**Department of Life Sciences**

**University of Calicut**

**Ph.D. Entrance Examination**

**Biochemistry** **Time: 2 Hr**
**Marks: 100**

**Part A**

Choose the correct answer from given options
Answer all questions. Each carries 2 Marks (25x2=50)

1. Lectins are

a. proteoglycans b. glycolipids c. glycoproteins d. lipoproteins

2. The pH of a mixture of 100ml 0.1N acetic acid (pKa 4.7) and 100ml 0.1N sodium acetate is

a. 7.0 b.7.4 c. 4.7 d. 6.6

3. In a cell and its environment $Na^+$-$K^+$ ATPase maintains

a. High internal $K^+$ concentration b. Low internal $K^+$ concentration

c. high internal $Na^+$ concentration d. the same internal and external concentrations of $K^+$

4. In non competitive enzyme inhibition, by varying the inhibitor concentration----------

a. Km remains unchanged b.Vmax remains unchanged

c. Both Km and Vmax are changed d. Both Km and Vmax remain unchanged

5. The competitive ELISA can be used

a. to detect very small amounts of antigen b. to detect antibody associated with allergies

c. both (a) and (b) d. to detect trace amounts of any molecule.

6. If $\Delta G^{o'}$for hydrolysis of ATP is -7.3 kcal/mol and that for the hydrolysis of Glucose 6-phosphate is -3.3kcal/mol calculate $\Delta G^{o'}$ for the phosphorylation of glucose; Glu+ATP Glu 6-P+ADP

a. -7.3 kcal/mol b. 3.3 kcal/mol c. - 4 kcal/mol d. 4 kcal/mol

7. Somatostatin is secreted by ---------- of pancreatic islets

a. $\alpha$ cells b. $\beta$ cells c. $\gamma$ cells d. $\delta$ cells

8. Identify the cell membrane receptors which are also known as serpentine receptors

a. Tyrosine kinase receptors b. G Protein coupled receptors

c. Insulin receptors d. Epidermal growth factor receptors

9. The rigid and nearly planar structure of peptide bond is due to

a. resonance stabilization b. hydrogen bonding c. low polarity d. none of the above

10. Using the given genetic code table predict the N terminal amino acid of the peptide translated from the mRNA sequence 3'-CCUAUAAAAUUAGGCGUA-5'

| First base position | Second base position: U | | | Second base position: C | | | Second base position: A | | | Second base position: G | | | Third base position |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U | UUU | [1]P | | UCU | S | | UAU | Y | | UGU | C | | U |
| | UUC | | | UCC | | | UAC | | | UGC | | | C |
| | UUA | L | | UCA | | | UAA | Stop | | UGA | Stop | | A |
| | UUG | | | UCG | | | UAG | | | UGG | W | | G |
| C | CUU | L | | CCU | P | | CAU | H | | CGU | R | | U |
| | CUC | | | CCC | | | CAC | | | CGC | | | C |
| | CUA | | | CCA | | | CAA | Q | | CGA | | | A |
| | CUG | | | CCG | | | CAG | | | CGG | | | G |
| A | AUU | I | | ACU | T | | AAU | N | | AGU | S | | U |
| | AUC | | | ACC | | | AAC | | | AGC | | | C |
| | AUA | | | ACA | | | AAA | K | | AGA | R | | A |
| | AUG | M | | ACG | | | AAG | | | AGG | | | G |
| G | GUU | V | | GCU | A | | GAU | D | | GGU | G | | U |
| | GUC | | | GCC | | | GAC | | | GGC | | | C |
| | GUA | | | GCA | | | GAA | E | | GGA | | | A |
| | GUG | | | GCG | | | GAG | | | GGG | | | G |

[1]The one letter symbol of amino acids.

a. Ser b. Met c. Ile d. Arg

11. The step-by-step addition of deoxyribonucleotide units to a DNA chain requires

a. $Mn^{2+}$ ion b. $Mg^{2+}$ ion c. $Zn^{2+}$ ion d. $Ca^{2+}$ ion

12. Which among the following aminoacids is both glucogenic and ketogenic?

a. Phe b. Leu c.Lys d. Ala

13. ……. protects deoxyhemoglobin from autooxidation

a. Distal His residues b. proximal His residues c. heme Fe d. N terminal amino groups of the $\alpha$ and $\beta$ chains

14. Penicillin irreversibly inactivates the enzyme:

a. Glycoprotein synthase b. Glycogen phosphorylase

c. Glycogen synthase d. Glycopeptide transpeptidase

15. Amyloids are insoluble fibrillar aggregates of

a. lipids b. carbohydrates c. proteins d. none of the above

16. Rubisco can catalyse

a. Oxidation only b. carboxylation only

c. oxidation and carboxylation d. phosphorylation only

17. DNA- footprinting is a suitable technique for identifying which of the following?

a. Particular mRNA in mixture b. Particular t-RNA in mixture

c. Introns within DNA d. Protein binding site within DNA

18. Agarose gels are preferred over acrylamide for the electrophoretic separation of DNA and RNA because it has

a. higher elasticity b. higher pore size c. galactose monomers d. lower elasticity

19. The activity of prolyl hydroxylase becomes affected in which of these deficiency diseases?

a. Scurvy b. Beriberi c. Rickets d. Kwashiorkor

20. GRASP is

a. A tool to report a precomputed list of proteins of known structure that structurally resemble the query protein
b. A congenital disorder
c. A program used to analyse the surface electrostatic potentials of proteins
d. A tool to categorise proteins in a four-level structural hierarchy

21. In SDS PAGE, TEMED is used to

a. Straighten the peptide chains b. Initiate polymerisation

c. Cleave disulphide linkages d. Impart negative charge to the peptide chains

22. Which of the following is non probability sampling?

a. Snowball b. Random c. Cluster d. Stratified

23. The inability of the body to form bicarbonate ($HCO_3^-$) in the kidney leads to

a. Jaundice b. Metabolic alkalosis

c. Metabolic acidosis d. Hemophilia

24. Which among the following is a ribozyme

a. RNAase III b. RNAase P c. RNAase E d. RNAase F

25. The retinoblastoma protein pRB is a

a. Tumor supressor protein b. oncogenic protein c. protooncogene d. none of the above

**Part B**

Answer all questions. Each carries 10 Marks (5x10=50)

1. i) Give an account of the metabolic role of 2-phosphoglycerate.

ii) Write a note on glucose-6-phosphate dehydrogenase.

2. i) Elaborate the significance of Ramachandran plot.

ii) Explain the metabolic relationship between sickle cell anaemia and malaria.

3. In an enzyme purification experiment, after four steps the activity was 900 U/ml. Find out activity in units if the first, second and third stage recovery were 20, 42 and 78 % respectively.

4. i) Why DNA is considered as the genetic material? Explain.

ii) Write a note on major post transcriptional modifications.

5. Describe the applications of Mass spectrometry in analytical biochemistry.

**UNIVERSITY OF CALICUT**

# SCHEME AND SYLLABUS FOR M. Sc. BIOCHEMISTRY (CCSS)

## COURSE OFFERED BY

## DEPARTMENT OF LIFE SCIENCES

2022 Admission onwards

| No | Code | Paper | Credit | Marks | | |
|---|---|---|---|---|---|---|
| | | | | Int | Ext | Total |
| **Semester 1** | | | | | | |
| **1** | BCH 1C01 | Analytical Biochemistry | **4** | **50** | **50** | **100** |
| **2** | BCH 1C02 | Biological Macromolecules and Structural Biology | **4** | **50** | **50** | **100** |
| **3** | BCH 1C03 | Microbiology and Immunochemistry | **4** | **50** | **50** | **100** |
| **4** | BCH 1C04 | Practical I | **2** | **50** | **50** | **100** |
| **5** | BCH 1C05 | Practical II | **2** | **50** | **50** | **100** |
| **Semester II** | | | | | | |
| **6** | BCH 2C01 | Enzymes : Kinetics, Mechanisms and Regulations | **4** | **50** | **50** | **100** |
| **7** | BCH 2C02 | Cell Biology and cell Signaling | **4** | **50** | **50** | **100** |
| **8** | BCH 2C03 | Biostatistics and Bioinformatics | **4** | **50** | **50** | **100** |
| **9** | BCH 2C04 | Practical III | **2** | **50** | **50** | **100** |
| **10** | BCH 2C05 | Practical IV | **2** | **50** | **50** | **100** |
| **11** | BCH 2C06 | Practical V | **2** | **50** | **50** | **100** |
| **Semester III** | | | | | | |
| **12** | BCH 3C01 | Metabolism and regulation | **4** | **50** | **50** | **100** |
| **13** | BCH 3C02 | Physiology and Developmental biology | **4** | **50** | **50** | **100** |
| **14** | BCH 3C03 | Molecular Biology and Genetics | **4** | **50** | **50** | **100** |
| **15** | BCH 3C04 | Practical VI | **2** | **50** | **50** | **100** |
| **(Any two from the following courses)** | | | | | | |
| **16** | BCH 3E01 | Neurobiochemistry | **4** | **50** | **50** | **100** |
| **17** | BCH 3E02 | Plant secondary metabolites | **4** | **50** | **50** | **100** |
| **18** | BCH 3E03 | Nutrition and nutrigenomics | **4** | **50** | **50** | **100** |
| **19** | | Open elective (from the same department/other departments) | **4** | **50** | **50** | **100** |
| **Semester IV** | | | | | | |
| **(Any two of the following courses)** | | | | | | |
| **20** | BCH 4E01 | Nanobiology and Applications | **4** | **50** | **50** | **100** |
| **21** | BCH 4E02 | Biochemical and environmental toxicology | **4** | **50** | **50** | **100** |
| **22** | BCH 4E03 | Industrial enzymes | **4** | **50** | **50** | **100** |
| **23** | BCH 4E04 | Clinical and diagnostic biochemistry | **4** | **50** | **50** | **100** |
| **24** | BCH 4C05 | Project work / Dissertation and Viva voce | **8** | | **100** | **100** |
| | | **Total** | **72** | | | **2000** |

**Internal Evaluation**

| Theory Paper | Marks | Practical Paper | Marks |
|---|---|---|---|
| a. Attendance* | 5 | a. Lab skill/Quality of records | 10 |
| b. Seminar | 5 | b. Practical test | 30 |
| c. Assignment | 5 | c. Viva voce | 10 |
| d. Test paper | 30 | Total marks | 50 |
| e. Viva/Field work | 5 | | |
| Total marks | 50 | | |

