BCC 101 FUNDAMENTALS IN BIOCHEMISTRY

Course credit: 4 – Three credit theory and one credit practical

THEORY **45 hours**

(15)

1.

1.1 Protein

Amino acids: features and properties

Protein structure: peptide linkage, covalent backbone, three-dimensional conformation; quartenary structure of oligomeric proteins.

Determination of -N and -C terminal amino acids

Protein functions

1.2 Carbohydrate

Monosaccharides: types, characteristics and properties; disaccharides, oligosaccharides, polysaccharides – biological significance

1.3 Lipid

Classification, structure, properties; biological significance.

(15)

2.

2.1 Bioenergetics

Thermodynamics, exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance.

2.2 Oxidative Phosphorylation

Redox enzymes, aerobic electron transport and oxidative phosphorylation

2.3 Carbohydrate metabolism

Central pathways of carbohydrate metabolism – regulatory mechanisms, bioenergetics and significance – EMP, HMP shunt, TCA cycle, Glyoxylate cycle.

Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen.

Gluconeogenesis from TCA intermediates / amino acids / acetyl-CoA.

Biosynthesis of polysaccharides and sugar interconversions.

3. **(15)**

3.1 Lipid metabolism

Catabolism: Oxidation of fatty acids

Anabolism: (a) Biosynthesis of fatty acids: saturated, unsaturated

(b) Biosynthesis of triglycerides, phospholipids, sterols

3.2 Nucleotides and Nucleic Acids

Purine and pyrimidine nucleotides: biosynthesis and its regulation.

Deoxyribo nucleotides: biosynthesis and regulation.

Biosynthesis of nucleotide coenzymes.

Catabolism of purine and pyrimidine nucleotides.

3.3 Amino acids

Biosynthethic pathways and their regulation.

Catabolism of amino acids.

PRACTICALS **45 hours**

1. Estimation of protein by direct spectroscopy.
2. Separation of amino acids by paper chromatography.
3. Comparison of colorimetric methods for protein estimation – Biuret, Folin-Ciocalteu, Bradford methods.
4. Comparison of methods for reducing sugar estimation – Nelson-Somogyi, DNSA, Glucose Oxidase
5. Estimation of total sugar by anthrone and phenol-sulphuric acid methods
6. Estimation of lipid by acid-dichromate method
7. Estimation of nucleic acid by direct spectroscopy.

Reference Books:

1. Lehninger Principles of Biochemistry edited by Albert Lehninger, Michael Cox, David L. Nelson. W. H. Freeman & Company
2. Biochemistry by Lubert Stryer, W. H. Freeman & Company
3. Outlines of Biochemistry by Eric Conn, Paul Stumpf, George Bruening & Roy H. Doi, John Wiley & Sons.
4. Principles of Biochemistry by Donald Voet, Judith G. Voet & Charlotte W. Pratt, John Wiley & Sons.
5. Hawk's Physiological Chemistry edited by Bernard L. Oser, McGraw-Hill Book Company.
6. Physiological Chemistry by Harold A. Harper, University Medical Publishers
7. Introduction to Practical Biochemistry edited by Plummer Mu and David T. Plummer, Tata McGraw-Hill Education.
8. Biochemical Methods edited by S. Sadasivam and A. Manickam. Publisher, New Age International (P) Limited
9. Laboratory Manual in Biochemistry edited by J. Jayaraman. Publisher, John Wiley & Sons, Limited.

BCC 102 ENZYMOLOGY

Course credit: 4 - Three credit theory and one credit practical

THEORY **45 hours**

1. Enzymes, kinetics and mechanism (15)

1.1 Nomenclature and classification of enzymes

1.2 Enzyme structure; enzyme-substrate complex, binding sites, concept of active centre, stereo-specificity. Role of coenzymes.

1.3 Enzyme activity - international units, specific activity, turnover number.

1.4 Enzyme kinetics: Enzymes as catalysts; Michaelis - Menten Equation - form and derivation, Line-Weaver Burk plot, steady state enzyme kinetics. Significance of Vmax and Km. One substrate reactions, effect of pH, temperature and inhibitors; Bi-substrate reactions.

1.5 Enzyme Inhibition – Reversible and irreversible inhibition: competitive, uncompetitive, non-competitive.

1.6 Enzyme catalysis mechanism:Determination of active centre– Identification of functional groups,kinetic studies,detectionof intermediates, X-ray crystallography, site-directed mutagenesis; Factors affecting catalytic efficiency - proximity and orientation effects, covalent and acid - base catalysis, strain in catalysis.

1.7 Structure function relations - Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, and; Na - K ATPase, non-protein enzymes - ribozymes.

2. Enzyme Regulation, Multienzyme systems, Enzyme turnover **(15)**

2.1 Enzyme Regulation: control of activity, availability of substrate and coenzymes/ cofactors, inhibitor or enhancer molecules, change in the covalent structure of enzyme

2.2 Regulatory enzymes: Allosteric (aspartate transcarbamylase)and Covalently Modulated Enzymes(glycogen phosphorylase, glutamine synthetase); Mechanism of action – and their significance in metabolism.

2.3 Zymogens and Isozymes.

2.4 Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase, fatty-acyl synthase); membrane-bound system (electron carrying enzymes).

2.5 Enzyme turnover – kinetics: Ks and Kd, and measurement of enzyme turnover, correlation between the rates of enzyme turnover and structure function of enzymes; mechanism of enzyme degradation, significance of enzyme turnover.

3. Enzyme purification **(10)**

3.1 Isolation and purification of enzymes: salt precipitation; dialysis; ultrafiltration; molecular exclusion chromatography; affinity chromatography; ion exchange chromatography. Specific activity and fold purification as criteria of purity. Zymograms.

3.2 Molecular weight determination: Exclusion chromatography; ultracentrifugation; PAGE, SDS-PAGE

4. Enzymes applications **(05)**

4.1 Enzyme immobilization: Methods - ionic bonding; adsorption; covalent bonding,

based on R groups of amino acids; microencapsulation and gel entrapment. Immobilized multienzyme systems

4.2 Clinical Enzymology- Enzymes as therapeutic agents, diagnostic tools and laboratory agents

4.3 Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors

PRACTICALS **45 hours**

1. Assay of enzyme activity, Rate of reaction.
2. Determination of optimal pH and temperature for enzyme activity.
3. Isolation and purification of enzyme: salting out; dialysis; ion-exchange chromatography; gel filtration.
4. Determination of specific activity, fold purification, percentage recovery of protein
5. Effect of substrate concentration on enzyme activity and determination of its Km, Vmax.

