

SYLLABUS

M.Sc. Biochemistry

CBCS

Session: 2022-24

SCHOOL OF STUDIES IN BIOCHEMISTRY

JIWAJI UNIVERSITY

GWALIOR 474 011 (MP)

CBCS: M.Sc. Biochemistry 2022-24

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Dr. Divakar

JIWAJI UNIVERSITY, GWALIOR-474011

Session 2022-24

CBCS M.Sc. BIOCHEMISTRY

Semester	Course Code	Title of the Paper	Type	Credits			
				L	T	P	Total
First	BCH-101	Fundamentals of Cell Biology	Core	03	-	-	03
	BCH-102	Biomolecules	Core	03	-	-	03
	BCH-103	Microbial Biochemistry	Core	03	-	-	03
	BCH-104	Bioinstrumentation	Core	03	-	-	03
	BCH-105	Lab Course I	Core	-	-	03	03
	BCH-106	Lab Course II	Core	-	-	03	03
	BCH-107	Seminar	AE & SD	-	-	01	01
	BCH-108	Assignment/Personality development (YOGA/Physical Education/Environment/Languages/Social Work)	AE & SD	-	-	01	01
	BCH-109	Comprehensive Viva Voce	Virtual	-	-	-	04
	Total Credits						
Second	BCH-201	Fundamentals of Molecular Biology	Core	03	-	-	03
	BCH-202	Immunochemistry	Core	03	-	-	03
	BCH-203	Bioenergetics and Metabolism	Core	03	-	-	03
	BCH-204	Enzymology	Core	03	-	-	03
	BCH-205	Lab Course III	Core	-	-	03	03
	BCH-206	Lab Course IV	Core	-	-	03	03
	BCH-207	Seminar	AE & SD	-	-	01	01
	BCH-208	Assignment/Personality development (YOGA/Physical Education/Environment/Languages/Social Work)	AE & SD	-	-	01	01
	BCH-209	Comprehensive Viva Voce	Virtual	-	-	-	04
	Total Credits						
Third	BCH-301	Recombinant DNA Technology	Core	03	-	-	03
	BCH-302A	Plant Biotechnology	Generic	03	-	-	03
	BCH-302B	Biochemical Toxicology	Elective	-	-	-	-
	BCH-303A	Clinical Biochemistry & Nutrition	Centric	03	-	-	03
	BCH-303B	Genomics and Proteomics	Elective	-	-	-	-
	BCH-304	Physiology & Endocrinology	Core	03	-	-	03
	BCH-305	Lab Course V	Core	-	-	03	03
	BCH-306	Lab Course VI	Core	-	-	03	03
	BCH-307	Seminar	AE & SD	-	-	01	01
	BCH-308	Assignment/Personality development (YOGA/Physical Education/Environment/Languages/Social Work)	AE & SD	-	-	01	01
BCH-309	Comprehensive Viva Voce	Virtual	-	-	-	04	
Total Credits							24
Fourth	BCH-401A	Cellular and Molecular Processes	Centric	03	-	-	03
	BCH-401B	Frontiers in Biochemistry & Biostatistics	Elective	-	-	-	-
	BCH-401C	Food Biochemistry and Processing	Elective	-	-	-	-
	BCH-402	Lab Course VII	Core	-	-	03	03
	BCH-403	Seminar	AE & SD	-	-	01	01
	BCH-404	Assignment/Personality development (YOGA/Physical Education/Environment/Languages/Social Work)	AE & SD	-	-	01	01
	BCH-405	Project Work	Core	-	-	12	12
BCH-406	Comprehensive Viva Voce	Virtual	-	-	-	04	
Total Credits							24
Total Credits for the Course							96

AE & SD – Ability Enhancement & Skill Development

Centric/Generic Elective courses will be conducted as per the availability of permanent faculty

-Minimum Number of credits be earned for award of degree-
[Valid credits 80 + Virtual credits 16]

96 credits

Original

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28/9/22

SYLLABUS

M.Sc. Biochemistry, CBCS
FIRST SEMESTER
Session: 2022-24

SCHOOL OF STUDIES IN BIOCHEMISTRY
JIWAJI UNIVERSITY
GWALIOR 474 011 (MP)

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BCH 101: Fundamentals of Cell Biology**UNIT I**

1. Cellular and Chemical Foundations of Life; Comparative Study of Prokaryotic & Eukaryotic Cells
2. An overview of Tools & Techniques used in Cell Biology; Experimental Models to study cell and molecular biology
3. Cell Membrane: Physicochemical Properties; Molecular Organization – asymmetrical organization of lipids, proteins and carbohydrates; and Functions
4. Molecular Models and Biogenesis of Cell Membrane

UNIT II

1. Transport of Small Molecules Across Cell Membranes: Types and Mechanism
2. Active Transport by ATP-Powered Pumps: Types, properties and mechanisms
3. Transport of proteins into mitochondria and chloroplast
4. Transport of proteins into and out of nucleus

UNIT III

1. Transport of proteins into endoplasmic reticulum
2. Processing of Proteins in Endoplasmic Reticulum and Golgi Apparatus
3. Transport by vesicle formation: Endocytosis and Exocytosis
4. Molecular Mechanism of vesicular transport

UNIT IV

1. Intracellular Digestion: Ultra structure and Functions of Lysosomes
2. Peroxisomes: Ultra structure, Functions and Biogenesis
3. Cell Motility and Shape I: Structure and Functions of Microfilaments
4. Cell Motility and Shape II: Structure and Functions of Microtubules and Intermediate Filaments

UNIT V

1. Intracellular communication through cell junctions: Molecular structure, organization and functions of Occluding Junctions, Anchoring Junctions and Communicating Junctions
2. Molecular Mechanism of Cell-Cell Adhesion: Ca^{++} dependent and Ca^{++} independent cell-cell adhesion
3. Extra-cellular Matrix & their receptors of Animals: Molecular Composition, Organization and Functions; Integrins: Molecular Structure, Types and Distribution
4. General Principles of Cell Signaling: Overview, signaling pathways and signaling in plants