*** 90% &above : 5 marks, 80 to 89%: 3 marks, 75 to 79%: 1 mark, below 75% : nil**

**Valuation scheme of Project/Dissertation**

| Sl. No. | Particulars | Weightage (%) |
|---|---|---|
| 1. | Review of literature and formulation of the research problem/ Objective | 20 |
| 2. | Methods and description of the techniques used | 15 |
| 3. | Analysis and Discussion of results | 30 |
| 4. | Presentation of the report, organization, linguistics style, references etc. | 15 |
| 5. | Viva voce examination based on the Project work /Dissertation | 20 |
| | Total | 100 |

**Audited courses are mandatory as per the PG regulations for which the student can register without earning credits during first and second semesters. Audit courses include Ability enhancement courses and professional competency courses related to the core area**

## SEMESTER I

## BCH1C01 Analytical Biochemistry

**Course outcomes (COs)**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe the concepts of sampling, quality control, laboratory management and automation. | K1, K2 |
| CO2 | Explain the principles of hydro dynamic, electro analytical, optical, spectroscopic, microscopic and radio activity based techniques. | K1, K2 |
| CO3 | Apply the knowledge in the above techniques in purification, separation and characterization of biomolecules from their natural sources. | K1, K2, K3 |
| CO4 | Design stepwise protocols for the purification, separation and characterization of biomolecules from their natural sources. | K1, K2, K3, K5 |
| CO5 | Develop good laboratory practices and minimize hazards in laboratory. | K1, K2, K3 |

**Unit I: Basics of Analytical Biochemistry**

Types of samples, Sample preparation for solid and semisolid samples, Extraction of solid samples, derivatization of samples. Quantitative measurement- limit of detection & quantification sensitivity. Calibration, Accuracy, precision and reliability. Managing laboratory information-properties of good information, management systems. Laboratory automation-planning, example, and validation.

**Unit II: Hydrodynamic techniques (Advanced level)**

Principle, Instrument Design, methods and Applications of all types of Adsorption and Partition Chromatography- Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Affinity chromatography, Ion-exchange chromatography and HPLC.

Centrifugation – Principle, methods and application, Ultra centrifugation, Viscometry, Osmosis, diffusion and surface tension.

**Unit III: Electro analytical techniques(Advanced level)**

Principle, Instrument Design, methods and Applications of Free and zone Electrophoresis – Paper electrophoresis, Gel electrophoresis, Poly Acrylamide gel electrophoresis, SDS PAGE, 2D - PAGE, native gels, gradient gels, Western, Southern and Northern blotting, Capillary electrophoresis, Isoelectric focusing, Electrophoresis of nucleic acids - agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis, Potentiometry, pH meter, conductometry.

**Unit IV: Optical and Spectroscopic techniques**

Principle, Instrument Design, methods and Applications of UV-Visible spectroscopy, Fluorescence spectra, IR spectra, Raman spectra, NMR, X ray diffraction, Polarimetry, ORD, CD, Light scattering, Refractometry, Flow cytometry, FISH, Cytometry, Mass spectrometry, MALDI TOF MS.

**Unit V: Microscopic techniques**

Principle and working of Compound microscope, Phase contrast microscope, Interference microscope , Fluorescence microscope , Polarizing microscope , Scanning and Transmission Electron Microscopy, cell fixation - fluid fixatives, freezing and section drying, fixation for electron microscopy, CCD camera, Introduction to Atomic force microscopy, Confocal microscopy, Histopathological studies - organ specific morphohistological examination, identification of morphological changes related to pathology.

**Unit VI: Analytical methods based on radioactivity**

Detection and measurement of radioactivity - GM counter, solid and liquid scintillation counter, primary and secondary fluors, quenching - Cerenkov counting. Autoradiography. Applications of radioisotopes in the biology and medicine. Hazards of radioactivity and precautions to be taken

**References**


1. Gradwohls Clinical Laboratory Techniques. Stanley S. Raphael. W.E. Company, London, UK.
2. Principles and Techniques of electron microscopy- Biological applications. Fourth edn. M.A Hayat., Cambridge University Press, Cambridge UK.

3. Practical Biochemistry- Principles and techniques. Fifth edn, Keith Wilson and John walker, Cambridge University press, Cambridge UK.
4. Modern Experimental Biochemistry. Third edn, Rodney F Boyer. (Benjamin/ Cummings series in Life sciences and Chemistry), Prentice hall, New Jersey, U.S.A.
5. Chromatographic methods. A Braithwate and F J Smith. Chapman and Hall, London, UK.
6. Gel Electrophoresis of Nucleic acids- A Practical approach. Second edn, Rickwood D and BD Hames. IRL Press, New York.
7. Spectrophotometry and Spectrofluorimetry: A Practical Approach. Harris DA and CL Bashford (Ed.), Oxford Umiversity press, U.K.
8. Introduction to Spectroscopy. Fifth edn, Donald L. Pavia, Gary M Lipman, George S Kriz, James R. Vyvyan, Cengage Learning, U.S.A.
9. Hand book of Instrumental Techniques for Analytical Chemistry by Frank Settle (Editor), Prentice Hall, U.S.A.
10. Principles of Fluorescence Spectroscopy, Third edn, J.R. Lakowicz, Springer, U.S.A.

## BCH 1C02. Biological macro molecules and structural Biology

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Recognize the living system as a complex interplay between carbohydrates, lipids, proteins and nucleic acids. | K1, K2 |
| CO2 | Identify the structure of biological macromolecules at different levels of organization (primary, secondary, tertiary and quaternary) and the nature of key bonds making them. | K1, K2 |
| CO3 | Investigate methods of purification for each type of biological macromolecule. | K1, K2, K3 |
| CO4 | Explain protein folding, its dynamics and diseases caused by protein misfolding. | K1, K2, K3 |

| | | |
|---|---|---|
| CO5 | Identify structure-function relationships of biological macro molecules and genome organization. | K1, K2, K3 |
| CO6 | Evaluate the role of different techniques like x-ray diffraction, lasers and microscopy in structural elucidation of biological macromolecules and their applications. | K1, K2, K3 |

**Unit I: Complex Carbohydrates**

Oligosaccharides: Glycosidic bonds; Classification: glycoproteins (O- linked and N- linked), glycolipids; Nature of carbohydrate moiety attached; Functions: as cell recognition factors, in intracellular targeting; Purification and Characterization of oligosaccharides from cell membranes

Polysaccharides: Classification: Homopolysaccharides (Cellulose, Starch, Chitin, and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin); Structural characteristics and functions of above mentioned polysaccharides; Exopolysaccharides from bacterial systems and their uses; Purification and Characterization of polysaccharides from biological systems.

**Unit II: Complex Lipids**

Glycerophospholipids: Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl glycerol, Phosphatidyl choline, Phosphatidyl inositol), CDP-diacylglycerol, Lung surfactants.

Glycosphingolipids: Structure and function of (Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides).

Eicosanoids: Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function.

Steroids: Steroids in animal system: Glucocorticoids, mineralocorticoids and Sex hormones (Site of biosynthesis, functions and mechanism of action; Sterols in Plant system: Phytohormones: Brassinosterroids (functions); Sterols in microbial system.

**Unit III: Proteins & Nucleic Acids**

Protein structure: Primary, Secondary, Tertiary and Quaternary structure of Proteins, Super secondary structures, Globular proteins (eg: Hemoglobin and Myoglobin), Fibrous proteins:

(Collagen), Protein folding, Path ways and dynamics of protein folding, Molecular chaperons, Protein stability, Diseases associated to protein conformation.

Nucleic acid structure and function: Supercoiling of the DNA molecule; topoisomers and superhelixes; Higher orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes; Conformation of Chromatin fibers, Organization of the DNA Sequence: Genes, pseudogenes, extragenic regions (beta globin gene and gene family) duplicated genes; Repetitive DNA sequences: Tandem repeats (Satellites, mini satellites, and micro satellites), Interspersed repeats (LINE, SINEs) Single copy genes, Reassociation kinetics, DNA Cot curve, RNA Structure: Types of RNA; structure of mRNA, tRNA and rRNA ,Si RNA, micro RNA with emphasis on importance of structure to its function.

**Unit IV: 3D-Structure Determination Methods and their Applications**

X-ray diffraction, Space groups; crystal symmetry; Miller Indices, Bravais lattices, X-ray diffraction and Bragg's law, X-ray structure determination of biomolecules and accuracy/refinement of x-ray crystallographic structures.

Lasers in Biology and Medicine

Basic concepts of coherence and laser definition; types of lasers (Xe; Nd-YAG etc.); fiber optics technology; applications of lasers for biomolecular structure determination (e.g. LIF) and to medicine (surgery, ophthalmology).

**Unit V: Microscopy Based on Single Molecule Methods**

Use of single molecule methods: Introduction, Electron Optics, Transmission Electron Microscope (TEM),Scanning Electron Microscope (SEM), Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM).

**References**


1. Biophysical Chemistry, C.R. Cantor and P.R. Schimmel, (Part 1,2,3), W.H. Freeman and company, U.S.A.
2. Principles of Physical Biochemistry, Keith Van Holde, Chien and Ho, 2nd Edn, Pearson.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, D.M. Freifelder, W.H. Freeman and company, U.S.A.
4. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill).
5. Biological Spectroscopy- I.D. Cambell & R.A. Durk, (Benjamin Cummings).
6. Proteins: Structure and Function: David Whitford: John Wiley &Sons.
7. Biochemistry, 5th edn, Lubert Stryer W.H. Freeman and company, U.S.A.

8. Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2.

9. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson VisitAmazon's David L. Nelson Pagesearch resultsLearn about Author CentralMichael M. CoxVisit Amazon's Michael M. Cox Pagesearch resultsLearn about Author Central.

10. Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.

11. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company-Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757

12. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365

13. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis Visit Amazon's Julian Lewis Pagesearch resultsLearn about Author Central, Martin Raff, Keith Roberts, Peter Walter Publisher: Garland Science; 5 edition ISBN-10: 0815341059 ISBN-13: 978-0815341055.

14. Genes XI by Benjamin Lewin (2008) Publisher: J&b ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224.

15. Molecular Biology Of The Gene 5/e (s) by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8177581813 ISBN-13: 9788177581812, 978-8177581812.