Reference Books:

1. Dixon and Webb. Enzymology
2. Harper, Harold. Review of Physiological Chemistry, Marusan Co
3. Stryer, L., Freeman, W.H., Biochemistry San Francisco.
4. Lehninger, A.L., Nelson, D.L., Cox, M.M. Principles of Biochemistry, Worth Publishers, New York.
5. Price and Stevens. Fundamentals of Enzymology.
6. Guyton and Hall. Textbook of Medical Physiology

BCC 103 ANALYTICAL BIOCHEMISTRY - I
Course credit: 4 – Three credit theory and one credit practical

	Contact Hours
THEORY	**45 hours**
1	**(15)**
1.1 Water – properties; interactions with aqueous systems; ionization of water. Concept of pH, Eh, Acid-Base associations, Concepts of Molarity, Molality and Normality, Buffers, Buffering capacity, Mechanism of Dissociation of Macromolecules, Dissociation constants, pKa, pI, Solvents (eleutropic series), Peroxide values, solubility and affinity constants, and physiological solutions.	(10)
1.2 Cell and tissue culture techniques: Stem cells, Typical cell lines, Establishment of Primary & secondary cell lines, Monolayer & suspension cultures.	(05)
2	**(15)**
2.1 Spectrophotometry: UV-VIS, fluorimetry, Atomic Absorption Spectrophotometry (AAS).	(05)
2.2 Microscopy: Compound microscope: Light, Dark and Phase-contrast, Inverted, Epifluroscence and Immuno-microscopy.	(05)
2.3 Centrifugation: Principles, methodology, application; Density gradient centrifugation; Ultracentrifugation, Preparative and Analytical centrifugation.	(05)
3	**(15)**
3.1 Chromatographic techniques: Thin-layer, paper chromatography, Column chromatography, Separation matrixes - Ion-exchange, Affinity, Molecular exclusion and Adsorbtion. Concept of Mobile phases, solvents and eluotropic series ; gradient elution (concave, convex and linear)	(05)
3.2 Electrophoretic techniques: Principles of electrophoresis Slab gel, tube: Continuous and discontinuous, 2-D, PAGE;SDS- PAGE, gradient –gels, IEF and ampholytes, Staining strategies and procedures (Coomassie Brilliant blue R/G 250, Silver, Fluorescent stains Flamingo, Oriole, SYPRO-Ruby); Stain-free gels; Agarose gel electrophoresis, Ethidium Bromide, SYBER GOLD SYBER GREEN II, DNA and RNA ladders, Tracking dyes Methylene blue, Xylene cynol; Blotting techniques: Southern, Western, Northern; RNA denaturing gels	(10)

PRACTICALS **45 hours**

1. Preparation of buffers, use of pH meter
2. Cell fractionation by differential sedimentation.
3. Separation of cells by density gradient centrifugation.
4. Visualization of cells – Light, Phase contrast, Fluorescent and Epifluorescent Microscopy
5. Separation of lipids by reverse phase thin layer chromatography
6. Separation of amino acids by 2-D thin layer chromatography
7. Column chromatography: Preparation of column, determination of void, bed, dead volume
8. Spectrophotometric demonstration of Beer Lambert Law and determination of extinction coefficient
9. UV-Vis monitoring of metabolic reactions (e.g., alkaline phosphatase reaction).
10. Measurement of fluorescence by spectrofluorimeter.
11. Demonstration of AAS.

Reference Books.

1. Norris, R., Ribbons, D.W. Molecular Cellular Microbiology. *In* Methods in Microbiology
2. Colowick, Sidney P., Kaplan, Nathan O., Methods in Enzymology, Academic Press.
3. Parakhia, Manoj V., Tomar, Rukam S., Patel, Sunil., Golakiya, B. A., Molecular Biology and Biotechnology: Microbial Methods

BCC 104 MICROBES IN HEALTH AND DISEASE
Course credit: 4 – Three credit theory and one credit practical

Contact hours

THEORY **45 hours**

1. Introduction **(03)**

1.1 Prokaryotic and Eukaryotic cell structure, organelles and their function

1.2 Microorganisms: Bacteria; Fungi; Viruses

1.3 Sterilization and Disinfection: Physical sterilants; Gas vapour sterilants; Chemical sterilants

2. Bacteria **(12)**

2.1 Growth

Bacterial structure; Gram characteristics.

Nutritional requirements; Respiration (aerobic and anaerobic) and Fermentations.

Growth cycle; Biphasic growth; Continuous culture; Synchronous growth.

Toxins, Enzymes; Pigments

2.2 Pathogens and Chemotherapy

Commensals; Pathogens; Opportunistic pathogens; Nosocomial infections.

Infections:Gastroenteric (*E. coli*, *H. pylori*); Respiratory (Streptococcal); Skin (Staphylococcal); Wound infections; Deep-seated (on prosthesis/ post-surgical intervention); Secondary infections.

Antibacterial agents; Drug resistance; Chemotherapy

3. Fungi **(15)**

3.1 Structure and Growth.

3.2 Secondary metabolites: pigments; mycotoxins; antibiotics.

3.3 Mycoses and Chemotherapy.

3.4 Applications of fungi – enzymes, bioremediation

4. Viruses **(15)**

4.1 Structure and Classification; Plant and animal viruses

4.2 Viral multiplication

4.3 Infections and therapy: Herpes group; Hepatitis group; H1N1 series; Rabies; HIV

PRACTICALS **45 hours**

1. Gram characterof bacteria.
2. Bacterial growth curve.
3. Growth of bacterial pathogens on selective media.
4. Antibiotic sensitivity test for bacterial pathogens.
5. Study and identification of fungi.

Reference Books:

1. Davis, Bernard D., Dulbecco, Renato, Eisen, Herman N., Ginsberg, Harold S., Microbiology, Lippincott Williams and Wilkins.
2. Stanier, Roger Y., General Microbiology.
3. Pelczar Microbiology, Tata McGraw-Hill Education.
4. Madigan, Michael T., Martinko, John M., Stahl David, Clark David P., Brock Biology of Microorganisms, Benjamin Cummings (editor).
5. Ingraham, John L., Ingraham, Catherine A., Introduction to Microbiology, Thomas Asia.
6. Moat, Albert G., Foster, John W., Spector, Michael P., Microbial Physiology. John Wiley

BCC 105 - BIOSTATISTICS

Course credit: 4 – Three credit theory and one credit practical

Contact hours

THEORY **45 hours**

1. **(15)**

1.1a. Characteristics of biological data: Variables and constants, discrete and continuous variables, relationship and prediction, variable in biology (measurement, ranked, attributes), derived variables (ratio, index, rates), types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data) (03)

1.1b. **Elementary theory of errors**: exact and approximate numbers, source and classification of errors, decimal notation and rounding off numbers, absolute and relative errors, valid significant digits, relationship between number of valid digit and error, the error of sum, difference, product, quotient, power and root, rules of calculating digits (03)

1.2. **Data handling**: Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations Tabulation and frequency distribution, relative frequency distribution, cumulative frequency distribution (05)

1.3. Graphical representation: types of graphs, preparation and their applications
Introduction to Bioinformatics
Concepts and applications (04)

2. **(15)**

2.1 Measures of central tendency: characteristics of ideal measure, Arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean; Median – calculation for raw data, for grouped data, for continuous series, limitations of median; Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes; Relationship between mean, median and mode; mid-range, geometric mean, harmonic mean, partition value, quartiles, deciles, percentiles (05)

2.2 **Measure of dispersion**: variability, Range, mean deviation, coefficient of mean deviation, , standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation Skewness – definition, positive, negative, purpose, measure, relative measure, Karl pearson's Coefficient, Bowley's Coefficient, Kelly's Measure, Moments (05)