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Practical Exercises

1. Sub cellular fractionation
2. Chromosome Preparation: Mitosis – Onion root tip, rat/mouse cornea, rat/mouse bone marrow, human lymphocytes
3. Chromosome Preparation: Meiosis – Rat/mouse testis, Grasshopper testis
4. Polytene chromosome preparation from *Drosophila* salivary gland
5. Identification of tissue typing: Histological preparation of tissue
6. Identification of different biomolecules in different tissues by histochemical techniques
7. Electron microscopy: Demonstration and good photographs for interpretation

Reference Books

1. Molecular Biology of the Cell, Alberts, *et al*
2. Molecular Cell Biology, Lodish, *et al*
3. Working with Molecular Cell Biology: A study Companion, Storrie *et al*
4. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
5. The Cell: A Molecular Approach, G.M. Cooper
6. The Word of the Cell, Becker *et al*
7. Cell Proliferation and Apoptosis, Hughes and Mehnet
8. Essential Cell Biology, Alberts *et al*
9. Biochemistry and Molecular Biology of Plants, Buchanan *et al*
10. Harpers Biochemistry Murray *et al*

Note: All text books are of latest editions.

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BCH 102: BIOMOLECULES**UNIT I**

1. Classification of carbohydrates, structure and function of monosaccharides and disaccharides:
2. Structure and function of homo- and hetero-polysaccharides
3. Glycoconjugates: Proteoglycans, Glycoproteins, Glycolipids: structure and biological roles.
4. Carbohydrates as informational molecules

Unit II

1. Lipids: Types, structure, properties and biological roles; Fatty acids: Structure, types and properties
2. Saponifiable lipids: Types, structure and properties
3. Non saponifiable lipids : Structure, types and properties
4. Lipoprotein, lipopolysaccharides and other hybrid molecules: Types, properties and functions

UNIT III

1. Amino acids : Structure, classification, abbreviations, properties and functions
2. Peptides and polypeptides
3. Synthesis of peptides and protein sequencing
4. Proteins : Properties, covalent structure, secondary, tertiary and quaternary structure

UNIT IV

1. Enzymes : Classification, mechanism of action, allosteric enzymes, multienzyme complex
2. Enzyme kinetics : Basic concepts
3. Water soluble vitamins : Structure, distribution, interaction and biological functions (mechanism of action not included)
4. Fat soluble vitamins : Structure, distribution and functions

UNIT V

1. Nucleotides : Structure of purine and pyrimidine bases, nucleosides, nucleotides
2. DNA : Structure and Conformation
3. DNA : denaturation, degradation, modification, repair, recombination and rearrangement
4. RNA : Structure, types and functions

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Practical Exercises

- 1 Qualitative analysis of carbohydrates
- 2 Qualitative analysis of proteins & amino acids,
- 3 Qualitative analysis of lipids,
- 4 Analysis of oils : iodine number, saponification value, acid number
- 5 Titration of amino acids
- 6 Colorimetric determination of pKa
- 7 Quantitative estimations of proteins- Biurent, Bradford, Lowery's, Spectrophotometric
- 8 Quantitative estimation of Carbohydrates

Reference Books

- 1 Principles of Biochemistry by Nelson, Cox and Lehninger
- 2 Biochemistry by G.Zubay
- 3 Biochemistry by Stryer
- 4 Biochemistry by Garrett and Grisham
- 5 Biochemical Calculations, Irwin H. Seigel, John Wiley and Sons Inc.
- 6 Biochemistry, DVoet and JG. Voet , J Wiley and Sons.
- 7 Biochemistry, D Freifilder, W.H. Freeman & Company.
- 8 Laboratory Techniques in Biochemistry and molecular Biology, Work and Work
- 9 A Biologist's guide to Principles and Techniques of Practical Biochemistry, Wilson & Goulding, ELBS Edition.

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BCH 103: MICROBIAL BIOCHEMISTRY**UNIT I**

- 1 Classification of Microorganisms: Basis of microbial classification, Haeckel three kingdom, Whittaker's five kingdom concept.
- 2 Morphology and fine structure of eubacteria and archeobacteria cell wall, cytoplasmic membrane and other organelles.
- 3 Pure culture techniques and preservation methods.
- 4 Preparation of Culture media, microbial staining.

UNIT II

- 1 Sterilization: Physical and chemical methods
- 2 Microbial Growth: Bacterial growth curve, Mathematical expression, measurement of Growth and factors affecting growth
3. Microbial Nutrition: Nutritional classification of Microorganisms, common nutritional requirements, mode of nutrition, transport of nutrients across the bacterial membrane
4. Oxygen toxicity: Study of catalase, peroxidase, superoxide dismutase, mechanism of oxygen toxicity.

UNIT III

- 1 Virus: Types, Isolation, cultivation, identification and viral replication.
- 2 Structure and morphology of Bacteriophage, Lytic and lysogenic cycle.
- 3 Life cycle of DNA Viruses: SV 40, RNA Viruses: Retroviruses
- 4 Cynobacteria : General account and their importance

UNIT IV

- 1 Infection and disease, types of Infection, Mechanism of pathogenicity
- 2 Bacterial Diseases: Staphylococcal and Clostridial food poisoning, Salmonellosis Shigellosis
- 3 Fungal diseases: Histoplasmosis , Aspergillosis
- 4 Viral diseases: Chicken pox, Hepatitis B, and Poliomyelitis

UNIT V

- 1 Mycoplasmas and diseases caused by them
2. Bacterial Recombination: Transformation, Conjugation, Transduction, Plasmids and transposons
3. Chemotherapeutic agents: Classification of antibiotics, Broad spectrum antibiotics, Antibiotics from prokaryotes
4. Anti-fungal and antiviral antibiotics, mode of action of antibiotics and resistance to antibiotics

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Practical Exercises

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms
3. Isolation of pure cultures from soil and water.
4. Growth; Growth curve; Measurement of bacteria population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria, Yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
6. Study of mutations by Ames test.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for portability and determination of MPN.
9. Bacterial transformation.
10. Biochemical characterization of selected microbes.
11. One step growth curve of coliphage.