16. Cell and Molecular Biology, 3e (2003) by Karp Publisher: Jw.ISBN: 0471268909 ISBN-13: 9780471268901, 978-0471268901.

## BCH 1C03: Microbiology and Immunochemistry

**Course Outcomes:**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Classify microbes using molecular level approaches used in microbial taxonomy. Explain virus structure, viral replication and cultivation. | K1, K2 |
| CO2 | Illustrate staining techniques for visualization and identification of | K1, K2 |

| | | |
|---|---|---|
| | microbes, methods of sterilization, disinfection and safe handling of microorganisms. | |
| CO3 | Discuss the preparation and maintenance of microbial cultures, applications of microbes in research and industry and concepts of environmental microbiology. | K1, K2 |
| CO4 | Describe immune system and its components, clinical immunology and immunological techniques. | K1, K2 |
| CO5 | Categorize antibodies and explain genetics of Igs, molecular genetic aspects of B cell differentiation, antibody mediated effector functions, monoclonal antibodies and abzymes. | K1, K2 |
| CO6 | Explain immunological reactions, related techniques and immune dysfunctions. | K1, K2 |

**Unit I: Basic microbiology**

Brief History of microbiology. Classification of microorganisms. Viruses-structure, viral replication and cultivation, Various staining techniques for visualization and identification of microbes. Methods of sterilization and disinfection. Instructions for safe handling of microorganisms.

**Unit II: Microbial growth and application of microbes in research and industry**

Cultivation and growth of bacteria, pure culture techniques, Diffent types of bacteriological media, bacterial growth curve, and measurement of growth, control of growth,. Application of microbes in Biochemical research, industrial production of antibiotics and other organic substances. Microbiology of fermented foods, Food spoilage and preservation processes. Different types of microbial fermentation and Bioreactors.

**Environmental microbiology-** Microbes as components of the environment-nutrient cycles-carbon-nitrogen, sulphur and phosphorus cycles, Degradation of industrial wastes, petroleum hydrocarbons, pesticides, biofouling and corrosion. Bacterial photosynthesis, symbiotic and non-symbiotic nitrogen fixation.

**Unit III: The immune system**

Nonspecific host defences-Anatomic, physiologic, phagocytic, and inflammatory components of innate immunity, lysosymes, interferons and connectins, pattern recognition in innate immunity. Inflammatory responses- major events, chemical mediators: acute phase proteins, histamines and kinins, Adaptive immunity, Cooperation between lymphocytes and antigen-presenting cells in adaptive immune response, primary and secondary immune responses, collaboration of adaptive and innate immune responses, comparative immunity, , Antigen recognition and processing, MHCs. Cellular dynamics (recirculation, selective lodging). Systemic function of immune system, Lymphoid cells and organs-evolutionary comparisons. Complement activation and Regulation.

**Unit IV: The antibodies-chemistry and diversity**

Different molecular forms (isotypes) of antibodies; heterogeneity of antibodies with respect to affinity for a single hapten. Fragmentation of antibodies into functionally distinct 'domains'; multiple polypepetides comprising the different isotypes of antibodies; primary structural bases for specificities and diversity of antibodies. Fc-receptors (FcR) for antibodies: structure and function, Three dimensional structural bases for antibody specificity; the immunoglobulin fold. Genetics of Igs; allotypes; molecular genetic aspects of B cell differentiation; the generation of receptor diversity; affinity maturation; antibody isotype switching. Antibody mediated effector functions: opsonisation, activation of complement system. Monoclonal antibodies and abzymes.

**Unit V: Immunological reactions and related techniques**

Immunogenicity and antigenicity, epitops, Antibody affinity and avidity, cross reactivity, Precipitation reactions and precipitin curves, Agglutination reactions: hemagglutination, bacterial and passive agglutinations, inhibition of agglutinations. Protocol, instrumentation and applications of: Immunoelectrophoresis, double immunodiffusion, rocket electrophoresis, radioimmunoassay, indirect, sandwich &competitive ELISA, ELISPOT assay, immunoflourescence, immuno histochemistry, Immuno blotting, immunoelectron microscopy, recombinant phage antibody system (RPAS), immunosensors.

**Unit VI: Immune dysfunctions**

Immunologically mediated allergies and hypersensitivities, Gell and Coombs classification of hypersensitivity: IgE-mediated, Antibody-mediated, Immune complex–mediated and Delayed-Type hypersensitivities. Immunopathologic changes: lymphocytic choriomeningitis, immune reactions in the eye. Genetically determined immunodeficiencies and their consequences, Protozoan and metazoan parasite infections; mechanisms of pathogenesis and

host immune responses, Primary and acquired immunodeficiencies, Organ-Specific and systemic autoimmune Diseases, roles of CD4+ T Cell, MHC, and TCR in Autoimmunity, Proposed mechanisms for induction of autoimmunity, Emerging Infectious Diseases.

**References**


1. Fundamentals of Microbiology, Aleamo Edward, Jones & Barret Publications, Massachusetts
2. Textbook of Microbiology, Anantha Narayanan & Jayaram Panicker, Orient Longmann.
3. Industrial Microbiology, Reed Gerald, Prescott and Dunn's, CBS Publications.
4. Microbology, Pelezar Michael J, Mc Graw Hill.
5. Immunology, Janis Kuby, W. H. Freeman and Company Ltd, USA.
6. Immunology, Ivan Roitt, J. Brostoff and David Mole Mosby Times Mirror Int. Pub. Ltd.
7. Essential Immunology, Ivan Roitt Blackwell Science Ltd.
8. Immunology, Edwards S. Golub, Sinauer Associate, Sunderland.
9. Antibodies, Harlow & Lane, Cold Springs Harbor Press.
10. Cellular and molecular immunology 6th edition: Abbas KA and Lichtman AH.
11. Immunobiology, 7th edition, Janeway, et. al. Garland Science Publishing.
12. Monoclonal Antibody and Immunosensor Technology-The production and application of rodent and human monoclonal antibodies, Ailsa M. Campbell, Elsevier Science Publishers, Amsterdam.


## BCH 1C04 Practical I

**Course Outcomes:**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Prepare different solutions and buffers. | K1, K3, K4 |
| CO2 | Develop expertise in sampling and laboratory management. | K1, K3, K4 |
| CO3 | Follow good laboratory practices and minimize hazards in laboratory. | K1, K3, K5 |
| CO4 | Become skilled in qualitative and quantitative analysis of biomolecules | K1, K2, K3, K4 |

| | | |
|---|---|---|
| | and macromolecules from natural sources using various separation techniques. | |
| CO5 | Perform separation of cell organelles using centrifugation techniques. | K1, K2, K3, K4 |

1. Preparation of standard solutions, weighing, quantitative transfer.
2. Qualitative analysis of carbohydrates (monosaccharide, disaccharides and polysaccharides)
3. Qualitative analysis of proteins and amino acids
4. Preparation of buffers using pH meter
5. Detection of isoelectric pH of a protein
6. Quantitative estimation of proteins – Comparative evaluation by Lowry *et al* method, Bradford method, Biuret method and spectrophotometric method, to establish accuracy
7. Quantitative estimation of reducing sugar
8. Extraction & Quantitative estimation of cholesterol
9. Estimation of muscle and liver glycogen
10. Extraction and estimation of starch from different biological samples
11. Iodine value and saponification value of oils
12. Paper Chromatography of sugars, amino acids
13. TLC of amino acids
14. Column chromatography of plant pigments and analysis of the spectra of different fractions
15. Polyacrylamide gel electrophoresis of proteins
16. Centrifugation: Organelle separation by differential centrifugation and density gradient centrifugation

## BCH 1C05 Practical II

**Course Outcomes:**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Develop expertise in staining techniques. | K1, K3, K4 |
| CO2 | Perform IMVIC, Widal, VDRL, Elisa and antibiotic sensitivity tests. | K1, K3, K4 |
| CO3 | Become skilled in performing immunodiffusion, immunoelectrophoresis and complement fixation. | K1, K3, K4 |

1. Gram's staining
2. Acid fast staining
3. IMVIC tests
4. Fermentation of carbohydrates
5. Antibiotic sensitivity test
6. Production of microbial enzymes- amylase, cellulase, lipase and pectinolytic enzymes
7. Widal test
8. VDRL test
9. Elisa
10. Immunodiffusion method
11. Immunoelectrophoresis
12. Complement fixation

## SEMESTER II

## BCH 2C01 Enzymes: Kinetics, Mechanism and Regulation

**Course Outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Recognize enzymes as important molecules that act as catalysts in biological systems, relate the structure and functions of enzymes, features of active sites, multi enzyme complexes. | K1, K2 |

| | | |
|---|---|---|
| CO2 | Identify the type and mode of action of an enzyme from E.C. number of that enzyme, Explain mechanisms enzyme catalysis, thermodynamics, kinetics, molecular interactions and regulatory aspects. | K1, K2, K3 |
| CO3 | Interpret and explain significant mechanisms of regulation of enzymatic action and specify importance of enzymes in regulation of metabolism. | K1, K2, K3 |
| CO4 | Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems considering kinetics and thermodynamics of enzymatic reactions. Determine specific activity of enzymes. | K1, K2, K3, K4 |
| CO5 | Draw kinetic plots and calculate kinetic parameters from experimental data. Analyze enzyme inhibition and regulation. | K1, K2, K3 |
| CO6 | Design step wise protocols for the extraction, purification and characterization of enzymes from different sources. | K1, K2, K3, K4, K5 |
| CO7 | Identify the clinical and industrial applications of enzymes. | K1, K2, K3 |

**U nit I: Enzyme kinetics**

Importance of enzymes in biological systems, active site, substrate specificity, mechanism of action of different co enzymes in specific reaction types, derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of $K_m$ & $V_{max}$ and their physiological significance. Importance of $K_{cat}/K_m$. Kinetics of zero & first order

reactions. Significance and evaluation of energy of activation. Collision & transition state theories. Michaelis – pH functions & their significance. Classification of multi substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, Suicide inhibition, linear-mixed type inhibitions and their kinetics, determination of $K_I$.

**Unit II: Mechanism of Enzyme Action**

Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Mechanism of action of chymotrypsin, carbonic andydrases, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase. Experimental approaches to the determination of enzyme mechanisms.

**Unit III. Enzyme Regulation**

General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. Feed back inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase & phosphofructokinase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

**Unit IV : Multienzyme systems and application of enzymes**

**Multienzyme system –** Occurrence, isolation & their properties: Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase. **Application of enzymes-**Therapeutic, enzymes as targets of drugs, clinical importance, diagnostics, immobilized enzymes, abzymes. Extraction and purification of enzymes from different sources.

