



**UNIVERSITY OF CALICUT**

**Abstract**

MSc programme in Biochemistry-University Teaching Department-under Choice based Credit Semester System (PG)-Revised Syllabus-approved -implemented with effect from 2013 admissions-Orders issued

---

**UNIVERSITY OF CALICUT (G & A - IV - J)**

U.O.No. 5347/2013/CU

Dated, Calicut University.P.O, 07.11.2013

---

*Read:-*1. U.O.No.GA IV/J1/1373/08 dated 01.07.2008.

2. Item No: 6 A of the minutes of BOS in Biochemistry Dated 22.2.13
3. The minute of Faculty of Science dtd 22.3.13
4. Item No: II C of the minutes of the Academic Council held on 30.07.13
5. Order of the Vice Chancellor in the file no:36207/J1/GAIV2013 on 6.9.2013

**ORDER**

The Choice based Credit Semester System was implemented in all Regular PG programmes in University Teaching Departments of the University with effect from 2008 admissions, as per paper read as (1).

The Modified Syllabus of MSc programme in Biochemistry under CCSS (PG) in the University Teaching Department was implemented with effect from 2010 admissions.

The Board of Studies in Biochemistry, vide paper read as (2), resolved to approve the Revised Syllabus of MSc programme in Biochemistry under CCSS (PG) in the University Teaching Department with effect from 2013 admissions.

The Faculty of Science and the Academic Council has also approved the same vide paper read as (3) and (4) respectively.

Sanction has, therefore, been accorded for implementing the Revised Syllabus of MSc programme in Biochemistry under CCSS (PG) in the University Teaching Department with effect from 2013 admissions.

Orders are issued accordingly.

(The Syllabus is available in the Official website of the University:universityofcalicut.info)

Muhammed S  
Deputy Registrar

To

- 1.The Dept. of Biochemistry
- 2.Controller of Examinations
- 3.Pareeksha Bhavan

Forwarded / By Order

Section Officer



**UNIVERSITY OF CALICUT**

**SCHEME AND SYLLABUS FOR M. Sc. BIOCHEMISTRY  
COURSE OFFERED BY  
DEPARTMENT OF LIFE SCIENCES**

**2013 Admission onwards**

## Regulations, Scheme and Syllabus for M. Sc degree course in Biochemistry

Eligibility: A candidate seeking admission to M.Sc Biochemistry must have B.Sc in Biochemistry

Admission: 50% of marks obtained in B.Sc degree course

Curriculum: Course of study consists of two academic years with four semesters

### Course Structure and Distribution of Marks

#### Course Structure

a)	Theory	No. of papers	External	Internal	Max. marks	Total marks
		13	80	20	100	1300
b)	Practical	6	80*	20	100	600
(*Experiment: 60 marks; Viva voce: 10 marks; Records: 10marks)						
c)	Dissertation	Total marks:				100
		(Submission: 75 marks; Presentation: 10 marks; Viva voce: 15 marks)				

#### Grand Total for the Course

2000

Each Practical Examination should be conducted by one external examiner in the subject and one internal examiner who actually imparted instruction in the particular semester.

#### Credits ( Work load per week per Semester)

Semester	Theory		Practical						
	Credit	Hours (Creditx1)	Credit	Hours (Credit x3)	Library/ Assignment /Tutorial	Project	Total Credits	Hours	Marks
I	3x4=12	12	2x2=4	12	6	-	16	30	500
II	3x4=12	12	2x3=6	18	-	-	18	30	600
III	5x4=20 (2EL)	20	2x1=2	6	4	-	22	30	600
IV	2x4=8 (2 EL)	8	-	-	14	8	16	30	300
Total	52	52	12	36	24	8	72	120	2000

#### Internal assessment:

Assessment should include seminar, assignment, written test and marks for attendance with the following split up of marks: Seminar-5 marks; Assignment - 5 marks; Written test - 6 marks; Attendance -4; Total 20 marks

## **Course Structure**

### **1<sup>st</sup> Semester**

BCH 1C01 Analytical Biochemistry

BCH 1C02 Biological Macromolecules and Structural Biology

BCH 1C03 Microbiology and Immunology

BCH 1C04 Practical I

BCH 1C05 Practical II

500 marks

### **2<sup>nd</sup> Semester**

BCH 2C06 Enzymes : Kinetics, Mechanisms and Regulation.