Reference Books

1. General Microbiology, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The MacMillan Press Ltd.
2. Brock Biology of Microorganism, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelzar, M.J., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Maloy, S.R., Cronan, J.E.Jr and Freifelder, D. Jones, Bartlett Publishers.
5. Microbiology-a Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Weseley.
6. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers

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BCH 104: BIOINSTRUMENTATION**UNIT I**

- 1 Centrifugation: Basic principle, type, instrumentation and applications
- 2 Spectroscopy: Basic principles of colorimetry, and UV visible spectrophotometry, instrumentation and applications
- 3 Infra red spectroscopy – Principle, instrumentation and applications
- 4 Fluorimetry: Principle, instrumentation and applications

UNIT II

- 1 Chromatography: Principle, types, instrumentation and applications
- 2 Affinity chromatography, HPLC and FPLC
- 3 Electrophoresis: Principle, types and applications
- 4 Isoelectric focussing and isotachopheresis – Principle & Applications

UNIT III

- 1 Atomic absorption spectroscopy: Principle, instrumentation and applications
- 2 Flame emission spectroscopy: Principle, instrumentation and applications
- 3 Polarimetry: Principle, instrumentation and applications
- 4 ORD and CD : Principle and Applications

UNIT IV

- 1 ESR: Principle, instrumentation and applications
- 2 NMR: Basic principle, instrumentation and applications
- 3 X ray crystallography: Principle, instrumentation and applications
- 4 Mass Spectrometry: Principal, Mass Analyzers and Applications

UNIT V

- 1 Microscopy: Light, phase contrast, interference, fluorescence and polarization microscopy
- 2 Electron microscopy: Principle and Applications
- 3 Confocal Microscopy: Principle and Applications
- 4 Radioactivity: Principle, Geiger Muller Counter, liquid scintillation counter, solid scintillation counter, gamma counter

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Practical Exercises

- 1 Verification of Beer's law
- 2 Determination of absorption maxima
- 3 Electrophoresis of Proteins-native and under denaturing conditions.
- 4 Amino acid and carbohydrate separations by paper & thin layer chromatography
- 5 Gas chromatography
- 6 Ion exchange and gel filtration chromatography
- 7 Separation of blood cells by density gradient centrifugation

Reference Books

- 1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freifelder
- 1 Biochemical Techniques: Theory and Practice by Robyt and White
- 2 Principles of Instrumental Analysis by Skoog and West
- 3 Analytical Biochemistry by Holme and Peck
- 4 Biological Spectroscopy by Campbell and Dwek
- 5 Organic Spectroscopy by Kemp
- 6 A Biologist's Guide to Principles and Techniques of Practical Biochemistry by Wilson and Goulding
- 7 Principles of Instrumental Analysis by Skoog, Hollar and Nicman

BCH-105: Lab Course I based on the Theory Papers BCH-101 & BCH-102

BCH-106: Lab Course II based on the Theory Papers BCH-103 & BCH 104

BCH-107: Seminar

BCH-108: Assignment

BCH-109: Comprehensive viva

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SYLLABUS

M.Sc. Biochemistry, CBCS

SECOND SEMESTER

Session: 2022-24

SCHOOL OF STUDIES IN BIOCHEMISTRY

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GWALIOR 474 011 (MP)

Original

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BCH 201: FUNDAMENTALS OF MOLECULAR BIOLOGY**UNIT I**

1. DNA Replication : General features of Replication; DNA Replication Machinery in Prokaryotes
2. DNA Replication Machinery in Eukaryotes
3. Enzymology of DNA Replication : DNA Polymerases; Primases; Ligases; Helicases; Topoisomerases; Gyrases and Single Stranded Binding Proteins
4. Regulation of DNA Replication

UNIT II

1. Transcription in Prokaryotes : Initiation, elongation and termination
2. Structure and functions of prokaryotic promoter
3. Control of transcriptional initiation in prokaryotes : Structure and functions of RNA Polymerase; Sigma factors – Types and functions
4. Control of transcriptional termination in prokaryotes : Intrinsic termination and Rho factor dependent termination; attenuation and antitermination

UNIT III

1. Regulation of Gene Expression in Prokaryotes : Operon concept, induction and repression, Structure and regulation of lactose and tryptophan operons
2. Transcription in Eukaryotes : RNA Polymerases – Types and properties; Promoter – Types, structure and properties
3. Transcription factors – Types and properties; Enhancers – Structure and properties; Response Elements
4. Post-transcriptional Modification Eukaryotes – 5' and 3' modification of mRNA

UNIT IV

1. Post-transcriptional Processing of pre tRNA and pre mRNA transcripts
2. Post transcriptional Processing of pre rRNA and Catalytic RNA
3. Genetic Code : Evidence and properties; Wobble hypothesis
4. Translational adaptors and amino acyl tRNA synthetases

UNIT V

1. Translation: Successive stages of protein synthesis in prokaryotes and its comparison with eukaryotes
2. Post-translational Modification: Types and Significance
3. Regulation of Gene Expression in Eukaryotes: *cis*-acting DNA Elements; Chromatin organization and regulation of gene expression; Regulation at the level of processing of transcripts
4. Regulation of Gene Expression in Eukaryotes: RNA Editing; DNA methylation and gene regulation; Regulation of gene expression by hormones; Regulation of gene expression at translational level

Journal

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Practical Exercises

1. Isolation of genomic DNA and restriction digestion
2. Size fractionation of restricted DNA fragments by Agarose Gel Electrophoresis
3. Quantitation of DNA
4. Determination of Amax of purified DNA fragments
5. Determination of Tm of nucleic acid
6. Isolation of RNA
7. Fractionation of poly (A)⁺ RNA

Reference Books

1. Lewin's Genes XII
2. Molecular Biology by Tropp
3. Molecular Biology by Turner *et al*
4. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp
5. Transcriptional Regulation in Eukaryotes by Carey and Smale
6. Translational control of gene Expression by Sonenberg *et al*
7. Chromatin and Gene Regulation by Turner
8. An Introduction to Genetic Analysis by Griffiths *et al*
9. Genome by Brown
10. Concepts of Genetics by Klug and Cummings
11. Proteins by Creighton
12. Molecular Cell Biology by Lodish *et al*

Note: All text books are of latest editions.