**References**

1. Fundamentals of Enzymology, Nicholas Price and Lewis Stevens, Third Edition, Oxford University Press.

2. Enzyme Kinetics: Catalysis & Control A Reference of Theory and Best-Practice Methods , Daniel L. Purich , Academic press.

3. The Enzymes edited by David S Sigman volume XX Mechanisms of catalysis third edition academic press, inc. 1992
4. The Enzymes kinetics and mechanism volume I1 Third Edition Edited by Paul D. Boyer academic press, New York and London 1970
5. Allosteric regulatory enzymes by Thomas Traut © 2008 Springer Science+Business Media, LL 2007
6. Lubert Stryer : Biochemistry, 5th edn. (Freeman)

## BCH 2C02 Cell Biology and cell Signaling

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe eukaryotic cell biology and cell processes at molecular level. | K1, K2 |
| CO2 | Explain cell cycle, cellular processes, cellular transport and cell signaling. | K1, K2 |
| CO3 | Apply such conceptual understanding to solve problems in cell biology. | K1, K2, K3 |

**Unit I Cell cycle**

Cell cycle - Different stages, variations, checkpoints, regulations of cell cycle, maturation Promoting factor, cells, cyclins , ubiquitin, protein ligases, Anaphase Promoting complex, inhibitors of CdK, growth factors and D cyclins. Rb protein and E2F transcription factors

**Unit II Cellular processes – Differentiation, Aging & Cell Death**

Cell Differentiation:Stages of development, regulation of development, cascade control/ Differentiation in Drosophila, maternal, Segmentation and homeotic Genes, Genetic control of embryonic development, Bi thorax mutant, Antennapediac mutant ,Hemeobox

Aging**:** Process of aging, theories of aging, Arking's contribution Oxidative stress, Telomere problem, DNA repair defects.

Cell Death: Necrosis and Apoptosis, Differences between necrosis and Apoptosis, stages in Apoptosis, mitochondrial damage DNA ladders, transglutaminase activity, programmed cell

death in *Ceanorhabdtis elegans* CED 3, CED 4, CED 9 and their roles in Apoptosis. Bax, Bid, Bcl2 proteins.

**Unit III Cell-cell communication and Transport across membranes**

Cell-cell interactions, cell-matrix interactions, cell adhesion proteins, cell junctions, tight junctions, gap junctions, desmosomes, coated pits, Overview of membrane protein - peripheral and integral, molecular model of cell membrane - fluid mosaic model and membrane fluidity, solute transport across membrane, endocytosis, exocytosis, phagocytosis, pinocytosis, Thermodynamics, kinetics and mechanisms of transport, symport, antiport, uniport, passive transport, active transport by ATP powered pumps, gated channels, types of transport systems, neurotransmission

**Unit IV Structure and Function of Signal Pathways**

General function of signal pathways, Structure of signaling pathways, Mechanisms of intercellular communication, Principles of intracellular signal transduction, Components of intracellular signal transduction, Coupling of proteins in signaling chains , Coupling by specific protein-protein interactions, Coupling by protein modules, Coupling by reversible docking sites ,Coupling by co localization, Linearity, Branching and crosstalk, Variability and specificity of receptors and signal responses,

Extracellular signaling molecules, Hormone receptors, Signal amplification, Regulation of inter- and intracellular signaling, Membrane anchoring and signal transduction, Signaling by nuclear receptors, G Protein-coupled signal transmission pathways, Intracellular messenger substances: second Messengers, Ser/Thr- specific protein kinases and protein phosphatases, Signal ransmission via transmembrane receptors with Tyrosine-specific protein kinase activity , Signal transmission via Ras proteins, Intracellular signal transduction: the Protein cascades of the MAP kinase, Membrane receptors with associated tyrosine kinase activity, Other receptor classes.

**References**


1. Cell and Molecular Biology Concepts and Experiments. Gerald Karp, John Wiley & Sons, Inc.
2. Molecular Cell Biology. Harvey Lodish
3. Biochemistry of Signal Transduction and Regulation. Gerhard Krauss, Wiley Publishers.
4. The Cell, A Molecular Approach. Geoffrey M Cooper
5. Signaling Mechanisms of Oxygen and Nitrogen Free Radicals. Igor B. Afanas'ev, CRC Press, Taylor & Francis Group, New York.

6. The World of the cell by Becker, Kleinsmith and Harden Academic Internet Publishers.

7. The Cell - Biochemistry, physiology and morphology by J. Brachet and A. E. Mirsky, Academic Press

8. De Robertis EDF & De Robertis EMF. Cell and Molecular Biology, Allied Pub Ltd.

## BCH 2C03. Biostatistics and Bioinformatics

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe statistical methods for collection, tabulation and representation of data, sampling and sample design. | K1, K2 |
| CO2 | Plot diagrammatic representations of data and calculate central tendencies. (mean, median, mode, range, mean deviation and standard error). | K1, K2, K3,K4 |
| CO3 | Perform correlation, regression and probability analysis of variables and calculate significance by t- test, Chi square test, goodness of fit and Analysis of variance. | K1, K2, K3,K4 |
| CO4 | Perform structural, functional and phylogenetic analysis using various softwares. | K1, K2, K3 |
| CO5 | Describe the concept behind drug designing with the application of bioinformatics tools. | K1, K2, K3 |
| CO6 | Perform the method of molecular docking and their application. | K1, K2, K3, K4 |

1. Biostatistics: Methods for collecting data, tabulation and representation of data, sampling and sample design, types of classification, tabulation, diagrammatic representation line diagram, bar diagram, pie diagram, histogram, frequency polygon, frequency curves and cumulative frequency curves. Measures of central tendency: mean, median, mode,

range, mean deviation and standard error. Correlation analysis and regression analysis, probability analysis of variables. Tests of significance: t- test, Chi square test and goodness of fit; Analysis of variance: one way classification and two way classification.

2. Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems.
3. Introduction to biological databases, classification of biological databases, Genbank, Protein Data Bank, Swiss-prot etc. Biological data formats, data retrieval - Entrez and SRS. ExPASSY
4. Introduction to Sequence alignment, Local and Global alignment concepts, Multiple sequence alignment –Progressive alignment. Database searches for homologous sequences –Fasta and Blast versions. Bioinformatics Softwares: Clustal, RasMol, EMBOSS, Genetic Analysis Software, Phylip. Evolutionary analysis: distances - clustering methods – rooted and unrooted tree representation.
5. Fragment assembly-Genome sequence assembly. Gene finding method, Gene prediction - Analysis and prediction of regulatory regions. Structure prediction and protein modelling.

**Rererences**


1. Andreqas D. Baxevanis, B. F. Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins John Wiley and Sons, New York (1998).
2. Jonathan Pevsner. Bioinformatics and functional genomics.2edn, John Wiley & Sons, Inc. 2009
3. Bryan Bergeron. Bioinformatics computing. Prentice Hall PTR. 2002
4. David W. Mount. Bioinformatics - sequence and genome analysis.
5. Arthur M Lesk. Introduction to Bioinformatics. Oxford University Press. 2002
6. Jerrold H. Zar. Biostatistical Analysis.5th Edn. 2009


## BCH 2C04 Practical III

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Establish expertise in enzyme assays | K1, K2 |
| CO2 | Perform enzyme kinetic analysis and interpret data. | K1, K2, K3,K4 |
| CO3 | Calculate Km and Vmax by MM plot and LB plot. | K1, K2, K3,K4 |

| | | |
|---|---|---|
| CO4 | Be skilled in extraction of enzymes from tissues. | K1, K2, K3, K4 |
| CO5 | Design stepwise protocol for enzyme isolation from a given sample. | K1, K2, K3, K4, K5 |

1 Assay of Alkaline and acid phosphatases in serum samples

2 Assay of serum amylase

3 Enzyme assays: Determination of optimum pH, optimum temperature, enzyme proportionality and time proportionality.

4 Ammonium sulfate fractionation of enzyme and desalting by dialysis/Sephadex G-25 filtration

5 Determination of total activity and specific activity of enzymes Trypsin, Pepsin etc

6 Determination of Michaelis-Menten constant ($K_M$) of an enzyme by Lineweaver-Burk method.

7 Determination of inhibitor constant ($K_I$) of an enzyme by Dixon's method.

8 Extraction of enzymes from animal tissues and isoenzyme analysis by PAGE

**9** Purification of amylase from plant sources

## BCH 2C05 Practical IV

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Maintain and culture cell lines | K1, K2, K3 |
| CO2 | Perform cell staining viability and cytotoxicity assays | K1, K2, K3,K4 |
| CO3 | Prepare karyotypes. | K1, K2, K3 |
| CO4 | Make microscopic slides of cells and identify various stages of cell cycle, measure hematological parameters and prepare blood smears | K1, K2, K3, K4 |

| | | |
|---|---|---|
| CO5 | Get familiarized with cell sorting technique. | K1, K2, K3 |

1. Introduction to equipment and reagents used in cell culture techniques.
2. Cell Culture techniques: Primary cell culture, maintaining cell lines.
3. Cell Staining with fluorescent as well as non-fluorescent dyes/Antibodies.
4. Cell viability assays: Trypan blue dye exclusion assay, MTT assay.
5. Isolation of peripheral blood mononuclear cells (PBMC).
6. Determination of $LC_{50}$ of PBMC after treatment with different cytotoxic compounds.
7. Examination of onion root tip cells for different stages of mitosis.
8. Preparation of different stages of Meiosis (grasshopper testis or immature anther).
9. Sub cellular fractionation and marker enzymes.
10. Preparation of Karyotype.
11. Blood smear preparation, differential WBC count, total WBC count and total RBC count.
12. Demonstration of cell sorting.

