (Visit all Modules like Entrez, Protein, gene, genome, MMDB), EMBL & DDBJ

Secondary nucleotide sequence databases

Uni Gene, SGD, EMI Genomes& Genome Biology

Protein sequence databases

ExpPASy, SwissProt/TrEMBL/UniProt & PIR

Sequence motif databases

Pfam& PROSITE,PRINT

Protein structure databases

Protein Data Bank, SCOP & CATH

Other relevant databases

KEGG,BRENDA,MetaCyc,BIOCyc, PQS, Dock Ground ,Pubmed & UCSC

3. Sequence alignment, database searching and Phylogenetic analysis

Similarity Searching Tools: Similarity searching BLAST (on NCBI)/FASTA (on EMBL): Theory and Algorithm, Types.

Sequence Alignment Basics: Similarity, Identity, Homology, Selectivity/Sensitivity, Linear and affine Gap penality, Basics of Scoring system and matrices (PAM, BLOSUM, GONNET, etc)

Sequence Alignment Methods: Brute force method, Dot matrix method, Global (Needleman-Wunsch) and Local Alignment (Smith-Waterman) using Dynamic Programming.

Multiple Sequence Alignment: Basic concept, scoring methods of MSA (Sum of Pair, Multi dimensional DP, Progressive, Iterative, Probabilistic), CLUSTALW/X tool.

Phylogenetic Analysis: Basic concept, Computer tools for phylogenetic analysis (PHYLIP, DISTANCES, GROWTREE, PAUP)

4. Molecular Modelling and Visualization

Computer tools

Docking : GLIDE & GOLD DOCK, AutoDock

Homology Modeling : MODELLER,SPDV

Visualization : VMD, Rasmol, PYMOL, CHIMERA,Jmol

Molecular Dynamics Simulatin : GROMACS, AMBER,CHARMM

5. Basic Knowledge of Microarray Analysis and Next generation sequencing Analysis.

6. Software Packages GCG, EMBOSS.

PAPER- BCH- 402

MICROBIAL BIOCHEMISTRY (ELECTIVE I)

The question paper will be divided in three parts A, B, & C.
PART A: Ten Questions ,two questions from each unit (No choice): 10x2 = 20 marks
PART B: Five Questions, one question from each group(Four to be answered): 5x4 = 20 marks
PART C: Five Questions, one question from each group(Three to be answered): 3x10= 30 marks

UNIT I : **General Introduction**,
History and development of Microbiology
Introduction of different types of microorganisms; Extremophiles, Acidophiles, Alkalophiles, Halophiles, Psychrophiles, and Thermophiles; Microbial nutrition and nutritional classification of microorganisms; Microbial growth: Growth curve, Measurement of growth and various factors affecting growth

UNIT II : **Methods of Microbiology**:
Sterilization – Methods of sterilization (moist heat, dry heat, filtration, radiation and chemicals); culture media. Pure culture techniques

UNIT III: Bacteria and Virus
Morphology and Ultra structure of Bacteria: Cell wall and other cell inclusions, structure involved with movement and attachment of the cell Archaebacteria
Virology: Structure, Composition, General properties and multiplication, Methods of assay, TMV, Bacteriophage and Retroviruses; replication of DNA and RNA viruses.

UNIT IV: Applied Microbiology
Food Microbiology: Spoilage of common foods (Fruits, Vegetables, milk, sea foods meat and canned food); food preservation methods; Microbial production of Common foods (bread, cheese, vinegar, beer, wine)
Medical Microbiology: Common microbial diseases of human (Tuberculosis, Cholera, Malaria, Kala azar, Syphilis and AIDS)

UNIT V: Environmental Microbiology
Environmental Microbiology: and Biogas production Monitoring of environmental pollution; Treatment of domestic and industrial wastes (hydrocarbon and pesticides), solid wastes and their treatment
Microbial mining: Microbial enhanced recovery of mineral resources
Biofertilizer- classification, production and applications
Biological Control of Insects: Viral, Bacterial fungal pesticides

PAPER- BCH- 403

CLINICAL BIOCHEMISTRY (ELECTIVE II)

The question paper will be divided in three parts A, B, & C.
PART A: Ten Questions, two questions from each unit (No choice): 10x2 = 20 marks
PART B: Five Questions, one question from each group (Four to be answered): 5x4 = 20 marks
PART C: Five Questions, one question from each group (Three to be answered): 3x10= 30 marks

UNIT I Prerequisites

Introduction to laboratory principles and instrumentation in clinical biochemistry
Instrument concepts, Chemical reaction Phase, Measurement approaches
Selection of Instruments

UNIT II Quality assurance

Control of pre analytical variable
Control of analytical variable
External and Internal Quality control mechanism

UNIT III Diagnostic Enzymes & Organ Function Test

Principles of diagnostic enzymology
Clinical significance of Asparate aminotransferase, Alanine aminotransferase, creatinine kinase, Aldolase and Lactate dehydrogenase
Assessment and clinical manifestation of renal and hepatic disease LFT and KFT
Evaluation of Gastric, intestinal and pancreatic functions, Bilirubin metabolism
Enzymatical determination of myocardial infarction.