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UNIT I

- 1 Immune response: Innate immune mechanisms and characteristics of adaptive immune response: Antigens, epitopes, Hepten: Factors affecting immunogenicity, , Super antigens
- 2 Anatomical organization of immune system: Primary lymphoid organs, Secondary lymphoid organs. Ontogeny and Phylogeny of lymphocytes, Lymphocyte traffic
- 3 Cell of the immune system: Hematopoiesis, Mononuclear cells and granulocytes, Antigen presenting cells, Lymphocytes and their subsets.
4. Inflammation; its mediators and the process, Cell adhesion molecules and their role in inflammation, lymphocyte homing, tissue injury and immune response leading to an inflammatory reaction, role of anaphylatoxins, granulocytes in inflammatory process

UNIT II

- 1 Major histocompatibility systems: Structure of MHC I and II molecules, polymorphism, distribution variation and function. Organization of MHC complex in Mouse and Humans. Association of MHC with disease
- 2 Recognition of antigens by T and B Cells: Antigen processing, Role of MHC molecules in antigen presentation and Costimulatory signals
- 3 T – cell receptor complex, T-cell accessory membrane molecules, activation of T cells, Organization and arrangement of T-receptor genes
- 4 B-cell receptor complex, Activation of B-cells, Immunoglobulins: Molecular structure, types and functions. Antigenic determinants on immunoglobulins

UNIT III

- 1 Molecular mechanism of antibody diversity: Organization of genes coding for constant and variable regions of heavy chains and light chains. Mechanisms of antibody diversity, Class switching
- 2 Antigen-Antibody interaction, avidity & affinity measurement
- 3 Monoclonal antibodies: Production, characterization and applications in diagnosis, therapy and basic research, Antibody engineering,
- 4 Complement system, components, activation pathways, and regulation of activation pathways, Complement deficiencies, Role of complement system in immune responses

UNIT IV

- 1 Cytokines: Structure and functions, cytokine receptors, signal transduction mediated by cytokine receptors, cytokine regulation of immune responses, cytokine related diseases and therapeutic applications of cytokines
- 2 Cytotoxic T cells and their mechanism of action, NK cells and mechanism of target cell destruction. Antibody dependent cell mediated cytotoxicity, Delayed type hypersensitivity. Techniques of Cell mediated immunity
- 3 Immunoregulation mediated by antigens, antibodies, immune complexes, MHC and cytokines
- 4 Hypersensitivity: Definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type-I reactions and consequences. Type II reactions, Immune

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UNIT V

- 1 Autoimmunity: Organ specific diseases, Systemic diseases, Mechanisms of autoimmunity and therapeutic approaches
- 2 Immunodeficiency syndromes: Primary immunodeficiencies and Secondary immunodeficiencies and their diagnosis and therapeutic approaches
- 3 Vaccines: Active and passive immunization, Whole organism vaccines, Macromolecules as vaccines, Recombinant-vector vaccines, DNA Vaccines, Synthetic peptide vaccines and sub-unit vaccines
- 4 Immunodiagnosics : Precipitation techniques, Agglutination, Fluorescence techniques, ELISA, RIA, Western blotting and Immno-histochemical techniques

Practical Exercises

- 1 Blood Film preparation and identification of cells.
- 2 Double diffusion and Counter Immunoelectrophoresis.
- 3 Immuno-electrophoresis; Radial Immunodiffusion.
- 4 Agglutination techniques: Direct & Indirect
- 5 Immunization and production of polyclonal antibodies
- 6 ELISA
- 7 Western -blotting.

Reference Books

- 1 Kubey, Immunology, R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osborne. (Freeman).
- 2 Immunology-Ashort Course, -Eli Benjamini, Richard Coico, Geoffrey Sunshine.
- 3 Immunology by Tizzard
- 4 Fundamentals of immunology by William Paul.
- 5 Immunology by Roitt *et al*
- 6 Immunology by Abbas

Practical

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BCH 203: BIOENERGETICS AND METABOLISM

UNIT I

- 1 First and second laws of thermodynamics
- 2 Concept of free energy
- 3 ATP Cycle, ATP as high energy compound, functions of ATP
- 4 Other high energy biological compounds

UNIT II

- 1 Basic Concepts of intermediary metabolism
- 2 Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, glyconeogenesis, glyoxalate pathway
- 3 Regulation of carbohydrate metabolism
- 4 Inborn errors of carbohydrate metabolism

UNIT III

- 1 Electron transport and oxidative phosphorylation
- 2 Biosynthesis and degradation of lipids
- 3 Regulation of lipid metabolism
- 4 Inborn errors of lipid metabolism

UNIT IV

- 1 Nitrogen assimilation
- 2 Biosynthesis of amino acids
- 3 Degradation of amino acids
- 4 Regulation of amino acid metabolism

UNIT V

- 1 Inborn errors of amino acid metabolism
- 2 Nucleic acid metabolism
- 3 Inborn errors of nucleic acid metabolism
- 4 Integration of metabolism and metabolomics

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Practical Exercises

- 1 To observe the catabolism of carbohydrates by micro-organisms
- 2 To observe the production of gas by micro-organisms during fermentation
- 3 To demonstrate the production of pyruvate and acetaldehyde during fermentation of glucose by yeast
- 4 To demonstrate biological oxidation and electron transport in heart muscle tissue
- 5 To observe the effect of fasting on the metabolism of rats