2.3 **Correlation analysis** – Correlation, covariance, correlation coefficient for ungrouped data, Spearson's Rank Correlation coefficient, scatter and dot diagram (graphical method)
Regression analysis - Linear and exponential function – DNSA conversion by reducing sugar, survival/growth of bacteria, regression coefficients, properties, standard error of estimates, prediction, regression analysis for linear equation (05)

3. **(15)**

3.1 Probability: Probability, Combinatorial Techniques, Elementary Genetics, Conditional Probability, Bayes' Rule, Statistical Independence, Binomial, Poisson, Normal Distributions (05)

3.2 **Hypothesis Testing**: Parameter and statistics, sampling theory, sampling and non-sampling error, estimation theory, confidence limits testing of hypothesis, test of significance; Students' T-test, t distribution, computation, paired t-test (05)

3.3 **Chi-square** test, F-test and ANOVA (05)

PRACTICAL **45 hours**

1. Excel spreadsheet and data analysis
2. Linear equation analysis (regression analysis)
3. Exponential equation analysis (Survival curve)
4. Chi square test
5. Normal distribution
6. Hypothesis testing

Reference books:

1. Kothari, C.R., Quantitative Techniques, Vikas Publishing House
2. Malhan, P.K., Arora, P.N., Biostatistics, Himalaya Publishing House
3. Danilina *et al.*, Computational Mathematics, Mir Publishers
4. Rao, Surya, Bio-Statistics for Health and Life Sciences, Himalaya Publishing House

BCC 201 CLINICAL BIOCHEMISTRY

Course credit: 4 – Three credit theory and one credit practical

THEORY **45 hours**

1. Analysis of Blood, Serum and Urine (15)

1. Composition of Blood, Serum, Cerebrospinal Fluid and Urine
2. Collection of clinical samples – blood, serum, urine; safety measures involved.
3. Analysis of Blood, Serum and Urine

(a) Blood:Haemoglobin, Total cell and Differential cell (TC/DC) counts,Erythrocyte sedimentation Rate (ESR); Clotting time.
Gas transport, transport of oxygen, carbon dioxide and hydrogen by haemoglobin; blood buffers, acid-base regulation/homeostasis
Glucose; Lipid profile; Urea; Gases: Oxygen and Carbon dioxide levels; pH

(b) Serum: Proteins, Albumin/Globulin Ratio; Bilirubin; Creatinine; Uric acid; Electrolytes; Enzymes:Serum Glutamate Pyruvate Transaminase (SGPT)/Alanine amino transferase (ALT); Serum Glutamic Oxaloacetic Transaminase (SGOT)/Aspartate Aminotransferase (AST);Alkaline phosphatase (ALP); Lactate dehydrogenase (LDH); CreatinePhosphoKinase (CPK); gamma-Glutamyltranspeptidase (GGT); Amylase.

(c) Urine: Colour, odour, sediment, crystals, glucose; protein/albumin.

2. Metabolic Disorders (15)

1. Disorders in metabolism

(a) Carbohydrate –Glucose Tolerance Test, Diabetes mellitus Type 1 and Type 2; Ketosis; Diabetic coma.
(b) Lipids – Dyslipidemia
(c) Proteins – Albuminuria
(d) Blood – Anaemia: Red blood cell deficiency, haemolytic, pernicious, sickle cell anaemias; acidosis, alkalosis
(e) Heart – Hypertension, Arterosclerosis
(f) Liver – Hepatitis
(g) Kidney – Water and electrolyte balance; Diabetes insipidus.

2. Inborn errors of metabolism
Congenital metabolic disorders involving chromosomal aberrations / enzyme deficiency; newborn screening test.

(a) Carbohydrate –Lactose intolerance, Galactosemia, Glycogen storage disease
(b) Lipid: Lipid storage/lipidosis – Gangliosides (Brain): Tay-Sach's disease; Glucosylceramide (Lysosome): Gaucher's disease; Sphingomyelin (Lysosome): Niemann Pick disease
(c) Amino acids –phenylketonuria
(d) Organic Acid – alcaptonuria
(e) Purine/pyramidine – Lesch-Nyhan Syndrome
(f) Porphyrins – acute intermittent porphyria
(g) Chromosome – Down Syndrome

(h) Blood – Thallasemia, Sickle cell anaemia.
(i) Skin – Xeroderma pigmentosum

3. **(15)**

1. Tests for diseases and/or therapeutics

(a) Liver Disorders and Liver Function Tests (LFT):
Bilirubin metabolism and clinical assessment. Types of jaundice; Acute and chronic liver diseases: cirrhosis, viral, metabolic and drug induced.
LFT: Serum Protein, Albumin and Globulin; SGPT; SGOT; ALP; Bilirubin

(b) Kidney Disorders and Renal Function Tests (RFT)
Renal threshold and clearance values, disorders of kidney, renal failure and proteinuria, renal tubular disorders.
RFT: Urinalysis – Red and white blood cells; Protein – Creatinine and Albumin: Creatinine Ratios; Serum Creatinine,electrolytes and uric acid; Blood urea; Glomerular filtration rate (GFR).

(c) Heart
Ischemic heart disease.
Role of enzymes/ proteins in assessment of myocardial infarction:
SGOT; CPK; LDH isozyme.

2. Cancers and apoptosis

1. Biochemistry of cancerous growth
2. Biochemistry of aging

PRACTICALS **45 hours**

1. Blood Glucose
2. Blood cholesterol
3. Liver function test
   Serum (a)Protein; (b)Albumin and Globulin; (c)SGPT; (d)SGOT; (e)ALP; (f)Bilirubin
4. Renal function test
   (a) Blood Urea; (b) Serum Creatinine and Uric Acid; Sodium and potassium
5. Minerals
   (a) Total iron and Total iron binding capacity (TIBC) in serum
   (b) Serum calcium; inorganic phosphate; chloride
6. Full urine report
   (a) Physical examination: Colour, odour, sediment, crystals,
   (b) Glucose; protein/albumin

Reference Books:

1. Pattabiraman R.N. Text book of Biochemistry, All India Publisher distribution.
2. Chatterjee M.N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers.
3. Vasudevan, D.M., Sreekumari S., Text book of Biochemistry for Medical Students, Jaypee Publishers.
4. Berg, Jeremy M., Tymoczko, John L., Stryer Lubert. Biochemistry, W.H. Freemann, N. York.
5. David, L.N., Michael, M.C., Lehninger, Albert, Biochemistry, Kalyani Publications, N.

Delhi.
6. Murray, Robert K., Bender, David A., Botham Kathleen M. *et al.* Harper's Illustrated Biochemistry, Appleton & Lange.
7. Kaplan Lawrence A., Amadeo J. Clinical Chemistry: Theory, Analysis, Correlation, Mousby Publisher, Missouri.
8. Ranjna Chawla, Practical Clinical Biochemistry, Jaypee publishers
9. Harold Varley, Alam H. Guwnelock et al. Varley's Practical Clinical Biochemistry.