BCH 2C07 Cell Biology and Cell Signalling

BCH 2C08 Biostatistics and Bioinformatics

BCH 2C09 Practical III

BCH 2C10 Practical IV

BCH2C11 Practical V

600 marks

### **3<sup>rd</sup> Semester**

BCH 3C12 Metabolism and Regulation

BCH 3C13 Physiology and Developmental Biology

BCH 3C14 Molecular Biology and Genetics

BCH 3C15 Practical VI

#### **(Any two of the following courses)**

BCH 3E01 Neurobiochemistry

BCH 3E02 Cancer Biology

BCH 3E03 Plant Secondary Metabolites

BCH 3E04 Nutritional Biochemistry

600 marks

### **4<sup>th</sup> Semester**

BCH 4C16 Project work and Viva voce

100 marks

#### **(Any two of the following courses)**

BCH4E 05 Nanobiology and Applications

BCH 4E06 Biochemical and Environmental Toxicology

BCH 4E07 Biochemistry of Drug Action

BCH4E08 Clinical and Diagnostic Biochemistry

200 marks

**Grand Total**

(500+500+600+400) =

**2000 marks**

No	Code	Paper	Creit	Marks		
				Int	Ext	Total
Semester I						
1	BCH 1C01	Analytical Biochemistry	4	20	80	100
2	BCH 1C02	Biological Macromolecules and Structural Biology	4	20	80	100
3	BCH 1C03	Microbiology and Immunology	4	20	80	100
4	BCH 1C04	Practical I (BCH 1C01 & BCH 1C02)	2	20	80	100
5	BCH 1C05	Practical II (BCH 1C03)	2	20	80	100
Semester II						
6	BCH 2C06	Enzymes : Kinetics, Mechanisms and Regulation	4	20	80	100
7	BCH 2C07	Cell Biology and cell Signaling	4	20	80	100
8	BCH 2C08	Biostatistics and Bioinformatics	4	20	80	100
9	BCH 2C09	Practical III (BCH 2C06)	2	20	80	100
10	BCH 2C10	Practical IV (BCH 2C07)	2	20	80	100
11	BCH 2C11	Practical V (BCH 2C08)	2	20	80	100
Semester III						
12	BCH 3C12	Metabolism and Regulation	4	20	80	100
13	BCH 3C13	Physiology and Developmental Biology	4	20	80	100
14	BCH 3C14	Molecular Biology and Genetics	4	20	80	100
15	BCH 3C15	Practical VI (BCH 3C12, BCH 3C13 & BCH 3C14)	2	20	80	100
<b><u>(Any two of the following courses)</u></b>						
16	BCH 3E01	Neurobiochemistry	4	20	80	100
17	BCH 3E02	Cancer Biology	4	20	80	100
18	BCH 3E03	Plant Secondary Metabolites	4	20	80	100
19	BCH 3E04	Nutritional Biochemistry	4	20	80	100
Semester IV						
<b><u>(Any two of the following courses)</u></b>						
20	BCH 4E05	Nanobiology and Applications	4	20	80	100
21	BCH 4E06	Biochemical and Environmental Toxicology	4	20	80	100
22	BCH 4E07	Biochemistry of Drug Action	4	20	80	100
23	BCH 4E08	Clinical and Diagnostic Biochemistry	4	20	80	100
24	BCH 4C16	Project work / Dissertation and Viva voce	8		100	100
		<b>Total</b>	<b>72</b>			<b>2000</b>