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UNIT I

- 1 Enzyme: Historical aspects, classification and nomenclature, EC number.
- 2 Mechanism of enzyme catalysis and action
- 3 Sub cellular localization and organization of enzymes
Methods of enzyme assay: continuous and sampling techniques, coupled enzyme assay and methods and significance of enzyme turnover number; specific activity

UNIT II

- 1 Enzyme purification techniques: objectives and strategy; methods of homogenization; method of isolation; purification and crystallization
- 2 Criteria of purity and tabulation of purification data; stable storage of enzymes
- 3 Characterization of purified enzyme
- 4 Coenzymes, Cofactors and Isoenzymes

UNIT III

- 1 Enzyme Kinetics: Equilibrium and steady state theory, rate equation and determination of K_m and V_{max}
- 2 Factors affecting rate of enzyme reaction: pH, temperature and pressure
- 3 Enzyme inhibition: reversible and irreversible inhibition, their type, inhibitor constant and its significance
- 4 Rapid reaction techniques, Efficiency of enzymes in non-aqueous environment

UNIT IV

- 1 Protein-ligand binding: types, cooperativity, Hill and Scatchard plot, Allosteric enzymes : Models of allostery, types and kinetics
- 2 Regulation of enzymes
- 3 Mechanism of action of Chymotrypsin; Ribonuclease; Lysozyme; Metallo-enzymes
- 4 Enzymes during aging and Degradation of enzymes

UNIT V

- 1 Enzyme immobilization; techniques; experimental procedures and effect of immobilization on kinetic parameters
- 2 Principle and Industrial application of immobilized systems
- 3 Enzyme biosensors
- 4 Enzymes in Medical diagnosis and enzyme therapy

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Practical Exercises:

- 1 Urease estimation in plant tissues
- 2 Assay of Acid phosphatase in plant seeds
- 3 Assay of Alkaline phosphatase in Kidney and Liver
- 4 Determination of optimum pH, temperature & time
- 5 Determination of Km value of alkaline phosphatase
- 6 Acetylcholinesterase estimation in Rat /Goat Brain
- 7 Enzyme purification: Ammonium sulphate precipitation, Ion exchange chromatography, molecular sieve chromatography.
- 8 Checking of purity of enzyme by PAGE
- 9 Molecular weight determination of enzyme by Gel Filtration
- 10 Immobilization of HRP (Horse reddish peroxidase).
- 11 Sub-cellular fractionation of rat liver and marker enzyme assays.

Reference Books

- 1 The Nature of Enzymology by R.L. Foster
- 2 Enzymes by Dixon and Webb
- 3 Fundamentals of Enzymology by Price and Stevens
- 4 Enzyme Catalysis and Regulation by Hammes
- 5 Enzyme Reaction Mechanisms by Walsch
- 6 The Enzymes vol I and II by Boyer
- 7 Enzyme Structure and Mechanism by Alan Fersht
- 8 Enzyme Assays: A Practical Approach by Eisenthal and Danson
- 9 Enzyme Biotechnology by G. Tripathi
- 10 Practical Biochemistry by Plummer.
- 11 Practical Biochemistry by Sawhney and R. Singh

BCH-205: Lab Course III based on the Theory Papers BCH-201 & BCH-202

BCH-206: Lab Course IV based on the Theory Papers BCH-203 & BCH 204

BCH-207: Seminar

BCH-208: Assignment

BCH-209: Comprehensive viva

Journal

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SYLLABUS

M.Sc. Biochemistry, CBCS

THIRD SEMESTER

Session: 2022-24

SCHOOL OF STUDIES IN BIOCHEMISTRY

JIWAJI UNIVERSITY

GWALIOR 474 011 (MP)

CBCS: M.Sc. Biochemistry 2022-24

Dr. Jyoti K. Jaiswal

Dr. Jyoti K. Jaiswal

Dr. Jyoti K. Jaiswal

BCH 301: RECOMBINANT DNA TECHNOLOGY**UNIT I**

1. General concept, principle and applications of Recombinant DNA Technology
2. Enzymes: Nucleases and restriction endonucleases – properties and types; phosphomonoesterases; polynucleotide kinase; DNA ligase; DNA polymerase I; RNA Dependent DNA Polymerase; terminal deoxynucleotidyl transferase; poly A polymerase
3. Prokaryotic host-vector system: Characteristics of *E. coli* as host; vectors for cloning in *E. coli* (plasmid, bacteriophage and plasmid-phage)
4. Other Prokaryotic host vector systems: Characteristics of Gram positive and Gram negative organisms as host and suitable vectors for cloning

UNIT II

1. Shuttle vectors: Features and Applications
2. Expression vectors for cloning in prokaryotes: Features and Applications
3. Factors affecting expression of cloned genes in prokaryotes
4. Cloning in Yeast: Properties of yeast as host for cloning and different types of vectors designed for cloning in yeast

UNIT III

1. Cloning in animals system: Animal system as a model host, Methods of introduction of foreign DNA in animal system
2. Vectors for cloning in animal system – SV 40, bovine papilloma virus, adenovirus, vaccinia virus, baculovirus and retrovirus vectors
3. Methods for Constructing rDNA and cloning: Inserts; vector insert ligation; infection, transfection and cloning
4. Methods for selection and screening of recombinant clones

UNIT IV

1. DNA Libraries: Types, advantages and disadvantages of different types of libraries; Different methods for constructing genomic and full length cDNA libraries
2. Gross anatomy of cloned insert – size, restriction mapping and location
3. Fine anatomy of DNA segment – General principle of chemical and enzymatic methods of nucleotide sequence analysis
4. Localization of cloned segments in genomes – molecular and chromosomal location

UNIT V

1. Methods for determination of copy number of a cloned gene in genome
2. Mutant construction: Introduction, deletion, insertion and point mutation
3. Biosafety Measures
4. Regulations for Genetically Engineered Products