BCC 202 MOLECULAR BIOLOGY

Course credit: 4 – Three credits for theory and one for practical

Contact hours

THEORY **45 hours**

1. **(15)**

1.1 Nucleic Acids: Structure of DNA and RNA, Bondings and different types of DNA (B-DNA & Z-DNA); DNA packaging in bacteria, viruses and eukaryotes, Hybrid genome of Eucaryotes: Regulatory sequences, yeast as a minimal model eukaryote, *Arabidopsis* as a model of higher eukaryote; Diversity of genomes and the tree of life.

1.2 DNA, chromosomes and Genomes: Structure and function of DNA, chromosomal DNA and its packaging in the chromatin fibre, chromatin structure, structural features (Telomere, Centromere and Repetitive sequences) of chromosomes and their functions.

Packaging of Viral genomes; bacterial genome - nucleoid, Evolution of Genomes; DNA Replication; Gene duplication and mutations.

2. **(15)**

2.1 DNA damage elements/factors: Types of DNA damage (spontaneous and induced DNA damage), mechanisms/pathways to remove damaged DNA: Excision repair, mismatch repair, recombination repair in *E.coli,* SOS Repair, role of Rec A in DNA damage repair, Photoreactivation repair in *E.coli* involving photolyase.

2.2 Mechanisms of Genetic Recombination: General and site specific recombination, Heteroduplex DNA formation (Homologous recombination), Synaptonemal Complex, Bacterial Rec BCD system and its stimulation of chi sequences; role of Rec A protein, homologous recombination, Holliday junctions.

3. **(15)**

3.1 How cells read the Genome: From DNA to Proteins -

(a) From DNA to RNA

(b) From RNA to Protein

(c) The RNA world and origin of life

3.2 Gene structure & Control of Gene expression in Prokaryotes and eukaryotes: An overview of Gene control, DNA binding motifs in Gene regulatory proteins, Genetic switches and their role in control of gene expressions; molecular Genetic mechanisms that create specialized cell types, Post-transcriptional controls-transcription attenuation, Riboswitches, Alternate splicing, RNA editing, RNA Interference, Translation of mRNA in Prokaryotes and Eukaryotes and role of Regulatory Switches, leader sequences and protein localization.

PRACTICALS **45 hours**

1. Isolation of plasmid DNA
2. Isolation of bacterial genomic DNA
3. PCR amplification of a specific gene (target DNA sequence) from genomic DNA. Agarose Gel analysis of PCR product to check its size and purity and gel documentation.
4. Curing of plasmid DNA by acridine orange/SDS and determination of plasmid loss

by loss of resistance to antibiotic and agarose gel electrophoresis.

5. NTG Mutagenesis and Screening of NTG - induced heavy metal resistant mutants

Reference books:

1. Bruce Alberts, Alexander Johnson, et al. Molecular Biology of the Cell
2. James E. Darnell, Harvey F. Lodish, David Baltimore. Molecular Cell Biology.
3. James D Watson. Molecular Biology of the Gene.
4. David Freifelder, George M. Malacinski. Essentials of Molecular Biology.
5. Elliott S. Goldstein. Benjamin Lewin Genes X.
6. Michael J. Simmons, D. Peter Snustad, Eldon John Gardner. Principles of Genetics.
7. Robert H. Tamarin**,** Principles of Genetics.
8. ***Davis*** L.G. , M.D. Dibner, J.F. Battey, Basic Methods in Molecular Biology. Elsevier Publishers
9. Twyman R. M. Advanced Molecular Biology.

BCC 203 ANALYTICAL BIOCHEMISTRY - II
Course credit: 4 – Three credit theory and one credit practical

Contact Hours

THEORY **45 hours**

1 **(15)**

1.1 **Bioimaging:** Principles, application and profile analysis: Confocal scanning, AFM, Optical tweezers, SEM, TEM

1.2 **Separation techniques**: Principles, application, and performance validation of Liquid chromatography, HPLC, HPTLC,Capillary electrophoresis, GC, PFGE, DGGE, TGGE.

2 **(15)**

2.1 **Techniques for Macromolecule structure and Interactions:** Principles, application and profile analysis of spectra ofFTIR, MALDI-TOF, NMR, MS, GCMS, LCMS, ICP-MS, X-ray diffraction, optical rotatory dispersion, circular dichroism.

3 **(15)**

3.1 **Radioisotopes:** Stable and radio isotopes, Disintegration kinetics, Radio-activity counters – GM Counter, Scintillation Counter, Autoradiography, Radiorespirometry, Tracer techniques for metabolic pathways.

PRACTICALS **45 hours**

1 Separation of molecules by HPLC.
2 Study of cell and cell components using SEM.
3. Demonstration of the use of:
GC, IR, NMR, and Mass/MALDI-TOF, AFM.
Elucidation of structure of acellular metabolite using IR, NMR and Mass profiles

Reference Books:

1) Philippe Sansonetti., Arturo Zychlinsky. Molecular Cellular Microbiology, In: Methods in Microbiology, Volume 31.
2) Molecular cellular microbiology In: Methods in Microbiology edited by J. R. Norris, D.W. Ribbons.
3) Methods in enzymology. Volume IV: Edited by Sidney P. Colowick and Nathan O. Kaplan, McCollum Pratt Institute, Johns Hopkins University, Baltimore, Maryland. Academic Press Inc., New York, New York.
4) Sidney P. Colowick, Nathan O. Kaplan. Methods in Enzymology, Volume 2.
5) Manoj V Parakhia; Rukam S Tomar; Sunil Patel and B A Golakiya. Molecular Biology and Biotechnology : Microbial Methods.

BCC 204 IMMUNOLOGY - I

Course credit: 3 – Two credit theory and one credit practical

THEORY **30 hours**

1. **(15)**

Immunity classification – innate and acquired immunity.
Cells and organs of immune system, organisation of lymphatic system
Macrophage activation; phagocytosis
Complement system: Complement fixation via classical and alternative pathway and its regulation, components of cascade – their structures and functions, complement fixation test
Cell mediated and humoral immunity.Primary and secondary immune response.

2. **(15)**

Antigens: definition, haptens, antigenic determinants, polysaccharides, lipids, nucleic acids; Immunogen
Antibodies: immunoglobulins (structure, classes and properties); antibody dependent cell cytotoxicity (ADCC)
Antigen – antibody reactions: *in vitro* precipitation, flocculation, agglutination, haemagglutination, passive haemagglutination, immunofluorescence, immunodiffusion, immunoprecipitation, immunoelectrophoresis, ELISA, RIA.
Types and functions of T Cells
Inflamation
Hypersensitivity reaction and autoimmune disorders: definitions
Immunohaematology: Blood group systems – MN, Rh, ABO; hemolytic disease of new born

PRACTICALS **45 hours**

1. Blood grouping determination
2. Ouchterlony test
3. Immunodiffusion slide techniques
4. Precipitin and agglutination.
5. Widal Test
6. Coomb's Test
7. C-Reactive Protein determination
8. ELISA
9. Rapid Tests [POCTs] for
   (a) Malarial antigens Pv/Pf
   (b) Dengue IgM and IgG antibodies
   (c) Hepatitis HBsAg
   (d) Human Luteinising hormone
10. Rheumatoid Arthritis Factor determination

Reference Books:

1. Ivan Roitt, Peter Delves., Roitt's Essential Immunology.
2. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby., Kuby Immunology.
3. James T. Barrett, Microbiology and Immunology Concepts.
4. Richard A. Goldsby, Thomas J. Kindt, Janis Kuby, Barbara A. Osborne. Immunology.
5. Eli Benjamini, Richard Coico, and Geoffrey Sunshine. Immunology A Short Course.
6. Lauren M. Sompayrac, How the Immune System Works.
7. Jacqueline Sharon. Basic Immunology.
8. Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai. Cellular and Molecular Immunology.
9. Charles A. Janeway, Mark J. Walport, Paul Travers. Immunobiology: The Immune System in Health and Disease.