## BCH 2C06 Practical V

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Explain the features of National Centre for Biotechnology Information (NCBI). | K3 |
| CO2 | Demonstrate proficiency in bioinformatics methods including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software | K4 |

| | | |
|---|---|---|
| | packages. | |
| CO3 | Use existing software effectively to extract information from large databases and to use this information in computer modeling. | K4 |
| CO4 | Preform sequence comparison using various alignment tools | K4 |
| CO5 | Create protein structures with modelling tools. | K4 |
| CO6 | Prediction of Gene structure, gene function and ORF position. | K4 |
| CO7 | Perform structural, functional and phylogenetic analysis using various softwares. | K4 |

1. Data retrieval from Swiss-Prot, GenBank and PDB, Pubmed, GEO
2. Pairwise Sequence Alignment using BLAST and FASTA
3. Multiple Sequence Alignment with CLUSTAL W
4. Gene structure and function prediction (using GenScan, GeneMark)
5. Protein sequence analysis (ExPASy proteomics tools)
6. Finding ORF of a Given Sequence
7. Retrieving Motif Information of a Protein Using Prosite
8. Retrieving Gene Information from TAIR database
9. Primer Designing
10. Global alignment of two sequences
11. Local Alignment of Sequences
12. Phylogenetic Analysis using PHYLIP
13. Calculating the Distance between the Ligand and a Particular Amino acid
14. Finding the Active Site Pockets of a given Protein Molecule
15. Primary Structure Analysis of a Protein Using ProtParam

16. Secondary structure analysis of a protein using SOPMA

17. Surface Analysis of a Protein Using CASTp

18. Retrieving details of a drug molecule

19. Protein/Nucleotide Sequence Analysis using EMBOSS

20. Molecular Visualization tools

21. Homology modeling using SPDBV/Modeller

22. Model structure refinement using SPDBV

23. Model validation using What Check and Pro Check

24. Docking using AUTODOCK/ HEX

## SEMESTER III

## BCH3C01 : Metabolism and regulation

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe reaction mechanisms and analyse underlying thermodynamic principles. | K1, K2, K3 |
| CO2 | Outline modern approaches to understand metabolism. | K1, K2, K3 |
| CO3 | Explain biochemical and genetic regulation of various metabolic pathways of carbohydrates, lipids, proteins and nucleic acids. | K1, K2, K3 |
| CO4 | Elaborate mitochondrial metabolism | K1, K2 |
| CO5 | Apply the knowledge of biochemical and genetic regulation of metabolism to interpret findings in research and diagnostic sectors. | K1, K2, K3 |

**Unit I Biological Reactions and mechanisms**

Group transfer reactions,Oxidation reductions,elimination, isomerization, rearrangement reactions, reactions make or break carbon – carbon bonds. Thermodynamics of biological reactions.

**Unit II Modern approaches to study metabolism**

Metabolic inhibitors, growth studies, and Biochemical genetics, radio isotopic techniques isolated organs, cells, and sub-cellular organelles, system biology approach- Transcriptomics, proteomics, metabolomics, applications of metabolic pathway data bases.

**Unit III Carbohydrate metabolism, regulation and disorders**

Regulation of glycolytic pathway, homeostasis and metabolic control, metabolic flux, metabolic control analysis, mechanism of flux control, supply demand analysis, regulation of glycolysis in muscle. Substrate cycling, Metabolism of minor sugars, Allosteric control of Glucogen Phosphorylase (GP) and Synthase(GS), cyclic cascades and Bicyclic cascades of GP and GS , Integration of Glycogen metabolism control mechanism, maintenance of blood glucose level, and its response to stress. Disorders associated with carbohydrate metabolism. Regulation of Gluconeogenesis, Cori cycle, Biosynthesis of oligosaccharides, glycoprotein synthesis, control of HMP shunt, deficiency of G 6P Dehydrogenase

**Unit IV Lipid, Aminoacid, protein, Nucleic acid metabolism, regulation and disorders**

Regulation of fatty acid metabolism, cholesterol metabolism and regulation, Eicosanoid metabolism- Prostaglandins, prostacyclins, Thromboxans, Leukotrienes, and Lipoxins. Phospholipid and Glycolipid metabolism. Disorders of lipid metabolism.

Protein degradation in cells- Lysosomal events, role of ubiquitin & proteosome. Regulation of Urea cycle, catabolism of aminoacids and disorders, Biosynthesis of non essential aminoacids, one carbon metabolism associated with aminoacid and nucleotide metabolism, metabolism of heme, physiologically active amines, and Nitric oxide.

**Unit V Mitochondrial metabolism, Energetics and regulation**

Regulation of TCA cycle, Uses and replenishing of TCA intermediates, Regulation of ETC and Oxidative phosphorylation, chemiosmotic theory, Mechanism of ATP synthesis, energy metabolism,. Bioenergetics , Mitochondrial Calcium Signalling: Role in Oxidative Phosphorylation Diseases, Role of Inorganic Polyphosphate in the Energy Metabolism,

**References**

1. Biochemistry 4th ed, Campbell and Farrell, Brooks/Cole Pub Co.

2. Biochemistry NMS. 4th edn, Davidson and Sittman, Lippincott. Willams and Wilkins.

3. Biochemistry, Donald Voet, J.G. Voet and John Wiley, 1995.

4. Biochemistry, 2nd ed. Kuchel and Ralston, Schaum's Outlines McGraw Hill.
5. Harper's Biochemistry. 26th ed. Murray, et al. McGraw Hill.
6. Lehninger's Principles of Biochemistry, 4th ed, Nelson Cox, McMillan Worth.
7. Biochemistry by Stryer. 6 edn., W. H. Freemanand company ltd, U.S.A.

## BCH 3C02: Physiology and developmental biology

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe key processes in plant physiology like photosynthesis, photomorphogenesis, photoperiodism, transport of nutrients and metabolites, mineral nutrition and plant hormones. | K1, K2 |
| CO2 | Explain tissue and organ systems in animals and their functions. | K1, K2 |
| CO3 | Outline the principles of animal developmental biology, events and stages in embryonic development, growth, regeneration and signaling cascades involved in the control of developmental program. | K1, K2 |
| CO4 | Highlight the key events in plant development. | K1, K2 |

**Unit I: Plant Physiology**

Photosynthesis: Photosynthetic pigments, Absorption and action spectra, light and dark reactions, Calvin cycle, photorespiration, C4 and CAM pathways. Phytochromes, Cryptochromes, photomorphogenesis, Photoperiodism. Transport of nutrients across the primary root, transport through sieve element, transport of metabolites from the source to the sink, Mineral nutrition and assimilations of inorganic nutrients. Plant Hormones: Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid.

**Unit II: Animal Physiology**

Tissue systems and their functions: Epithelial tissue, Connective tissue, muscular tissue and Nervous tissue. Endocrine system: Glands and Hormones, Secretory mechanisms, Circulatory systems: general plan, Heart cycle including electrocardiogram. Respiratory system: respiratory pigments, transport of gases in blood, regulation of body pH. Excretory system: Physiology of mammalian kidneys. Reproductive system: Asexual and sexual reproductive system, Gonads, gametes, Gametogenesis and hormonal control, Fertilization.

**Unit III: Animal Developmental biology**

Early embryonic development: Cleavage-types and mechanism, formation of blastula, gastrulation, neurulation, cell migration, organogenesis and growth. Cell specification, Progressive determination, Pattern formation, Regeneration, cAMP signaling during development.

**Unit IV: Plant Developmental Biology**

Male and female gametophyte development, pollination and fertilization. Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, seedling development, Embryogenesis: Basic layout of dicot and monocot embryos, stages of embryo development, embryonic axis, cell division and pattern formation in embryo, Shoot development: Structure and function of shoot apical meristem (SAM), Leaf development: Emergence of leaf primordium from SAM, Root development: Root apical meristem structure and function, lateral root, Flower development: Transition from vegetative to reproductive stage, inflorescence meristem, development of monocot flowers.

**References**


1. The Arabidopsis Book, ASPB publication (available freely at www.aspb.org)
2. Biochemistry and Molecular Biology of plants Ed. Buchanan, Grussem and Jones, ASPB publication.
3. Plant Physiology by Taiz and Zeiger, Sinauer Associate Inc. Publishers
4. Developmental Biology 8 th , Ed: Scott F Gilbert
5. Essentials of Developmental Biology (3 rd edition): JMW Slack
6. Principles of Developmental Biology (2 nd , edition): Louis Wolpert
7. Ecological developmental Biology integrating epigenetics, medicine and evolution: Scott F Gilbert and Epel
8. Animal Physiology by Hill, Wyse & Anderson
9. Animal physiology by Randall Burggren & French
10. Guyton textbook of Medical physiology

## BCH3C03 : Molecular biology and Genetics

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Explain key biochemical events in DNA replication and transcription. | K1, K2 |
| CO2 | Describe gene expression, mutation, DNA damage and repair. | K1, K2 |
| CO3 | Outline the concepts of genetics and evolutionary biology. | K1, K2 |
| CO4 | Apply these knowledge to solve current problems in molecular biology | K1, K2, K3 |

**Unit I DNA replication and transcription**

DNA replication - Energetics of DNA replication, replicon, prokaryotic DNA polymerases, functions of other replicating enzymes and proteins (primase, helicase, SSB protein, ligase, Rnase H, topoismerases, sliding clamp, sliding clamp loader), simultaneous synthesis of leading and lagging strands, eukaryotic DNA polymerases, initiation of DNA replication (origin of replication, initiation from oriC, regulation of initiation of *E.coli*, eukaryotic initiation), termination of replication, problem of end completion of linear DNA, telomeres and telomerase. Transcription-Prokaryotic transcription, transcription cycle (initiation, elongation and termination), bacterial promoters, different σ factors, abortive initiation, processivity and editing functions of elongating polymerase, Rho-dependent and Rho-independent terminations. Eukaryotic transcription- RNA polymerases, transcription factors, processing of mRNA in eukaryotes.

**Unit II Gene expression**

Translation- Initiation, elongation and termination of translation (both pro- and eukaryotic). Regulation of gene expression-Principles of transcriptional regulation, different operons and their regulation. Gene regulation at steps after transcription, Regulation in λ phage. Eukaryotic gene regulation, Control of transcriptional regulators, Gene silencing, RNA in gene regulation, translational control of gene expression.Recombination-Generalized homologous recombination, models (Holliday, Meselson-Radding, doublestranded break),

proteins involved in homologous recombination in *E.coli*, homologous recombination of circular DNAs, site-specific recombination, transposition, IS and Tn elements, replicative and non-replicative transposition, composite transposons.

**Unit III Genomic Instability**

Gene Mutation- Concept on origin of mutations taking bacteria as an example-Classical experiments of Luria and Delbruck, Newcombe and Lederberg – Fluctuation test, Plate spreading, Replica plating and Sib selection; Spontaneous mutation, different types of mutants, induced mutation, physical and chemical mutagens, mutator gene, mutational hot spots, selection-screening-enrichment of mutants (auxotroph, ts etc.), reversion, Ames test, suppression, hyper-mutation and programmed mutation, Molecular mechanism of mutations. DNA Repair-Different types of DNA damages, Repair processes- damage reversal – photoreactivation, repair of alkylation damage, damage removal- nucleotide excision repair, base excision repair, mismatch repair, inducible repair pathways.