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Practical Exercises

1. Bacterial Culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA
3. Quantitation and determination of A_{260} of nucleic acids
4. Restriction digestion of plasmid DNA and analysis
5. Cloning in plasmid vectors
6. Gene expression in *E. coli* and analysis of gene product
7. Polymerase Chain Reaction

Reference Books

1. Principles of Gene Manipulation and Genomics by Primrose & Twyman
2. Gene Cloning & DNA Analysis: An introduction by T.A. Brown
3. Recombinant DNA – By Watson et al
4. Biotechnology: Theory and Techniques (Vol I & II), by Chirikjian
5. Molecular Genetics of Bacteria by Dale
6. Molecular Cloning (Vol I, II & III) by Sambrook & Russell
7. Applied Molecular Genetics, by Miesfeld
8. Genes and Genome by Singer & Berg
9. Molecular Biotechnology by Glick & Pasternak
10. Plant Molecular Biology (Vol I & II) by Gilmartin & Bowler

Note: All text books are of latest editions:

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BCH -302A PLANT BIOTECHNOLOGY

UNIT I

1. Specialized plant organelles : Cell plate, Cell wall- Chemical and physical composition, biosynthesis, primary and secondary cell walls, Plasmodesmata, Plasids- Types and functions, Importance of vacuoles and microbodies, Meristematic cells an root quiescent zone
2. Absorption, adsorption and transport of water and ions in plants
3. Translocation of inorganic and organic substances
4. Structure and biogenesis of organelles involved in photosynthesis in plants

UNIT II

1. Chloroplast membrane and molecular organization of thylakoids, proton gradient and electron transfer in chloroplasts of plants and in purple bacteria-difference from mitochondria
2. Light receptors- Chlorophyll, light harvesting complexes, bacteriorhodopsin as ion pump
3. Photosystem I and II- Location, mechanism of energy transfer between photosystems, ferredoxin, plastocyanin, plastoquinones and carotenoids; Hill reaction and photophosphorylation
4. The Calvin Cycle- Evidence, mechanism and stoichiometry, role of light in activation of dark phase enzymes

UNIT III

1. Photorespiration: Mechanism and regulation
2. The C4 mode of photosynthesis: Mechanism, stoichiometry and purpose, difference from C3 in relation to plant productivity
3. Crassulacean Acid Metabolism: Mechanism and regulation
4. Biological Nitrogen Fixation: Formation of ammonia, conversion of nitrate to ammonia, assimilation and secondary assimilation of ammonia, inhibitors

UNIT IV

1. Molecular properties of nitrogenase system, *nif* genes and their regulation, applications of biological nitrogen fixation
2. Molecular effects and mechanism of action of Auxin, Gibberellic Acid, Ethylenes, Cytokinins, Abscisic acid
3. Secondary metabolites: Plant alkaloids and Phenolics- Distribution, localization, biosynthesis and biological functions
4. Biochemistry of seed development and fruit ripening and Defense system in plants

UNIT V

1. Introduction to plant tissue culture and laboratory organization
2. Tissue culture media: Composition and preparation, initiation and maintenance of callus and suspension culture, single cell clones
3. Organogenesis: Somatic embryogenesis, transfer and establishment of whole plant in soil
4. Protoplast isolation, culture, regeneration and somatic hybridization and applications of plant tissues culture

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Practical Exercises

1. Estimation of plant proteins
2. Estimation of plant lipids and carbohydrates
3. Isolation of plant pigments, their analysis and determination of absorption Maxima
4. Chloroplast isolation
5. Hill Reaction
6. Estimation of nitrogenase
7. Estimation of nitrate reductase- *in vivo* method
8. Fruit ripening
9. Estimation of total phenolic compounds
10. Estimation of anthocyanin pigments

Reference Books

1. Handbook of Photosynthesis by Mohammad Pe Sarakle
2. Plant Physiology by Salisbury and Ross
3. Introduction to Plant Biochemistry by Goodwin and Mercer
4. Seed: Physiology of Development and Germination by Bewley and Balck
5. Biochemistry of Energy Utilization in Plants by Blakie
6. Plant Biochemistry by Dey and Harbome

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BCH 302B : BIOCHEMICAL TOXICOLOGY**Unit I**

1. Introduction to Toxicology
2. Basic Concepts: Toxicants of public health hazards and toxic compounds
3. Epidemiology and biostatistics in Toxicology
4. Absorption, translocation and excretion of toxicants

Unit II

1. Toxicological testing methods
2. Systemic toxicity testing
3. Exposure assessment and analytical methods in toxicology, Toxicological pathology
4. Biomagnification and bioaccumulation

Unit III

1. Toxic metals in environment
2. Petroleum and solvent toxicity
3. Toxicology of pesticides
4. Toxicity of ionizing radiations, gaseous pollutants

Unit IV

1. Biotransformation and degradation of toxicants
2. Toxicokinetics
3. Organ toxicology, Genetic and reproductive toxicology
4. Toxicogenomics

Unit V

1. Nutrition toxicology and Immunotoxicology
2. Neurotoxicology and Occupational toxicology
3. Environmental Toxicology
4. Risk assessment and chemical safety evaluation, Legislation and International regulation

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Practical Exercises

1. Determination of LD₅₀/LC₅₀
2. Determination of metal content in samples
3. Determination of Biological Oxygen Demand
4. Determination of Chemical Oxygen Demand
5. Biomarkers of neurotoxicity of organophosphate compounds

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UNIT I

1. Basic Concepts of Nutrition : Composition of human body, Energy requirements of man and woman and factors affecting energy requirements, Measurement of energy expenditure,
2. Energy contents of foods, Direct and indirect calorimetry, Definition of BMR and SDA and factors affecting these, Thermogenic affects of foods,
3. Dietary requirements, Glycemic index of foods, Available and unavailable carbohydrates, physiological action of unavailable carbohydrates.
4. Protein reserves of human body, Essential amino acids and concept of protein quality, Protein requirement at different stages of growth.
5. Protein energy malnutrition: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkar diseases

UNIT II

1. Minerals: Nutritional and clinical significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
2. Vitamins : Dietary sources, biochemical functions, specific deficiency diseases associated with fat and water soluble vitamins, Hypervitaminosis,
3. Nutritional requirements during pregnancy, lactation and of infants and children
4. Obesity : Definition and classification, Factors contributing to obesity, Obesity related diseases, Role of leptin in regulation of body mass, Nutritional approaches in management of obesity
5. Clinical nutrition: Role of diet and nutrition in the prevention and treatment of lifestyle disorders such as Diabetes mellitus, Cardiovascular disorders, hypertension, rheumatic disorders hyper/hypo thyroidism, liver and kidney disorders.