# **SYLLABUS**

## **SEMESTER I**

### **BCH1C01 Analytical Biochemistry**

#### **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. Gradwohl's Clinical Laboratory Techniques. Stanley S. Raphael. W.E. Company, London, UK.
2. Principles and Techniques of electron microscopy- Biological applications. M.A Hayat., Mac Millan Press, London UK.
3. Practical Biochemistry- Principles and techniques. Keith Wilson and John Walker (Eds), University press, Cambridge UK.
4. Modern Experimental Biochemistry. Rodney F Boyer. Benjamin/ Cummings publishing company Inc. Redwood city, California.
5. Chromatographic methods. A Braithwaite and F J Smith. Chapman and hall, New York.
6. Gel Electrophoresis of Nucleic acids- A Practical approach. Rickwood D and BD Hames. IRL Press, New York.
7. Spectrophotometry and Spectrofluorimetry: A Practical Approach. Harris DA and CL Bashford (Ed.) IRL Press, Oxford.
8. Introduction to Spectroscopy. Donald L. Pavia Gary M Lipman, George S Kriz. Harcourt brace College Publishers, Orlando, Florida.
9. Hand book of Instrumental Techniques for Analytical Chemistry By Frank Settle (Editor) Prentice Hall PTR.



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

### **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: Brassinosteroids (functions); Sterols in microbial system.

### **Unit III: Proteins & Nucleic Acids**

Protein structure: Primary, Secondary, Tertiary and Quaternary structure of Proteins, Super secondary structures Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein: (Collagen), Protein folding, Path ways and dynamics, Molecular chaperons, Protein stability, Membrane Protein (ATP synthetase), 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; Reassociation kinetics, Repetitive DNA sequences: Tandem repeats (Satellites, mini satellites, and micro satellites), Interspersed repeats (LINE, SINEs) Single copy genes; 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. C.R. Cantor and P.R. Schimmel; Biophysical Chemistry; Freeman.
2. Keith Van Holde, Chien and Ho. Principles of Physical Biochemistry 2nd Edition Pearson.
3. D.M. Freifelder; Physical Biochemistry: Applications to Biochemistry and Molecular Biology (Freeman).
4. J.R. Lakowicz; Principles of Fluorescence Spectroscopy (Springer).
5. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill).
6. Biological Spectroscopy- I.D. Cambell & R.A. Durk, (Benjamin Cummings).
7. Proteins: Structure and Function: David Whitford: John Wiley & Sons.
8. Lubert Stryer : Biochemistry, 5th edn. (Freeman).
9. Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2.
10. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson Visit Amazon's David L. Nelson Page search results Learn about Author Central Michael M. Cox Visit Amazon's Michael M. Cox Page search results Learn about Author Central.
11. Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.

12. 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
13. 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
14. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis [Visit Amazon's Julian Lewis Pagesearch results](#)[Learn about Author Central](#), Martin Raff, Keith Roberts, Peter Walter Publisher: Garland Science; 5 edition ISBN-10: 0815341059 ISBN-13: 978-0815341055.
15. Genes IX by Benjamin Lewin (2008) Publisher: J&b ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224.
16. 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.
17. Cell and Molecular Biology, 3e (2003) by Karp Publisher: Jw ISBN: 0471268909 ISBN-13: 9780471268901, 978-0471268901.
18. Molecular Cell Biology (2002) by H.S. Bhamrah Publisher: Anmol Publications ISBN: 8126111429 ISBN-13: 9788126111428, 978-8126111428.
19. Cell and Molecular Biology by S. Sundara Rajan (2003) Publisher: Anmol Publications ISBN: 8126113553 ISBN-13: 9788126113552, 978-8126113552.

## **BCH 1C03: Microbiology and Immunochemistry**

### **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, Different 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**

Non specific host defences-Anatomic, physiologic, phagocytic, and inflammatory components of innate immunity, lysosomes, 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 polypeptides 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, immunofluorescence, 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<sup>+</sup> 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. Reed Gerald, Prescott and Dunn's Industrial Microbiology, CBS Publications.
4. Microbiology: 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 6<sup>th</sup> edition: Abbas KA and Lichtman AH.
11. Immunobiology 7<sup>th</sup> 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 (BCH 1C01 & BCH 1C02)**

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 (BCH 1C03)**

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 2C06 Enzymes : Kinetics, Mechanism and Regulation

#### Unit 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  $K_I$  and numerical based on these.

#### 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 anhydrases, 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, Units of activity, determination of specific activity

### **References**

1. Fundamentals of Enzymology By Nicholas Price and Lewis Stevens, Third Edition Oxford University Press.
2. Enzyme Kinetics: Catalysis & Control A Reference of Theory and Best-Practice Methods by Daniel L. Purich Published by Academic press 2010
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 II 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 2C07 Cell Biology and cell Signaling**

### **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, Antennapedia 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 transmission 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 2C08. Biostatistics and Bioinformatics**

### **Unit I :Biostatistics**

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.