**Unit IV Concepts of Genetics**

Mendel's experiments as an example of good scientific technique, Chromosomal basis of inheritance, Linkage and crossing over- 2 point test cross, 3 point test cross, recombination as a basis for variation; Quantitative inheritance; Extra chromosomal inheritance. Genotype and phenotype; Genotype-environment interaction; Norm of reaction, Developmental Noise; Concept of Dominance; Penetrance and expressivity; Concept of alleles - Multiple alleles, Test for allelism, types of alleles, Benzer's rII alleles; Interaction between genes - Modified dihybrid ratios; Genetic basis of sex determination and dosage compensation in Drosophila, C.elegans and humans, sry gene; Sex linked inheritance. Cytoplasmic inheritance and maternal effects (snail coiling and kappa particle inheritance), cytoplasmic male sterility.

**Unit-V Genes and evolutionary genetics**

Evolutionary Genetics-Mechanisms like selection, migration and mutation, genetic drift, human evolution, origin of major human groups. Hardy - Weinberg theory; factors affecting Hardy-Weinberg equilibrium, Punctuated equilibrium, Present status – functional and structural genomics; ; Modern concept of the gene- cistron, recon, and muton; Split gene; Overlapping genes, Assembled genes, Repeated genes, Polyprotein genes, Nested genes. Gene Mapping **:** Bacteria, *Neurospora, Drosophila*, pedigree analysis in human, concept of physical, cytological and genetic map; chromosome walking; chromosome jumping; brief outline of human genome project.

**References**

1. Molecular Biology of the Gene by Watson-Baker-Bell-Gann-Levine-Losick,5th Edn., Pearson Education

2. Molecular Biologyby D. Freifelder, Narosa Publishing House, New Delhi

3. Genome by T.A. Brown, John Wiley & Sons

4. Microbial Genetics by D. Freifelder, Narosa Publishing House, New Delhi

5. Gene VII by Lewin Benjamin (Oxford)

6. Molecular Cell Biology by J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.)

7. DNA Repair & Mutagenesis by E.C.Friedberg, G.C.Walker and W. Seide (ASM Publisher)

8. Principles of Genetics- D.P.Snustad and M.J.Simmons, John Willey and Sons
9. Genetics, P.J.Russel- Pearson-Benjamin Cumming
10. Genetics- M.W.Strickberger, Prentice Hall
11.Concepts of Genetics- W.S.Klug and M.R.Cummins, Pearson pub
12.Principles of Genetics- R.H.Tamarine, Tata McGraw Hill
13.Principles of Genetics- E.W.Sinnot, L.C.Dunn, T.Dobzhansky, Tata McGrawl Hill pub
14.Cell and Molecular Biology- E.D.P.DeRobertis and E.M.F.DeRobertis, Williums & Wilkins
15.Instants Notes in Genetics- P.C.Winter, G.I.Hickey and M.L.Fletcher, Viva Books
16.Genetics- T.A Brown

## BCH 3C04 Practical VI

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Get expertise in metabolic disorder analysis using various body fluids. | K1, K2, K3, K4 |
| CO2 | Isolate and estimate plant metabolites. | K1, K2, K3, K4 |
| CO3 | Perform experiments on animal and plant developmental biology. | K1, K2, K3, K4 |
| CO4 | Become skilled to do molecular biology experiments. | K1, K2, K3, K4 |

1. Glucose Tolerance Test in rats
2. Determination of creatine clearance
3. Analysis of lipid profile after a high fat diet
4. Assay of cellulase activity by agar diffusion method
5. Estimation of ascorbic acid from plant tissues
6. Extraction and estimation of plant sterols
7. Embryo dissection
8. Acetolysis of pollen grains and study of pollen morphology
9. Estimation of RNA by colorimetric and spectrophotometric methods
10. Extraction of DNA and its estimation by colorimetric and spectrophotometric methods
11. Isolation of RNA from yeast
12. Agarose gel electrophoresis of DNA
13. Transformation
14. Hyperchromic shift on DNA melting
15. Isolation of plasmids
16. Bacterial conjugation
17. Determination of Erythrocyte sedimentation ratio (ESR)
18. Removal of chick blastoderm and preparation of stained whole mounts.
19. Vital staining experiments on chick embryo employing the window method and tracing the development of stained parts.
20. Collection identification and study of invertebrate larval forms.
21. Histological preparation of stained slide of chick amphibian embryos.

## BCH3E01 Neurobiochemistry

### Course outcomes

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Outline the physiology and anatomy of human nervous system and chemistry of neurotransmitters. | K1, K2 |
| CO2 | Describe how neurons are connected in neuronal circuits that control bodily functions and behavioral output. | K1, K2 |
| CO3 | Explain the basis of learning and memory. Apply the knowledge in neuroscience to study how neurochemicals and drugs influence the operation of neurons, synapses, and neural network. | K1, K2, K3 |
| CO4 | Highlight the features of neurodegenerative diseases. | K1, K2 |
| CO5 | Analyse the biochemistry of vision, muscle contraction and describe the concepts of developmental neurobiology. | K1, K2 |

**Unit I Nervous system & Neurotransmission**

Neuromorphology and Neurocellular Anatomy : Central Nervous system – General features of Neurons, Cellular organization of neurons Dendrites and Axons, neurotubules, neurofilaments, synapse, astrocytes, oligodendrocyte, ependymal cells, schwan cells. Peripheral nervous system (PNS): Muscle, nerve endings, sensory receptors and effector endings; peripheral nerves, spinal and cranial nerves; afferent pathways and sense organs. Spinal cord: Topographical anatomy,spinal nerves, spinal meninges, joint reflexes, gray and white matter of spinalcord. Neurotransmission: Membrane potential, Resting potential – Depolarization, repolarization and hyperpolarization, Action potential. Mechanism of axonal neurotransmission. Membrane channels – Types of channels, ion gated, voltage gated, chemically gated, mechanically gated and responsive to intracellular messengers.

**Unit II Chemistry of Brain & neurotransmitters**

Chemical composition of brain :Formation, structure and biochemistry of myelin, chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations.

Neurotransmitters: Synthesis, storage, release, uptake, degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate, Aspartate, Nitrous oxide, etc. Neuropeptides. Synaptic transmission – Cholinergic receptors – Nicotinic and Muscarinic receptors, Agonists and Antagonists – their mode of action and effects. Adrenergic receptors, serpentine receptors and intracellular signaling. Fast and slow receptors. Exocytosis of neurotransmitter – Role of synapsins, synaptogamins, SNAP, SNARE and other proteins in docking, exocyotosis and recycling of vesicles.

**Unit III Basis of Memory, Drug interactions and neurological disorders**

Learning and memory: Mechanism of short term memory and Long Term Potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, protein kinases, cAMP, NO, Calpain and other proteins in memory and learning process. Synaptic plasticity.

Interaction of drugs with CNS :Mechanism of action of anesthetics, analgesics, hallucinogens, depressants, stimulants and toxins on the nervous system. Addiction and drug abuse.

Diseases of nervous system :Molecular basis of Alzheimer's disease, Parkinson's disease, Multiple sclerosis, Schizophrenia, Myasthenia Gravis, Amyotrophic lateral sclerosis, Huntington's disease.

**Unit IV Vision, movement & Developmental neurobiology**

Biochemistry of vision and muscle contraction: Rod and cone cells, visual cycle, mechanism and regulation of vision, color vision. Thick and thin filaments, interaction of actin and myosin muscle contraction, role of calcium and regulation of muscle contraction. Smooth muscle contraction and its regulation.

Developmental neurobiology: Organogenesis and neuronal multiplication, axonal and dendritic growth, glial multiplication and myelination, growth in size, regeneration and repair mechanisms, plasticity.

**References**


1. Basic Neurochemistry by Siegel
2. Elements of Molecular Neurotoxicity by CUM Simth
3. Neuroanatomy by Grossman and Neavy

## BCH 3E02 Plant secondary metabolites

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Describe biochemistry, physiology, functions and applications of plant secondary metabolites | K1, K2 |
| CO2 | Explain the biosynthesis of different secondary metabolites and their regulatory mechanisms. | K1, K2 |
| CO3 | Outline the tissue and segment specific accumulation of secondary metabolitesand tissue specific control of enzymes in secondary metabolism | K1, K2 |
| CO4 | Highlight the role of secondary metabolites in plantdevelopment, specialised cell and storage space differentiation. | K1, K2 |

**Unit I Biochemistry, physiology and functions of secondary metabolites**

Primary and secondary metabolism, Biosynthesis of secondary metabolites-basic pathways, synthesis from primary metabolites, transport, storage, turnover and degradation, energetics. Role of secondary metabolites in plant defense, microbes as pathogens, phytoalexins and microbial infection, Plant defense substances and risk for humans, prussic acid and wounding by animals, role of mustard oils and false amino acids, role of secondary metabolites in attraction of pollinators and protection against UV radiation, induced accumulation of secondary metabolites, evolution of secondary metabolism, Role of secondary metabolites as pharmaceuticals. Importance of secondary metabolites in medicine and agriculture.

**Unit II Alkaloids, betalains, cyanogenic glycosides, glucosinolates and non-protein amino acids**

Biosynthesis, Nicotine and tropane alkaloids, Pyrrolizidine alkaloids, Benzylisoquinoline alkaloids, Monoterpene indole alkaloids, Ergot alkaloids, Acridone alkaloid, Purine alkaloids, Taxol, Betalains, cyanogenic glycosides, glucosinolates and non-protein amino acids, functions and applications of different alkaloids, Control mechanisms and manipulation of alkaloids and industrial enzymes.

**Unit III Polyphenols and related compounds**

General phenylpropanoid pathway and formation of hydroxycinnamate conjugates, shickimic acid pathway, involvement of mono oxygenases in biosynthesis of phenolics, Major classes of phenolics, Structure and functions of- flavonoids, anthocyanins, coumarins, lignans, tannins, gallotannins, ellagitannins, suberins and cutins, Pharmacological applications of different polyphenols.

**Unit IV Terpenoids, sterols and cardiac glycosides**

Nomenclature, classification and occurrence of terpenoids, Functions, biosynthesis and applications of terpenoids, phytohormones, carotenoids, sterols, cardiac glycosides, brassinosteroids, phytoecdysteroids, steroid saponins and steroid alkaloids, Essential oils-chemistry and applications.