BCC 205 HORMONES

Course credit: 2 – Two credit theory

THEORY **30 hours**

1. **(15)**

1. Introduction: History, endocrine glands, chemical messengers;
2. Classification of hormones
3. Receptor type, Intracellular receptors - Steroid hormone receptors, Thyroid hormone receptors, sensitisation & desensitization of receptors, short term regulation & Long term regulation.
4. Stimulus of hormones, regulation of biosynthesis and release, feedback mechanism.
5. Cell signalling and Mechanism of secretion of hormone, physiological and biochemical actions, pathophysiology – hyper- and hypo- secretion.
1. Hypothalamic Hormones - CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH.
2. Pituitary Hormones - Anterior Pituitary hormones - Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH; Posterior Pituitary - Vasopressin, Oxytocin.
3. Pancreatic Hormones - Insulin, Glucagon, Diabetes type I &II .
4. GI tract Hormones - Gastrin, Secretin, CCK, GIP, Ghrelin.

2. **(15)**

1. Adrenal Cortex Hormones - Aldosterone (renin angiotensin system) & cortisol; Pathophysiology - Addisons disease, Conn's syndrome, Cushings syndrome; Hormones of Adrenal Medulla, Epinephrine and norepinephrine.
2. Hormones regulating Ca^{2+} Homeostasis - PTH, Vit D, Calcitonin; Pathophysiology - Rickets, Osteomalacia, Osteoporosis.
3. Reproductive Hormones - Male and female Sex hormones, interplay of hormones during reproductive cycle, Pregnancy, Parturition and Lactation; Oral Contraceptives.
4. Endocrine disorders: Gigantism, Acromegaly, dwarfs, pigmies; Pathophysiology - Diabetes insipidus, Thyroid Hormone (include biosynthesis) - Goiter, Graves' disease, Cretinism, Myxedema, Hashimoto's disease.
5. Other organs with endocrine function - Heart (ANP), Kidney (erythropoietin), Liver(Angiotensinogen, IGF-1), Adipose tissue(Leptin, adiponectin); Pathophysiology - Obesity. Growth factors: PDGF, EGF, IGF-I,II , & NGF.

Reference books:

1. Jeremy M Berg, John L Tymoczko, Lubert Stryer. Biochemistry.
2. Christopher K. Mathews., Kensal E. van Holde., Kevin G. Ahern. Biochemistry.
3. Nelson and Cox. Lehningers Principles of Biochemistry.
4. Anthony W. Norman., Gerald Litwack. 1997. Hormones.
5. David Gardner, Dolores Shoback. Greenspan's Basic and Clinical Endocrinology.
6. Thomas C. Moore. Biochemistry and Physiology of Plant Hormones.

BCC 206 MEMBRANE BIOCHEMISTRY
Course credit: 1 – One Credit Theory

THEORY **15 Hours**

1. Composition and architecture of membranes and membrane dynamics: Lipid bilayer, membrane protein, membrane carbohydrate , Phases of membrane and phase transition, lipid-lipid interaction, lipid- protein interaction. Role of Lipid raft and Caveolins in membrane function.
2. Solute transport across the membrane: passive and active transport, transporter protein (Channel protein and carriers), kinetics of glucose transport.
3. Membrane receptors: Types of receptor,
   Molecular mechanism of signal transduction: Recognition of receptors and mode of action. Role of glycolipid and diacyglycerol in signal transduction.

Reference Books.

1. Cell Physiology by A G Giese., W B Sauders Co publication.
2. Cell and Molecular Biology by De Robertis EDP and De Robertis EMP.
3. Lehninger Principles of Biochemistry by Nelson DL and Cox M M. W. H. Freeman & Co.
4. Biological Membranes: a practical approach. Findlay, J. B. C., Evans, W.H., IRL Press.
5. Molecular Cell Biology. Lodish, H., Baltimore, D., et al., W. H. Freeman Publication.
6. The Cell: a molecular approach. Cooper, G. M., Hausman, R. E., Sinauer Assoc. Incorporated
7. Biochemistry. Zubay, G., Wesley, A.

BCC 207 RESEARCH METHODOLOGY

Course credit: 2 – One Credit Theory and one Credit Practical

THEORY **15 hours**

1. Biosafety in the laboratory

(i) Good laboratory practices (GLP) maintained
(ii) Precautions necessary for personal safety with regard to use of organisms and/or hazardous chemicals
(iii) Proper treatment and/or disposal of experimental substances.

2. Ethics in research

(i) Sincerity in experimental design.
(ii) Integrity in report of results, eschewing manipulated observations.
(iii) Evil of plagiarism.

3. Defining the problem.

(i) Selecting a emerging/ vital / thrust area for research.
(ii) Concept of basic and applied research.
(iii) Gathering information about the problem.
(iv) Reasoning out strategies to engage into the research topic.

4. Literature survey

(i) Gathering information on existing research findings on the topic and on state-of-the-art techniques to achieve some advancement in the field of research.
(ii) Lacunae in current knowledge in the area of research
(iii) Writing a description of the literature survey with due citations and proper record of bibliography

5. Defining the Aims and Objectives

(i) Aim: The intent of the work.
(ii) Objectives: The main 3-5 points to achieve the aim.

6. Work Plan – Time-bound Frame

(i) Long term plan of work: Month-wise.
(ii) Short term/Immediate plan of work: Week/Day-wise.
(iii) Time management in experimental planning.

7. Research design

(i) Maintaining a laboratory note book
(ii) Field trip: Sample collection; viewing and assessment of habitats/location.
(iii) Experimental: Description of strategies to meet the objectives using state-of-the-art techniques and proper citation of established/recorded procedures.
(iv) Instrumentation: Involves proper handling and correct usage:
- Maintaining proper record on log books.
- Reporting duly any mishap/ misfunctioning
- Maintaining cleanliness and care of the instrument during and after use.

8. Experimental protocol

(i) Flow-sheet
(ii) Importance of date, time of individual steps

(iii) Materials: chemicals and glassware – size and numbers required
(iv) Significance of triplicate readings.

9. Presentation of data
(i) Record of observations : Importance of recording in the laboratory note book, every observation during the experimental process – intended/unintended; value of serendipity.
(ii) Tabular presentations of results
(iii) Graphical presentations
(iv) Statistical and computational analysis where required

10. Analysis and Conclusions
(i) Analyzing the data
(ii) Drawing an inference/conclusion from the analysis
(iii) Planning the next experiment based on the conclusion of the previous.