### **Unit II : Introduction to Bioinformatics:**

Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems.

### **Unit III Biological Databases**

Introduction to biological databases, classification of biological databases, Genbank, Protein Data Bank, Swiss-prot etc. Biological data formats, data retrieval - Entrez and SRS. ExPASSY,

### **Unit IV: Sequence alignment and Bioinformatics softwares**

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, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip. Evolutionary analysis: distances - clustering methods – rooted and unrooted tree representation.

### **Unit V : Gene prediction and Protein modeling**

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 2C09 Practical III (BCH 2C06)**

- 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 2C10 Practical IV (BCH 2C07)**

1. Examination of onion root tip cells for different stages of cell division
2. Karyotype preparation
3. Blood smear preparation, differential WBC count, total WBC count and total RBC count
4. Isolation of lymphocytes from blood
5. Liver perfusion and isolation of hepatocytes
6. Separation of blood cells
7. Histology-tissue/cell staining techniques
8. Microscopic examination of specialised cells-cardiac, kidney, nerve and liver cells

### **BCH 2C11 Practical V (BCH 2C08)**

1. Data retrieval from Swiss-Prot, GenBank and PDB
2. Similarity search – BLAST
3. Multiple Sequence Alignment - CLUSTAL W
4. Gene structure and function prediction (using GenScan, GeneMark)
5. Protein sequence analysis (ExPASy proteomics tools)
6. Molecular phylogeny (PHYLIP)
7. Secondary Structure Prediction of Protein
8. Protein/Nucleotide Sequence Analysis using EMBOSS
9. Molecular Visualisation tools
10. Homology modeling using SPDBV
11. Model structure refinement using SPDBV
12. Model validation using What Check and Pro Check
13. Docking using AUTODOCK/ HEX

## **SEMESTER III**

### **BCH3C12 : Metabolism and regulation**

#### **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 Applied to Life Span and Disease, Mitochondrial Calcium Signalling:

Role in Oxidative Phosphorylation Diseases, Role of Inorganic Polyphosphate in the Energy Metabolism, Optimisation of Cell Bioenergetics in Food-Associated Microorganisms, Targeting the Mitochondria by Novel Adamantane-Containing 1,4-Dihydropyridine Compounds

### **References**

1. Campbell and Farrell, 2002. Biochemistry 4th ed. Brooks/Cole Pub Co.
2. Davidson and Sittman, 1999. Biochemistry NMS. 4th ed. Lippincott. Williams and Wilkins.
3. Donald Voet, J.G. Voet and John Wiley, 1995. Biochemistry.
4. Kuchel and Ralston, 1998. Biochemistry, 2nd ed. Schaum's Outlines McGraw Hill.
5. Murray, et al. 2003. Harper's Biochemistry. 26th ed. McGraw Hill.
6. Nelson Cox, 2004. Lehninger's Principles of Biochemistry, 4th ed. McMillan Worth.
7. Biochemistry by Stryer. W. H. Freeman; 6 editions (2006).



## **BCH 3C13 : Physiology and developmental biology**

### **Unit I Plant Physiology**

Photosynthesis: Environment and its impact on photosynthesis, Photomorphogenesis, Phytochromes, Cryptochromes, photomorphogenesis, Photoperiodism, Transport of nutrients across the primary root, transport through sieve element, transport of metabolites from the source to the sink, genetic regulation of transport systems in response to nutrients availability and growth status, Mineral nutrition and assimilations of inorganic nutrients, metabolism of Nitrogen, calcium. Plant Hormones: Auxin, Gibberellins, Cytokinins, Ethylene, Absciscic 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, endocrine and neuroendocrine systems. Circulatory systems: general plan, electrical and mechanical properties of myogenic and neurogenic hearts. Heart cycle including electrocardiogram, Respiratory system: respiratory pigments, transport of gases in blood, regulation of body pH, respiratory response to extreme conditions like hypoxia, diving and exercise. Excretory system: Osmoregulation in water and terrestrial environment. Physiology of mammalian and nonmammalian kidneys. Reproductive system: Asexual and sexual reproductive system, Gonads, gametes, Gametogenesis and hormonal control, Fertilization, Capacitation.