**Unit V Seconary plant products and Cell & Tissue differentiation**

Organogenesis and accumulation of secondary compounds, Tissue and segment specific accumulation, Tissue specific control of enzymes in secondary metabolism, Integration of secondary metabolism into developmental program, lignifications, role of accumulation of secondary products in specialised cell and storage space differentiation

**References**


1. Plant Physiology (Taiz, L. and Zeiger, E.) 2002, Sinauer Associates Inc.
2. Plant Biochemistry (P.M. Dey and J. B. Harborne Ed.), Academic Press
3. Introduction to Plant Biochemistry (Mercer, T. W. and Goodwin, E. I.) 1983, Oxford
4. Biochemistry of plant secondary metabolism, 2nd Edition (Michael Wink- Ed.) Wiley Blackwell Publishers
5. Plant Biochemistry, 4th Edition (Hans-Walter Heldt, Birgit Piechulla, Fiona Heldt), Academic Press
6. Natural products from plants (Peter B. Kaufman, Leland J. Cseke, Cara Warber, James A. Duke, Harry L. Brielmann) CRC Press
7. The Biochemistry of plants A Comprehensive Treatise (P.K. Stumpf and E.E. Conn-Ed.) Volume 7, Secondary Plant Products, Academic Press Inc.


## BCH 3E03 Nutrition and Nutrigenomics

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Discuss the nutritional aspects of carbohydrates, lipids, proteins, vitamins | K1, K2 |

| | | |
|---|---|---|
| | and minerals | |
| CO2 | Describe nutritional disorders and neuroendocrine control of hunger and satiety | K1, K2 |
| CO3 | Explain molecular mechanisms of genetic variation linked to diet | K1, K2 |
| CO4 | Outline the key concepts of nutrigenomics, epigenetics and genetic buffering mechanisms. | K1, K2 |

**Unit I Perspective on human nutrition**

Food groups, nutritive and energy value of foods, BMR. Nutritional aspects of carbohydrates, lipids, proteins, vitamins and minerals. importance of micronutrients, Essential amino acids, essential fatty acids, visible and invisible fat, Dietary fiber,

**Unit I Nutritional disorders**

Protein- energy malnutrition- Kwashiorkor, marasmus. Diet related diseases- obesity. Eating disorders, . Regulation of food intake- psychological and physiological aspects. Neuroendocrine control of hunger and satiety. Dietary fat, cancer and atherosclerosis. Nutrition, inflammation and chronic disorders .

**Unit III Molecular basis of nutrition**

Mechanisms of genetic variation linked to diet, Micronutrients and evolution of skin pigments, Evolution of taste as a survival mechanism. Natural food toxins in diet and evolution of xenobiotics metabolism in humans. Effect of gene interaction with reference to vitamins and minerals on genomic machinery and gene products, retinoic acid, vitamin C, vitamin B, vitamin D, vitamin K, calcium, selenium, zinc (calcium signaling, zinc finger protein, seleno proteins and superoxide dismutase),

**Unit IV Nutrigenomics and Epigenetics**

Gene polymorphism and dietary nutrients and cellular homeostasis. Micronutrient- gene interaction- Vitamin A and Vitamin D responsive genes, steroid responsive element binding protein, PPAR, Nuclear hormone receptor super family- Regulation of gene expression by nutrient regulated transcription factors. Genetic buffering mechanisms- gene duplication, phenotypic stability and health, phenotypic instability and disease- role of nutrients example- folate, carrier protein. Nutritional epigenetics.

References

1. Nutritional Biochemistry (2nd Edition)- Tom Broddy(Elsevier)
2. Molecular Nutrition and Genomics- M.Lucock, 2007, Wiley.
3. Advanced Nutrition- Berdanier and Lempleni,2009, CRC Press.

4. Molecular basis of Human Nutrition- T.Sanders and P. Emery
5. Natural therapeutic Nutrition- C.H. Robinson and M. R. Lawler

## BCH4E01 Nanobiology and Applications

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Enumerate the tools and techniques used in nanobiology. | K1, K2 |
| CO2 | Illustrate biosensors and their applications. | K1, K2 |
| CO3 | Explain biofunctionalisation, bioconjugation and applications. | K1, K2 |
| CO4 | Highlight the significance of nano drug delivery systems. | K1, K2 |
| CO5 | Describe the applications of nanotechnology in life science. | K1, K2 |

**Unit I Introduction to Nanotechnology**

The Emergence of Nanotechnology, Limitations of Micron Size, Significance and Key Features of Nano-Size , Advantages of Scaling Down to Nano-Size, Size of biological entities, Manipulating Molecules: The Scanning Probe Microscopes, Carbon Fullerene, Carbon Nanotubes, Non-Carbon Nanotubes and Fullerene-Like Material, Quantum Dots and Other Nano-Particles, Nanowires, Nanorods, Magnetic Nanoparticles and other nanomaterials, Interface Between Nanotechnology and Biotechnology: Supramolecular Biochemistry, Nanobionics and Bio-Inspired Nanotechnology.

**Unit II Biosensors**

Bioreceptors-Ligand–Receptor Systems, Immobilization Methods , Biosensors with Electrochemical Detection, Affinity Biosensors, Biosensors Based on chemiluminescent and Bioluminescent Detection, Biochips, DNA Microarrays , Protein and Other Microarrays.

**Unit III Biofunctionalization, Bioconjugation & its applications**

Fluorescent nanoparticles, polymeric nanoparticles, magnetic nanoparticles, carbon nanotubes, protein and peptide conjugation. Self-Assembly of Biological and Bio-Inspired

Nano-Materials, Formation of DNA-Based Materials: Peptide-Based Nanomaterials, Conjugation of Peptides for Self-Assembly, Aromatic Interactions for the Formation of Nanostructures, The Formation of Aromatic Dipeptide Nanotubes (ADNT), The Formation of Spherical Nanostructures by short peptides, Peptide Nucleic Acid (PNA).

**Unit IV Nano Drug Delivery**

Conventional Drug Delivery, Targeted Drug Delivery, Chemistry of Drug Delivery Vehicles, Liposomal Vesicles, Microemulsions, Polymeric, magnetic, ceramic nanoparticles, dendrimers, nanotubes. Delivery Profiles, Methods of preparation of drug nanoparticles.

**Unit V Applications of nanotechnology in life science**

Nanostructures and Nanosystems, Nanopore Technology, Nano Self-Assembling Systems, Nanosomes and Polymersomes, In Vitro Diagnostics , Medical Application of Nanosystems and Nanoparticles, Nanoparticles in Molecular Imaging - Quantum Dots, Ultrasound Contrast Agents, Magnetic Nanoparticles

**References**


1. Plenty of Room for Biology at the Bottom: An Intoduction to Bionanotechnology by Ehud Gazit.
2. BioNanotechnology by Elisabeth S. Papazoglou, Aravind Parthasarathy, First edition.
3. Nanobiotechnology BioInspired Devices and Materials of the Future by Oded Shoseyov, Ilan Levy.
4. Nanoscience nanobiotechnology and nanobiology by P. Boisseau, P. Houdy , M. Lahmani.
5. Nanobiotechnology Concepts, Applications and Perspectives by Christof M. Niemeyer and Chad A. Mirkin.

## BCH 4E02 Biochemical and Environmental Toxicology

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Utilize advanced quantitative and qualitative analysis methods to analyze and solve toxicological and/or chemical problems. | K1, K2, K3, K4 |
| CO2 | Demonstrate the basic principles of toxicology and illustrate toxicity risk assessment and fate of toxicants in humans. | K1, K2 |
| CO3 | Discuss the concepts of genetic toxicology, pesticide toxicology, food toxicology and metal toxicity. | K1, K2 |
| CO4 | Evaluate acute and chronic toxicity of environmental chemicals and explain the protocols and interpretation of various toxicity tests. | K1, K2, K3 |
| CO5 | Explain the role of regulatory agencies and their responsibilities. | K1, K2 |
| CO6 | Describe the management of toxicological risk and enlist regulatory approaches. | K1, K2 |

**Unit I Principles of Toxicology**

Toxicants, therapeutic dose, dose-response curve, multiple toxicants response, serum enzymes behavior, hepatic and non-hepatic enzyme change during toxicity. Biotransformation of Toxicants : Toxicants entry and fate in living system, absorption, distribution, excretion and detoxification, phase I and phase II reactions and their interrelationships, components of mixed function oxidases, substrate - cytochrome P450 interactions, isoenzymes of cytochrome P450, inducers and inhibitors of microsomal metabolic transformation, lipoxygenase, lipid peroxidation, influence of various factors on the manifestation of toxicity. Extramicrosomal enzymes and their role in detoxification.

**Unit II Mechanism of Action of Toxicants**

Chemotherapy - Synergism and Antagonism, Determination of ED50 & LD50. Acute and Chronic exposures. Factors influencing Toxicity. Pharmacodynamics & Chemodynamics. relation of chemical structure and biological activity, drug receptor interactions, effect of

toxicants on structure, biosynthesis and catabolism of proteins lipids, carbohydrates and nucleic acids, toxic response of different tissues and organelles, tissue specificity.

**Unit III Toxicology**

Genetic toxicology: Chemical mutagenesis, screening of mutagens, genetic diseases. Nature, mechanism and biological features of chemical carcinogenesis, carcinogens. Teratogenesis, teratogens and their action.

Pesticide toxicology: Insecticides: organochlorines, anticholinesterases-organophosphates and carbamates. Fungicides, herbicides. Environmental consequences of pesticide toxicity. Biopesticides.

Food toxicology: Toxicology of food additives, animal and plant toxins.

Metal toxicity: Heavy metals: arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity.

**Unit IV Environmental Toxicology & Toxicity Testing**

Environmental Toxicology: Air, water and soil pollution, environmental pollutants and their control. Pathogenic microorganisms, use of microorganisms in waste management, leaching of environmental pollutants. Industrial effluent toxicology.

Toxicity testing: Test protocol, genetic toxicity testing and mutagenesis assays: In vitro test system- bacterial mutation test, reversion test, Ames test, fluctuation tests and eukaryotic mutation test. In vivo mammalian mutation tests, host mediated assay and dominant lethal test. DNA repair assays. Chromosome damage test. Toxicological evaluation of recombinant DNA-derived proteins. An overview of regulatory agencies: Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory approaches.

**References**


1. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, III rd
2. edition, Macmillan publishing company, New York.
3. Williams P L& Burson J L (1985) Industrial Toxicology, Van- Nostrand Reinhold, New York.
4. Hayes A W (1988) Principles and methods of toxicology, II nd edition, Raven press, New York.
5. Stewart C P& Stolman A ,Toxicology, vol I, Academic press, New York.