UNIT III

1. Basic concepts of laboratory diagnoses: Concept of accuracy, precision, normal and reference value determination and factors affecting reference values.
2. Types of diagnostic specimens, collection, processing and preservation of specimens, Types of anti-coagulants and their mode of action.
3. Organization and basic requisites of Clinical Biochemistry laboratory viz., Instrumentation, Biowaste management, Quality control: Internal and External
4. Clinical significance of specific plasma/ CSF proteins, Clinical applications of serum protein eletrophoresis, Phenyl ketonuria.
5. Hemoglobinopathies; Hemoglobin, porphyrin and related compounds : Disorders and diagnosis

UNIT IV

1. Disorders of Carbohydrate metabolism : Glucose metabolism and role of Insulin. Diabetes mellitus, types, etiology and pathogenicity, ketone bodies, Hypoglycemia. Carbohydrate intolerance.

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BCH-303B: GENOMICS & PROTEOMICS**Unit I**

1. Introduction Structural organization of genome in Prokaryotes and Eukaryotes;
2. Organelle DNA-mitochondrial, chloroplast;
3. DNA sequencing-principles and translation to large scale projects;
4. Recognition of coding and non-coding sequences and gene annotation;
5. Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

1. Genome sequencing projects Microbes, plants and animals;
2. Accessing and retrieving genome project information from web;
3. Comparative genomics,
4. Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

1. Microarray chips: Types of DNA chips and their production.
2. Gene Therapy for Human Diseases.
3. Protein Crystallization; Theory and methods: API Electrospray and MALDI-TOF.
4. SNP's and GMS (Genome mismatch Signals)

Unit IV

1. Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins;
2. Microscale solution isoelectricfocusing; Peptide fingerprinting;
3. LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics,
4. Protein-protein interactions, Yeast two hybrid system.
5. Functional Proteomics: Significance of Proteome research

Unit V

1. Overview of Bioinformatics; Introduction to MEDLINE on PubMed systems for accessing Biological Information Entrez, Swissport, PIR, NCBI.
2. Sequence Databases: Contents, Structure, and annotation for Human Genome Databases, Plant Genome Databases, Retrieving and installing a programme (Tree Tool)
3. Multiple sequence alignment programmes; Genome mapping applications: EST and functional genomics, EST cluster gene discovery, ORF prediction
4. Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

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Page 30

UNIT I

1. Composition of Blood: Structure, functions and biogenesis of RBC
2. Functions of hemoglobins, plasma proteins
3. Circulatory System (Open and closed circular, lymphatic systems)
4. Mechanism of blood coagulation : extrinsic and intrinsic pathways, inhibitors of coagulation

UNIT II

1. Urine formation: Formation of dilute and concentrated urine
2. Regulation of water electrolyte balance and role of kidney and hormones
3. Acid-base balance and its regulation by kidney and hormones
4. Digestive system

UNIT III

1. Nerve impulse transmission: structure of neuron, mechanism of conduction of nerve impulse along axon, neurotransmitters
2. Presynaptic and post-synaptic events of neuromuscular junctions
3. Ultra structure and molecular mechanisms of contraction of skeletal muscles and its regulation, energetics of muscle contraction, relaxation
4. Contraction of smooth muscles

UNIT IV

1. General characters and classification of hormones, receptors and mechanism of action of hormones
2. Structure, synthesis, secretion, transport, metabolism and function of the hormones secreted by the pituitary
3. Structure, synthesis, secretion, transport, metabolism and function of the hormones secreted by parathyroid
4. Hormones of the thyroid structure, synthesis, secretion, transport, metabolism and functions

UNIT V

1. Hormones of the adrenal medulla; structure, synthesis, secretion, transport, metabolism and functions
2. Hormones of the adrenal cortex: structure, synthesis, secretion, transport, metabolism and functions
3. Hormones of the pancreas: structure, synthesis, secretion, transport, metabolism and functions
4. Hormones of the testis and ovary: structure, synthesis, secretion, transport, metabolism and functions

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Practical Exercises :

1. To determine Hb% by Sahli's hemometer in blood samples
2. To determine the hematocrit
3. To determine the concentration of heparin in blood samples
4. To determine the PTT in blood samples
5. To demonstrate the effect of diet and hormones on the glycogen content of rat liver

Reference Books

1. Physiology by Guyton
2. Medical Physiology by Best and Taylor
3. Physiology by Garrett
4. Harper's Reviews of Biochemistry

BCH-305: Lab Course V based on the Theory Papers BCH-301 & BCH-302

BCH-306: Lab Course VI based on the Theory Papers BCH-303 & BCH 304

BCH-307: Seminar

BCH-308: Assignment

BCH-309: Comprehensive viva

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Dr. J. J. J. J.