### **Unit III Animal Developmental biology**

Principles of Developmental Biology: Evolution of developmental patterns, Principles of experimental embryology, Genomic equivalence. Signaling cascades involved in the control of developmental program with specific examples Early embryonic development: Cleavage – types and mechanism, Gastrulation, Cell specification, Progressive determination, Pattern formation, Regeneration, Compensatory e.g. mammalian liver, Tetrapod limb development, Life cycle, Pattern formation, cAMP signaling during development, sex determination, polarity development

### **Unit IV Plant Developmental Biology**

Introduction of model plants used for developmental studies in plant system, Reproduction: Male and female gametophyte development, genetic and hormonal regulation

of reproduction, pollination and fertilization. Seed formation and germination: Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, seedling development, Embryogenesis: Basic lay out 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](http://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 (2004)
9. Animal physiology by Randall Burggren & French (2005)
10. Guyton textbook of Medical physiology

## **BCH3C14 : Molecular biology and Genetics**

### **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, topoisomerases, 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  $\sigma$  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  $\lambda$  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 Biology by 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 McGraw Hill pub
14. Cell and Molecular Biology- E.D.P.DeRobertis and E.M.F.DeRobertis, Williams & Wilkins
15. Instant Notes in Genetics- P.C.Winter, G.I.Hickey and M.L.Fletcher, Viva Books
16. Genetics- T.A Brown

### **BCH 3C015 Practical VI (BCH 3C12, BCH 3C13 & BCH 3C14)**

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**

### **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, schwann 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 spinal cord. 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, exocytosis 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 . CANCER BIOLOGY**

### **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, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, 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 Introduction 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. Dunmock N.J. and Primrose S.B. Introduction to modern virology, Blackwell Scientific Publications, Oxford.
7. Franks W. and Teich N.M. An introduction to cellular and molecular biology of cancer, Oxford Medical Publications.

## **BCH 3E03 Plant secondary metabolites**

### **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, Benzyloquinoline 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, shikimic 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 Secondary 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, 2<sup>nd</sup> Edition (Michael Wink- Ed.) Wiley Blackwell Publishers
5. Plant Biochemistry, 4<sup>th</sup> 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 3E04 Nutritional Biochemistry**

### **Unit I Energy content of foods**

Composition of human body. Energy content of foods. Measurement of energy expenditure: Direct & indirect calorimetry. Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.

### **Unit II Dietary requirements**

Dietary requirements and sources of available and unavailable carbohydrates. Physicochemical properties and physiological actions of un-available carbohydrates (dietary fibre). Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for man and concept of protein quality. Cereal proteins and their limiting amino acids. Protein requirement at different stages of development. Major classes of dietary lipids. Properties and composition of plasma lipoproteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

### **Unit III. Acid base regulation**

Electrolyte concentrations of body fluids. Acid base regulation in the human body. Concept of metabolic and respiratory acidosis and alkalosis. Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water-soluble vitamins. Hypervitaminosis symptoms of fat-soluble vitamins. Nutritional requirements during pregnancy & lactation and of infants & children.

### **Unit IV. Food born toxicants and malnutrition**

Food processing and loss of nutrients during processing and cooking. Anti-nutrients: Naturally occurring food born toxicants: Protease inhibitors, Hemagglutins, Hepatotoxins, Allergens, Oxalates, Toxins from Mushrooms, Animal food stuffs and sea foods. Protein energy malnutrition (PEM): aetiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor diseases.

## **Unit VI Nutrition in Health and Diseases**

Techniques for the study of starvation. Protein metabolism in prolonged fasting. Protein sparing treatments during fasting. Basic concept of High protein, low caloric weight reduction diets. Definition and classification. Genetic and environmental factors leading to obesity. Obesity related diseases and management of obesity. Role of leptin in regulation of body mass. Role of diets & nutrition in the prevention and treatment of diseases: Dental caries, Fluorosis, Hyperlipidemia, Atherosclerosis. Food allergy, Definition, Role of antigen, host and environment. Types of Hypersensitivities. Diagnosis and management of allergy.