11. Presentations
(i) Seminar on research reports/ personal research findings
(ii) Presentations at Conferences
(a) Poster: Title, Authors and Affiliation; Abstract; Introduction; Methodology – Flow charts; Results – Graphical display; Conclusions; References significant to the presented data
(b) Oral : Title with Authors and Affiliation; Introduction; Methodology and Results – Graphical display; Summary/Conclusions.

12. Research manuscript writing
(i) Choice of scientific journal – attention to 'Aim and Scope' of the journal with respect to the area of personal research, impact factor.
(ii) Following explicitly the 'Instructions to authors' of the journal
(iii) Reference to sample papers of the journal for proper layout and details.

13. Thesis Writing
(i) Preliminary: Content page; Certificates; Acknowledgements.
(ii) Literature survey (with proper flow of thought, due citations and proper indexing of bibliography)
(iii) Abstract
(iv) Methodology with due citation
(v) Results – Text, arrangement of figures, tables
(vi) Discussion (substantiated with reported data duly cited, corroborating earlier records or defending new findings)
(vii) Conclusion
(viii) Bibliography
(ix) Appendix

14. *Viva Voce*
Introduction
Methodology – Results & Discussion
Conclusion/Summary
Acknowledgements.

PRACTICALS **45 hours**

1. Literature survey on a given research area.

2. Defining a research problem.
3. Designing an experiment with respect to a given objective.
4. Experimental work.
5. Presentation of data.
6. Report writing.

References

1. Research Methodology methods and techniques. Kothari C. R. New Age Internat Publ.
2. Research Methodology. Rajendra Kumar C. APH Publ Corporation, New Delhi.
3. Methods of Research Good C. V. and Douglas E.
4. How to write a scientific paper. Day R.A. Cambridge University Press.
5. Guide to scientific and technical writing. Cooray P.G.
6. The craft of scientific writing. Alley, M. N.N. Prentice.

BCO 101 GENETIC ENGINEERING
Course credit: 4 – Three Credit Theory and One Credit Practical

THEORY **45 hours**

1. Introduction to genetic engineering (Recombinant DNA technology) **(15)**

(a) Enzymes used in Recombinant DNA technology: restriction endonucleases, exonucleases, DNA ligases (T4 & *E.coli* ligases), Terminal DNA transferase, DNA Polymerases (Taq, Amplitaq, vent,Exo-vent, Pfu, T4 etc), Reverse transcriptase, T4 polynucleotide kinases, Alkaline-phosphatase, S-1 Nuclease, Mung bean nuclease, RNases.

(b) Gene cloning systems/Hosts: Gene cloning in E.coli and other organisms such as *Bacillus subtilis*, *Saccharomyces cerevisiae* (yeast) and other microbial eukaryotes.

(c) Cloning vectors: plasmid(pUC19, pBR 322 and their derivatives), λ phage, cosmid, Phasmid (Lambda Zap); shuttle /transfer vectors.

(d) Sequencing Vectors: pUC 19 and M-13 Phage vector

(e) High capacity Cloning vectors: BAC and YACs.

(f) Expression vectors: Prokaryotic (pET, pGEX-2T and others) and their characteristics; regulatable strong bacterial and viral promoters (*lac, trp, tac,Lambda PL, SV40, T7*) for induction of gene expression.

(g) Preparation of rDNA molecule and its transfer to appropriate host (bacteria/ yeast/ plant cell/ animal cell) using a suitable technique: transformation, electroporation, transfection, gene gun, Particle bombardment.

2. **(10)**

(a) Gene Cloning strategies: Cohesive end cloning and Blunt end cloning, Shot gun cloning and directed cloning; Genomic DNA cloning and cDNA cloning, screening of Gene libraries for recombinant clones.

(b) Other Recombinant DNA techniques: Use of radioactive and non-radioactive nucleotides for DNA probe preparation and detection of hybrids, Gel retardation assay, Restriction mapping, RFLP, PCR, RT-PCR, Real time PCR and its applications, DNA micro arrays and their use in Genomics; DNA sequencing using Sanger's Dideoxy chain termination method and automated sequencer; chromosome walking, Hybrid release and hybrid arrest translation to screen the clones, site directed mutagenesis.

3. **(10)**

(a) Application of Genetic Engineering in Biology, forensics and medicine

(i) Screening of Genetic diseases using DNA probes (DNA diagnostics); Production of recombinant proteins and drugs (insulin, tissue plasminogen activator, erythropoietin, human growth hormones, Antibodies (including Bispecific antibodies for cancer treatment),vaccines, interferons, DNA vaccines: merits and demerits; Edible vaccines- merits and demerits; DNA typing and finger printing

(ii) Manipulation of gene expression in Prokaryotes; Strategies to isolate functional promoters, gene expression from strong and regulatable promoters, Developing fusion proteins and separation of cloned protein by protease induced cleavage, Genetic manipulation to increase recombinant protein stability and secretion using signal sequences.

(**b) Application of Genetic Engineering in Agriculture**

(i) Development of transgenic crops resistant to insect pests, bacterial, fungal and viral pathogens.

(ii) Strategies to develop transgenic crops and horticulture plants using various tools of recombinant DNA technology: Development of Bt Brinjal, Golden Rice and flavr savr tomato

(iii) Importance of *Agrobacterium tumefaciens* in genetic manipulation of plants (Role of Ti plasmids), Role of *Bacillus thuringiensis* (*Bt* genes) to develop insect pest resistant crops.

4. **(10)**

(a) Application of Genetic Engineering in Industry

Genetic manipulation of microbes to over produce industrially valuable enzymes, recombinant pharmaceuticals, nutraceuticals and other biomolecules , production of fermentation products using recombinant organisms, SCP production.

(b) Application of Genetic Engineering in Biomonitoring and Bioremediation of environmental pollutants

Microbial degradation of xenobiotics such as PAH by recombinant microbes, bioremediation of toxic heavy metals, biohydrometallurgy using recombinant microbes for recovery of precious metals. Genetic manipulation of microbes to develop biosensors for monitoring toxic organic and inorganic pollutants.

PRACTICALS

45 hours

1. Restriction mapping of bacterial plasmid
2. Transformation of bacteria with plasmid
3. Cloning of DNA fragment in pUC 19.
4. Demonstration of insertional inactivation marker

Reference Books:

1. Principles of Gene manipulation – R.W. Old and S.B. Primrose
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA- B.R. Glick and J. J. Pasternak
3. Genetic Engineering –Williamson
4. Gene Cloning -Glover
5. Molecular Cloning: A Laboratory Manual -Sambrook et al. 1989
6. Basic Methods in Molecular Biology- L. G. Davis, M. D. Dibner and J.F. Battey
7. Methods for General and Molecular Bacteriology- Gerhardt, Murray, Wood and Krieg
8. Methods in Microbiology-Vol. 21 (Plasmid Technology)- J. Grinsted & P. M. Bennett (Ed)
9. Genetic Engineering – Kreutzer and Massey

BCO 102 NUTRITION AND FOOD BIOCHEMISTRY
Course credit: 4 – Three Credit Theory and One Credit Practical

THEORY **45 hours**

I. Vitamins, Minerals, Water, Fibre **(15)**

1. Fat soluble vitamins: physiological role, deficiency disorders, toxicity of Vitamin A.
2. Water soluble vitamins:physiological role and deficiency disorders.
3. Mineral metabolism: macronutrients – calcium, magnesium, sodium, potassium, phosphorus, sulphur and chlorine; trace elements – essential and non-essential; physiologic role and deficiency disorders.
4. Water metabolism, electrolyte imbalance; dehydration.
5. Fibre and its significance in diet.