6. General and Applied Toxicology by Marrs and Turner, Macmillan Press Ltd.

7. Basic Environmental Toxicology by Lorris G. Corkerthm and Barbara S S Shane CRP Press Inc.

8. Introduction to Food Technology by Takayurki Shibamato & Leonard F. Bzeldanes.

9. Molecular Biotechnology by Barnard R Glick & J J Pastmak.

## BCH4E03 INDUSTRIAL ENZYMES

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Explain different enzymes used in industries, their sources, production and optimization. | K1, K2 |
| CO2 | Describe the techniques employed in the usage of different enzymes in industry. | K1, K2 |
| CO3 | List out the enzyme inhibitors used in industry and describe their mode of action. | K1, K2 |
| CO4 | Highlight the regulatory and economic aspects of industrial enzymes. | K1, K2 |

**Unit I**

Prospects of enzyme technology, Industrial enzymes- carbohydrases, peptidases, nucleases and other technical enzymes, therapeutic enzymes. Novel enzymes from natural sources, Strain improvement for enzymes from microbial source, Physiological optimization.

**Unit II**

Enzyme stabilization- immobilization- carriers, adsorption, covalent coupling, cross-linking and entrapment, Micro-environmental effects, Enzyme reactors- batch, membrane, solid-bed. Modified enzymes, Synzymes, Protein engineering of industrial enzymes. Biocatalytic applications- enzyme based biotransformations.

**Unit III**

Enzyme inhibitors: types of inhibitors, global market, commercial enzyme inhibitors, Sources of enzyme inhibitors, Applications of enzyme inhibitors- food, biomedical and agriculture. Regulatory requirements and Economic considerations for industrial enzymes

**References:**

1. Enzymes Biotechnology - Gray N, Calvin M and Bhatia SC
2. Fundamentals of Enzyme kinetics - Cornish-Bowden A
3. Enzymes in industry - Aehle W
4. Industrial Enzymes: Structure, Function

and Applications - Uhlig H
5. Industrial Enzymes: Structure, Function and Applications - Polaina J and MacCabe AP

## BCH 4E04 Clinical and Diagnostic Biochemistry

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Explain methods for collection and preservation of clinical samples, management and automation of clinical laboratory and quality control in biochemical analysis. | K1, K2 |
| CO2 | Describe the development, causes, clinical features, diagnosis and management of metabolic disorders, hormonal imbalance, vitamin deficiency, blood clotting disorders and diseases related to digestion & absorption of food. | K1, K2 |
| CO3 | List out the organ function tests and their diagnostic significance. | K1, K2 |
| CO4 | Highlight the concepts of diagnostic enzymology. | K1, K2 |

**Unit I Basic understanding of clinical samples**

Blood, CSF, urine, bile; biopsy specimens. Methods for collection and preservation of samples. Instruments used in an automated Biochemistry laboratory. Management of clinical laboratory, Quality control in Biochemical analysis. Concepts of accuracy, precision, reliability reproducibility and other factors of quality control; normal values, therapeutic index. Auto-Analyzers, hematology counter, Blood gas analyzers, Application of micro analytical methods in diagnostic biochemistry.

**Unit II Metabolic disorders of carbohydrates and lipids**

Disorders of carbohydrate metabolism-glycogen storage diseases; Diabetes mellitus; Galactosemia and lactose intolerance. Disorders of protein metabolism- PEM; Phenylketonurea and alkaptonurea; Tyrosinaemia; MSUD; Cystienurea. Urea cycle disorders; albinism. Glucose tolerance tests. Disorders of lipid metabolism- Hyperlipidemia, Hyper cholesterolemia; disorders of ketone body metabolism, sphingolipidosis; diseases associated with lipo-

protein metabolism-atherosclerosis and coronary artery diseases; fatty liver, and lipotrophic factors.

**Unit III Disorders of nucleic acid metabolism and hormonal imbalance**

Disorders of nucleic acid metabolism-Purine and pyrimidine metabolism; Uric acid and gout ; Gouty arthritis. Disorders of hormonal balance – Hyper and hypothyroidism, growth hormone imbalance, disorders of sex hormone imbalance, Organ functions and function tests- Liver functions and liver function test. Hepatitis, cirrhosis; jaundice, hepatic coma. Tests for the assessment of liver functions. Cardiac function tests. Gastric function test. Kidney function and kidney function tests- creatine clearance and inulin clearance.

**Unit IV Disorders associated with vitamin deficiency, blood clotting and digestion & absorption of food**

Disorders associated with vitamin deficiency. Disorders of mineral metabolism. Disorders of porphyrin and heme metabolism –Porphyrins – different types, Jaundice. Disorders of clotting mechanisms – Agranulocytosis; different types of anemias. Hypertension, Heamaturia, thrombocytosis; Hemophilia; sickle cell anemia.. Muscular dystrophy; hemophilia. Disease related to digestion and absorption of food. Achlorohydria; ulcers gastritis; H.pylori - induced gastritis.

**Unit V Diagnostic Enzymology**

Principles of diagnostic enzymology. Clinical significance of cardiac, hepatic Gastrointestinal and renal enzymes, Enzyme tests in determination of myocardial infarction, enzymes of pancreatic origin and biliary tract.

**References**

1. Devlin Thomas M, Text Book of Biochemistry with clinical correlations, Wiley Liss, New York
2. Zubay Geoffrey, Biochemistry, Wm C Brown publishers
3. Murray Robert et al, Harper's Biochemistry, Appleton & Lange
4. Vasudevan D M and Sreekumari S, Text Book of Biochemistry for medical students, Jayadeep Brothers, N. Delhi
5. Harold Harper, Review of Physiological chemistry, Marusan Co
6. Conn E E and Stump P K, Outlines of Biochemistry,Wiley, N. Delhi
7. Voet Donald & Voet Judith, Biochemistry, John Wiley sons, US
8. Garrett Reginald H and Grisham Charles M, Biochemistry, Saunders College Publishing, Philadelphia

9. Kaplan Lawrence A et al, Clinical Chemistry, Mosby.

## BCH4C05 Project work / Dissertation and Viva voce

### Course Outcomes

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge level |
|---|---|---|
| CO1 | Describe basic concepts and tools of research methodology. | K1, K2 |
| CO2 | Collect relevant bibliographic material from different sources. | K1, K2, K3 |
| CO3 | Perform experimental analysis, organize data to make a written project report (having Introduction, Backgrounds, material and methods, results, conclusion, Bibliography etc.). | K1, K2, K3, K4, K5 |
| CO4 | Present the project work and answer the queries. | K4, K5, K6 |

**Open Elective offered by the Department of Life Sciences**

## BCH 3O01CANCER BIOLOGY

**Course outcomes**

On completing the course, the student will be able to:

| No. | Course outcome | Knowledge Level |
|---|---|---|
| CO1 | Identify cancer as a disease at molecular level | K1, K2 |
| CO2 | Explain molecular biology of cancer including oncogenes and tumor suppressor genes. | K1, K2 |
| CO3 | Describe Principles of cancer initiation, progression and metastasis | K1, K2 |
| CO4 | Explain cancer therapies and mechanism of drug action. | K1, K2 |

**Unit I Cancer Biology**

Overview: Introduction, historical perspective. Carcinogenesis; Free radicals, antioxidants and cancer, Aberrant metabolism during cancer development, cancer initiation, promotion and progression. Cellular Differentiation, Malignant Behavior. Different forms of cancers, Phenotypic characteristics of cancer cells, Clinical features & pathology of cancer, Diet and cancer.

**Unit II Cancer Related Genes**

**Oncogenes**

Overview: Retroviral oncogenes, Cellular proto-oncogenes, Oncogene Activation, Growth Factors and Receptors, Signal Transduction, Transcription Factors.

**Tumor suppressor genes / cell cycle regulators**

Tumor suppressor genes, DNA Viruses and human cancer. Telomerase and cell immortalization , Cell:cell interactions, DNA methylation; epigenetic silencing of suppressor genes, Apoptosis in cancer biology

**Unit III Principles of Cancer Metastasis**

Loss of cell adhesion; invasion and angiogenesis; clinical significances of invasion, hetrogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane distruption, Three step theory of Invasion, Proteinases and tumour cell invasion.

**Unit IV Understanding Cancer as a Disease**

Paraneoplastic syndromes; cancer endocrinology, Epidemiology of cancers, Gene rearrangements; detecting oncogene abnormalities in clinical specimens, prediction of aggressiveness of Cancer. Recent trends in cancer research.

**Unit V Cancer Therapy**

Different forms of therapy, Chemotherapy, radiation therapy. Translating therapies from the laboratory to the clinic, Strategies of anticancer drug therapy, Mechanisms of cytotoxic drug action, Strategies of anticancer immunotherapy. Recent trends in cancer therapy.

**References**


1. An Introduciton to Cellular and Molecular Biology of Cancer, Oxford Medical Publications, 1991.
2. The Cell, A Molecular Approach. Cooper, G. 2nd edition, ASM Press, 2000.
3. Cancer Biology, Ruddon, K. 3rd edition, Oxford University Press, 1995.
4. Molecular Biology of the Cell, Alberts.. 4th edition, Garland Press, 2002.
5. Basic Pathology Kumar, R. 6th edition, W.B. Saunders, 1997.
6. Introduction to modern virology, Dunmock N.J. and Primrose S.B. Blackwell Scientific Publications, Oxford.
7. An introduction to cellular and molecular biology of cancer, Franks W. and Teich N.M. Oxford Medical Publications.


**ANNEXURE**

# DIRECTORY OF KNOWLEDGE LEVEL NOTIONS AND RELATED ACTION VERBS BASED ON REVISED BLOOM'S TAXONOMY

**K1 (Knowledge Level-1: Remember)**

Action verbs: Define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state.

**K2 (Knowledge Level-2: Understand)**

Action verbs: Classify, convert, defend, discuss, distinguish, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate.

**K3 (Knowledge Level-3: Apply)**

Action verbs: Apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate, schedule, show, sketch, solve, use, write.

**K4 (Knowledge Level-4: Analyze)**

Action verbs: Analyze, calculate, categorize, classify, compare, compare, contrast, criticize, derive, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, relate, select, separate, test.

**K5 (Knowledge Level-5: Evaluate)**

Action verbs: Arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, recognize, revise, rewrite, set up, summarize, synthesize, tell, write.

**K6 (Knowledge Level-6: Create)**

Action verbs: Argue, assess, attach, choose, conclude, defend, estimate, evaluate, explain, judge, justify, interpret, predict, rate, select, summarize.