## **References**

1. Modern Nutrition in Health and Diseases by Whol and Goodhart.
2. Human Nutrition and Dietics – S Davidson and J R Pasmore; ELBS, Zurich.
3. Tietz Fundamentals of Clinical Chemistry by Carl A Burtis & E R Ashwood (eds.) (5th Edn.) Saunders WB Co.
4. Lecture Notes on Clinical Biochemistry – L G Whitby, A F Smith, G J Beckett, S M Walker, Blackwell Sci inc.

## **SEMESTER IV**

### **BCH4E05 Nanobiology and Applications**

#### **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 Introduction 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 4E06 Biochemical and Environmental Toxicology**

### **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 ED<sub>50</sub> & LD<sub>50</sub>. 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 (1960) 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 Shibamoto & Leonard F. Bzeldanes.
9. Molecular Biotechnology by Barnard R Glick & J J Pastmak.

## **BCH4E07 Biochemistry of Drug Action**

### **Unit I: Theories and hypothesis of drug action**

Commonly used terms like, Receptor, Antagonism, Dose-response curve, Log dose-response curve (LDR), Double-reciprocal plot, PAX values, Theories of drug action, occupancy theory, Affinity, Efficacy(intrinsic activity), Spare receptors, Rate theory, Inactivation theory, The liquid membrane hypothesis and examples from biologically relevant substances: for example bile salts.

### **Unit II: Types of Drug Interactions**

Pharmacokinetic interactions. Pharmacodynamic interactions, Interactions Resulting from Alterations in Metabolizing Enzymes, due to Enzyme induction and Enzyme inhibition, Interactions Resulting from Alterations in Protein Binding. Interactions Resulting from Changes in Renal Excretion, Risk Factors and Management of Drug Interaction, Clinical Significance of Interactions

### **Unit III: Surface activity of drugs**

Drugs like Analgesics, Antimicrobials, Drugs acting on autonomic nervous system, Anti histamines, Drugs affecting renal and cardiovascular function, Drugs acting on central nervous system, General anesthetics, Local anesthetics, Antidepressants, Hypnotics, sedative and anxiolytic agents, Antiepileptic drugs, Antipsychotic drugs, Miscellaneous, Surface activity of proteins, Anticancer Drugs, Steroids, Prostaglandins, Vitamins, Proton pump inhibitor.

### **Unit IV: Adverse Drug Reactions**

Drug-Induced Liver Injury, Drug Hypersensitivity Reactions Involving Skin, Adverse Drug Reactions Affecting Blood Cells, Molecular Mechanisms of Adverse Drug Reactions in Cardiac Tissue, Mechanisms of Drug-Induced Nephrotoxicity, Receptor- and Reactive Intermediate-Mediated Mechanisms of Teratogenesis, The Keap1-Nrf2 Cellular Defense Pathway, Role of Reactive Metabolites in Drug-Induced Hepatotoxicity, The Role of Cytokines in the Mechanism of Adverse Drug Reactions, Signal Transduction Pathways Involved in Drug-Induced Liver Injury, Mitochondrial Involvement in Drug-Induced Liver Injury.

### **References**

1. Handbook of Experimental Pharmacology, Volume 196, Adverse Drug Reactions  
Editor-in-Chief F.B. Hofmann, München.

2. Surface activity in drug action vol. 21 R.C. Srivastava, A.N. Nagappa, 2005 ELSEVIER
3. MEDfacts, by George R. Bailie, PharmD, PhD, Curtis A. Johnson, PharmD, Nancy A. Mason, PharmD, and Wendy L. St. Peter, PharmD, bcps.pocket guide of drug interactions Second Edition.
4. Mechanism of action of Drugs on the nervous system, Second edition, By Ronald W Ryall, Cambridge University press.

## **BCH 4E08 Clinical and Diagnostic Biochemistry**

### **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 lipoprotein 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, Hematuria, 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.