II. Nutritional Disorders and Diseases **(15)**

1. Digestion and absorption in the gastrointestinal tract
2. Protein malnutrition disorders – Marasmus, Kwashiorkar.
3. Carbohydrate excess and imbalanced diets.
4. Eating disorders – Bulemia
5. Starvation
6. Food borne diseases:

(a) Bacterial pathogens: *E. coli* – emphasis on EHEC O157:H7, *Salmonella, Shigella, Vibrio, Yersinia*, *Staphyloccocus, Clostridium, L. monocytogenes, H. pylori* emerging pathogens.
(b) Viral: Hepaptitis, Polio.
(c) Fungal toxins.

6. Prions and other non-bacterial forms.

III. Food Spoilage and Food Preservation **(15)**

1. Forms of food spoilage – physical, chemical, microbiological.
2. Predictive food microbiology - Types of foods and their spoilage
3. Factors affecting the growth and survival of microorganisms in foods: Intrinsic and extrinsic
3. Food preservation technologies: Heat processing, low temperature storage, control of water activity, irradiation, high pressure processing, modified atmospheres, preservatives: chemicals, natural organic molecules (nisin) and enzymes.
4. Quality control and Validation

(a) Microbiological examination of foods
(b) Plant sanitation
(c) Hazard Analysis and Critical Control Point (HACCP) concept.

7. Good Manufacturing Practice (GMP) and Quality Systems

PRACTICALS
45 hours

1. Examination of heat treatment for preservation

(a) Determination of thermal death point and thermal death time
(b) Determination of D value

2. Examination of hygiene of a restaurant/canteen:

(a) table surface by a template and swabof a predetermined surface area
(a) utensils, by swab method

3. Examination of foods and determination of food spoilage microorganisms
(a) Biochemical reactions: enzymic browning of fruits; auto-oxidation; rancidity of fats
(b) Microbiological analysis of food product(s) as quality control measure.
(c) Microbiological analysis of drinking water by membrane filter technique

Reference Books:

1. Physiological Chemistry. Harper, H. A., University Medical Publishers.
2. Hawk's Physiological Chemistry. Oser, B. L., (Ed.) McGraw-Hill Book Company.
3. Modern Food Microbiology. Jay, J.M., Loessner, M.J., Golden, D.A., Springer Science, New York.
4. Food Microbiology. Adams, M. R., Mass, M. O. New Age International Ltd Publishers, New Delhi.
5. Food Microbiology. Frazier, W. C., Westhoff, D. C., M. C. Graw-Hill Companies, Inc., New York.
6. Food Microbiology and Hygiene. Hayes, P. R. Chapman & Hall, London
7. Food Microbiology. Montrille, T. J., Matthews, K. R., ASM Press, NW Washington, USA.

BCO 103 IMMUNOLOGY II
Course credits: 3 – Three Credits Theory

1 1.1 Phagocytosis – Cell surface receptors/markers and their role, killing mechanisms; NK cells – Cell to cell recognition for normal and modified cells, receptors, initiation of apoptosis and killing of target cells, malfunctioning of NK cells; role of mast cells in immunity (05)

1.2 Concept of immunoglobulin domain, distribution of immunoglobulin domain, superfamily member, structure and function of TCR, diversity of antigen binding domain, concept of segmented gene, gene organisation of Ig and TCR, generation of gene during differentiation and development of B and T Cells, expression of Ig and TCR Cistrons, class switch and regulation of expression, B and T Cell ontogeny (05)

1.3 Major Histocompatibility Cluster – Introduction to MHC I, II and III, structure and function of MHC I and II, distribution and recognition of MHC I and II, gene organisation and concept of polymorphism, expression and its regulation, processing of extracellular antigen by APC, presentation of intracellular antigen by nucleated cells, recognition of MHC I and II by TCR/CD3 complex; Members of MHC III and their roles (in brief). (05)

2 2.1 Ontogeny of T- and B-cells, immunocompetent T and B cells, recognition, signalling and activation of T cells by APC, control and regulation of activated T-Cells, B-Cell activation – Type 1 thymus-independent antigen, Type 2 thymus-independent antigen, thymus dependent antigen, cooperation with T-cells and activation of resting B-cells, antigen processing by B-cells, stimulation by cross-linking surface Ig (05)

2.2 Cytokine as messengers, receptor for cytokine – gp130 subfamily, c and c receptor subfamily, signal transduction and effects, network interactions; TH1 and TH2 responses; Cytokine mediated chronic inflammatory response; Killer T Cell and its regulation; effect of antigen dose and maturation of affinity of antibodies; role of memory cells (05)

2.3 Antigen as major factor in control, feedback control of antibody production, T cell regulation – T-helper cells, T-cell suppression; Idiotypic networks, influence of genetic factors, immune regulation through hormone; T-cell tolerance. (05)

3 3.1 Concept of inflammation (self-revision), complement fixation (self-revision), defence against intracellular bacterial pathogen, immunity to viral infection, immunity to fungi, immunity to parasitic infections; Passively acquired immunity, vaccination – herd immunity, strategies, killed organisms as vaccines, live attenuated vaccines, subunit vaccine, epitope vaccines, vaccines in use and experimental vaccines, Adjuvant and new approaches in vaccine development. (05)

3.2 Immuno-techniques: Antigen antibody interactions in solution (self revision), identification and measurement of antigen (self revision), epitope mapping, hybridoma technology and monoclonal antibody revolution, catalytic antibodies, engineering antibodies, antigen-antibody based affinity chromatography (revision of techniques), isolation of leukocyte and subpopulations, localization of antigen *in cyto* and *in tissue*, assessment of functional activity, genetic engineering of experimental animal for immune response investigation (05)

3.3 Clinical immunology (Immunodeficiency): phagocytic cell defects, complement system deficiency, primary B-call deficiency, primary T-cell deficiency, combined immunodeficiency, secondary immunodeficiency, comparison between SCID and AIDS, recognition of immunodeficiency. (05)

References Books.