UNIT IV Disorders of Metabolism- Part I

Disorder of Carbohydrate metabolism- Diabetes mellitus, Hypoglycemia, Glycogen storage disease, Galactosemia, Glucose tolerance test
Disorder of Amino acid metabolism – Phenylketoneuria (PKU), homocysteineuria, tryosinemia, aminoaciduria
Disorder of Lipid and related metabolism
Clinical interrelation between lipids (sphingolipidosis, multiple sclerosis), lipidosis, lipoproteins and apolipoproteins, diagnostic tests for apolipoproteins, HDL & LDL cholesterol & triglyceride related disorder
Hormonal disorder – Anterior and Posterior pituitary hormonal related diseases, thyroid function, Andrenocortical steroids and gonadal steroids
Disorder of Vitamins and Trace elements.

UNIT V Disorders of Metabolism- Part II

Haematological disorders – Disorder of erythrocyte metabolism, haemoglobinopathies, thalassemias & Anaemias, Homeostatsis and thrombosis, Extrinsic and intrinsic pathways of blood clotting, laboratory test to assess coagulation and thrombolysis
Electrolyte and blood gases related disorders, respiratory and renal mechanism of acid base disorders
Disorder of Mineral metabolism- Hypercalcemia, Hypocalcemia, Normocalcemia, Hypophosphatamia, Hyperphosphatamia,
Disorder of Nucleic Acid Metabolim - Purine metabolism and Pyrimidine metabolism

Detoxification strategies – Enzymes related to detoxification, Polymorphism in drug metabolizing enzymes, Detection of toxic substances and their elimination strategy.

PRACTICAL PAPER- BCH- 404

MICROBIAL BIOCHEMISTRY (ELECTIVE I)

1. Good laboratory practices and aseptic techniques in microbial laboratory.
2. Sterilization techniques: Moist heat, dry heat, filtration, LAF etc.
3. Preparation of culture media: Solid and liquid
4. Isolation and enumeration of microorganisms (bacteria & fungi) from air, water and soil.
5. Purification of microorganism by streak plate technique.
6. Preparation of slants and sub-culturing.
7. Simple and differential staining of bacteria (Gram's staining, AFB stain, Capsule, spore and flagella staining).
8. Urine Culture and Sensitivity test:- Plating, Inoculation and putting Antibiotic Disc
9. Determination of growth phases of *E.coli* by measurement of absorbance
10. Determination of growth phases of *Aspergillus niger* by dry weight method.
11. Determination of total vs viable count of *Aspergillus niger.*
12. Reductase test for milk quality.
13. Isolation of microorganisms from common food items such as curd, bread, Pan massalas.
14. Drug sensitivity test of bacteria.
15. Determination of MIC of antibiotic against bacteria.
16. Isolation of antibiotic resistant mutant bacteria by auxanography techniques.
17. Biochemical characterization of bacteria (Amylase, Catalase, Phosphatase test; Sugar Fermentation /utilization.
18. Isolation of genomic DNA from bacteria.
19. Separation of genomic DNA by agarose gel electrophoresis.
20. Testing of water quality.

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SEMESTER IV

PRACTICAL PAPER- BCH- 404
CLINICAL BIOCHEMISTRY (ELECTIVE II)

1. Thin Layer Chromatography
2. Electrophoresis
3. ELISA (HIV, TSH, HBSAg, Tuberculosis and Kala-azar etc)
4. PCR, RIA
5. Test for Diabetic Profile:- Blood Glucose, G.T.T and Glycosylated Hemoglobin (HBA1C)
6. Organ function test (by Kit Method):-
   a) Liver Function Test (LFT):- Bilirubin, SGPT, SGOT, Total Protein,

Albumin, A/G ratio and Alkaline Phosphatase etc.

b) Kidney Function Test (KFT):- Urea, Uric Acid and Creatinine etc.
c) Pancreatic Function test:- Serum Amylase, Serum Lipase etc.
d) Cardiac Profile:- Lipid Profile etc.

7. Electrolyte test:- Na^+,K^+,Cl,HCO_3
8. Anaemia Profile:- Fe in blood , Iron binding capacity and detection of sickle cell anemia
9. Aldehyde test:- Screening test for Kala-azar
10. Detection of Minerals – Ca, P, Mg and copper etc.
11. Detection of toxic substances – Hg, Selenium, Cobalt, Alcohol (Methanol & Ethanol) etc.
12. Blotting Techniques

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