SYLLABUS

M.Sc. Biochemistry, CBCS
FOURTH SEMESTER
Session: 2022-24

SCHOOL OF STUDIES IN BIOCHEMISTRY
JIWAJI UNIVERSITY
GWALIOR 474 011 (MP)

CBCS: M.Sc. Biochemistry 2022-24

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2022

UNIT I

1. Fundamental concepts, definition and principal classes of transposable elements
2. Mechanism of transposition
3. Transposable elements in Prokaryotes: Types, structure and significance
4. Transposable elements in Eukaryotes: Types, Structure and significance

UNIT II

1. Principles of cell signaling
2. Signaling through G-protein-coupled receptors
3. Signaling through enzyme coupled receptors
4. Alternative signaling routes in gene regulation

UNIT III (Cell Cycle & Regulation)

1. Overview of cell cycle in eukaryotes
2. Cell cycle control system
3. Molecular events during different phases of cell cycle
4. Regulation of cell division cycle

UNIT IV

1. Overview of cancer and properties of cancer cell
2. Causes of cancer
3. Cancer critical genes: Types, characteristics and properties
4. Cancer prevention and treatment

UNIT V

1. Fundamental concepts, definition and types of cell death
2. Phases of apoptosis; Morphological and Biochemical changes associated with apoptosis
3. Apoptotic pathways
4. Apoptotic regulators and significances of apoptosis

Cyber Journal

Vol. 1
2022

UNIT I

1. Introduction and organization of animal cell and tissue culture laboratory, Contamination, Primary and established cell line culture
2. Serum and protein free defined media and their applications, measurement of viability and cytotoxicity
3. Introduction to balanced salt solutions and simple growth medium: Brief introduction of the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon dioxide and supplements
4. Biology and characterization of the cultured cells, measurement of parameters of growth

UNIT II

1. Basic techniques of mammalian cell culture: Disaggregation of tissues, Primary and established cell line cultures and mass culture techniques
2. Stem cell technology: Types of stem cell, manipulations of stem cells
3. Factors governing manipulation of stem cell, Therapeutic cloning for embryonic stem cell (ESC's)
4. Applications of stem cell cultures

UNIT III

1. Nanobiotechnology: Introduction to nanoscience, Tools for measuring nano structures
2. Biosensor development and its applications
3. Microarray chips: Types of DNA chips and their production
4. SNP's and GMS (Genome mismatch repair)

UNIT IV

1. Functional proteomics: Methods of proteome analysis
2. Human Genome Project (HGP): The human genome/ Social implications
3. Forensic applications of DNA analysis
4. Intellectual property: Various forms of IP, Patents: Conditions of patentability, the process of obtaining a patent, who can obtain a patent, Why obtain patent, source of patent information, Recent changes in IPR and Patent policies, IP in Biochemistry

UNIT IV

1. Introduction to Biostatistics, Common terms, Statistical population and sampling methods, Classification and Tabulation of data, Diagrammatic and graphical presentation
2. Frequency distribution and measures of central value, Measures of variability, Standard deviation, Standard error, Range, Mean, Deviation, Coefficient of variation
3. Correlation and Regression, Positive and negative correlation, Calculation of correlation coefficient and regression coefficient, linear regression and regression equation
4. Test of significance; t-test, chi-square test and analysis of variance
5. Design of experiment, randomization, replication, local control, complementary randomized, randomized block design, Factor analysis, Path analysis

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Reference Books:

1. Protein-Protein Interactions by Erica Golemis
2. A passion for DNA (Genes, Genomes and Society) by J.D. Watson
3. Modern Genetic Analysis by Anthony J.F. Griffiths et al.
4. Nanobiotechnology- Next Big Idea by Mark, Ratner, Daniel Ratner
5. Gene Cloning by T.A. Brown
6. Latest information on academic Websites
7. DNA Microarrays and Gene Expression by P. Baldi and G.W. Hatfield
8. Statistics for Agricultural Sciences by G Nageswara Rao
9. Fundamentals of Statistics by Goon *et al.*

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BCH 401C- FOOD BIOCHEMISTRY & PROCESSING**UNIT I**

1. Introduction to Food Biochemistry, Water Chemistry
2. Role of carbohydrates in Food Industries, starch, cellulose, hemicellulose, gums, pectins, modified starch
3. Browning reactions in food: Enzymatic and non-enzymatic browning of foods of plant and animal origin during storage and processing
4. Analytical Techniques in Food Biochemistry

UNIT II

1. Proteins: Introduction, Proteins derived from milk, eggs, meat, fish muscle, oil seed and cereals. Modified proteins, Applications in Food Industry
2. Fats: Oils-hydrogenation and Winterization, vegetable and animal fats, Frying and shortenings, change of flavour in fats and oils, lipid oxidation and factors affecting lipid oxidation
3. Fat and water soluble vitamins, effect of various processing and treatments on vitamins
4. Minerals: Types, and effects of various treatments

UNIT III

1. Enzymes: In food analysis and Food processing
2. Biochemistry: Vegetables and vegetable processing, Fruits and fruit processing
3. Biochemistry of Milk constituents, milk processing, meat, poultry
4. Food Spoilage and microbial safety of food, Food preservation methods

UNIT IV

1. Fermentation: Principle, fermentation of fruits, vegetables,
2. Bioreactors: Principle of working, Types and designs
3. Pre and Probiotics, Functional Foods
4. Food Fortification: Methods, significance and applications
5. Food Packaging: Introduction, methods, significance and applications

UNIT IV

1. Food Processing: Principles, thermal processing, Technology
2. Biosensors: Principle and types, Use in detection of contaminants, pathogens and food borne toxins
3. Food quality: Concept, attributes, measurement techniques, TQM
4. Food laws and regulations

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Practical Exercises:

38/38

1. Estimation of minerals and vitamins
2. Estimation of Crude fibre
3. Determination of moisture content
4. Determination of TSS
5. Preparation and analysis of fruits and vegetable based products
6. Preparation and analysis of cereal, dairy, and bakery based products
7. Quality assessment
8. Tests for food adulterants
9. Isolation and cultivation of probiotics
10. Microbial analysis of processed and unprocessed food

BCH-402: Lab Course VII based on the Theory Paper BCH-401 (A/B/C)

BCH-403: Seminar

BCH-404: Assignment

BCH-405: Project work

BCH-406: Comprehensive viva

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