1. Immunology. Goldsby, R. A., Kindt, T. J., Osborne, B. A., W.H. Freeman.
2. Textbook Of Immunology. Bona, C. A., Bonilla, F. A., Fine Arts Press.
3. Immunobiology. Janeway, C. A., Travers, P., Walport, M., Shlomchik, M. J., Garland Science.
4. Roitt's Essential Immunology. Delves, P., Martin, S., Burton, D., Roitt, I., Wiley-Blackwell

BCO 104 NEUROCHEMISTRY
Course credit: 2 – Two Credits Theory

THEORY **30 hours**

1. **(15)**

1. Organization of Nervous system, CNS,ANS,PNS, Blood Brain Barrier.
2. Nerve, neuron, glial cells and synapse structure.
3. Afferent pathways and Sense organs.
4. CSF composition, function and circulation
5. Biochemical composition of Nerve tissue. Carbohydrates, lipid and amino acid
6. Transport of amino acid, protein, nucleic acid metabolites.
7. Energy metabolism in Brain
8. Transmission across the synapse,membrane potential in steady state,
9. Action potential generationandpropagation,pre and post synaptic events
10. Synaptic transmission, channel pumps ,Ligand- gated ion channels and transporters

2. **(15)**

1. Neurotransmitters, neuromodulators, neuropeptide turnover, metabolism regulation
2. Types of neurotransmitter receptors, receptor- effector mechanisms, properties of Cholinergic receptor, acetylcholine receptors, acetylcholine esterase, Nicotinic receptors, Glutamate receptors, GABA and Glycine receptors, Catecholamine receptors, monoamine oxidase inhibitors. Serotonin receptors,antagonists and re-uptake inhibitors, properties. Nitric oxide in cells.
3. Sensory modalities and sensory circuits, sensory perception of taste,vision, odor,hearing and touch.
4. Coordination between nervous system and endocrine system. Influence of Growth factor, Hormones and Cytokinins in brain functions
5. Biochemistry of Behavior ; Pleasure,stress , love , memory
6. Biochemistry of mental and neurodegenerative disease, Depression, Post traumatic stress disorder. Schizophrenia, Alzheimer's disease, Huntington's disease, senile dementia. Movement disorders, Parkinson's disease.
7. CNS active drugs, their classification and mode of action. Conventional antipsychotics. Anxiolytics,.Antidepressants.
8. Drugs of abuse and their mechanism of action

Reference Books:

1. Basic Neurochemistry by G. J. Siegel, B. W. Agranoff, W. Albers, S. K Fisher, M. D. Uhler.
2. Goodman and Gilman's The Pharmacological Basis of Therapeutics. L. Brunton, B. Chabner, Bjorn Knollman.
3. Elements of Molecular Neurobiology. Smith, C.U.M..
4. Principles of Neural Science. E. Kandel, J. Schwartz, T, Jessell.

BCO 105 DRUG METABOLISM
Course credit: 2 – One Credit Theory and One Credit Practical

THEORY **(15 hours)**

1 **Drugs**

Drugs – Definition; types – therapeutic, drugs of abuse, poisons.
Routes of drug administration
Absorption and distribution of drug through organ /tissue - factors affecting distribution
Physicochemical properties of drugs, organ/tissue size, blood flow to the organ, physiological barriers to the distribution of drugs, drug binding blood/ tissue/ macromolecules.
Protein/tissue binding of drugs – factors affecting protein binding of drugs, significance and kinetics, tissue binding of drugs

2 **Metabolism**

Biotransformation of drugs
Organs of drug metabolism: hepatic and extrahepatic
Mechanism – inactivation, bioactivation, reactive intermediates, Cytochrome P450 I (CYP I), Cytochrome P450 II (CYP II), and oxidation enzymes, epoxide hydrolase, quinoneoxidoreductation, conjugation enzymes.
Phase 1:
CYP-Catalyzed: Hydroxylation (Primarily at C, N, some at S), Dealkylation (N- and O-dealkylation), Deamination, Epoxidation, Reduction.
Non-CYP-Catalyzed: Oxidation (Alcohol and Aldehyde Dehydrogenase, Flavin-Containing Monooxygenase, Monoamine Oxidase), Reductase (Quinone Reductase), Hydrolysis (Esterases, Amidases, Epoxide Hydrolase)
Phase 2:
Glucuronidation, Sulfation, Acetylation, Glycine conjugation (minor), Glutathione conjugation (toxic substances).
Extrahepatic metabolism.
Excretion of drugs: renal excretion, factors affecting renal excretion, nonrenal routes of excretion & factors affecting excretion and enterohepatic circulation.
Factors affecting biotransformation.
Pharmacological activity of metabolite, deposition of metabolite.
Significance of drug metabolism
Drug – drug interaction

3 **Genetic variation in drug response and toxicity**

Pharmacogenetics: a tool for identifying genetic factors in drug dependence and response to treatment
Clinically relevant genetic variations in drug metabolizing enzymes

4 **Therapeutic drug monitoring**

A prioiri and *a posteriori* drug monitoring
Characteristics of drugs subject to monitoring

PRACTICALS **(45 hours)**

1. Hydroxylation of drug by liver homogenate and spectrophotometric/ spectrofluorometric detection.
2. Therapeutic drug monitoring: detection of tricyclic antidepressants in serum.
3. Immunochromatographic assay for detection of drugs of abuse.
4. Thin layer chromatographic detection of drugs of abuse.
5. Breath Test for Alcohol Abuse.
6. Case study of incidence, effects and management of substance abuse at the individual and at the community level.

Reference books

1. Goodman & Gilman's The pharmacological basis of therapeutics, Brunton, L. L., Chabner, B., Knollmann, B. C., (Eds.), McGraw Hill Medical.
2. Drug metabolism. Gonzalez, F. J., Tukey, R. H. In: Brunton, L. L., Chabner, B., Knollmann, B. C., (Eds.), Goodman & Gilman's The pharmacological basis of therapeutics, McGraw Hill Medical.
3. Casarett and Doull’s Toxicology. Klaassen, C. D., Amdur, M. O. and Doull, J. Macmillan publishing company, New York.
4. Principles and methods of toxicology. Hayes, A. W. Raven press, New York

BCO 106 BIOCHEMISTRY OF ENVIRONMENTAL POLLUTION AND REMEDIATION

Course credit: 4 – Three Credit Theory and One Credit Practicals

THEORY
45 hours

1. **Environment and Pollutants** (15)

Environment: Atmosphere, soil, aquatic – fresh water, marine systems; biogeochemical cycles.

Pollutants: classification, toxicity, synergistic or antagonistic action.

Eco-toxicology:concept of permissible limits, ED50 & LD50; acute and chronic exposures; biochemical effects and genotoxicity.

Monitoring of pollution using indicator microorganisms, biosensors: genetically modified organisms and enzymes

Significance of dissolved oxygen, BOD,COD.

Environment protection regulations, impact assessment and standards

2. **Impact of environmental pollution** (15)

Atmosphere

Greenhouse gases and CFCs – sources and effect on the ozone layer; consequences; concept of carbon credit.

Atmospheric particulate matter and smog – effect on respiratory system

Elements such as asbestos, lead – toxicity and occupational hazards.

Soil

Xenobiotics, agricultural chemicals, improper waste disposal

Hydrocarbons: petroleum andpolynuclear aromaticssuch as naphthalene, benzo-pyrene, solvents, pesticides, lead and other heavy metals – significance on health.

Aquatic – fresh water, marine systems

Discharge of industrial effluents such as mining, metals, pesticides, textiles, thermal waters, aquaculture, sewage; oil spills – impact on aquatic life and the food chain; consequences on human health.

3. **Remediation of waste** (15)

Treatment of waste

Concepts of Reuse, Recycle, Recovery.

Waste water/ sewage treatment: use of activated sludge; recent advances

Solid waste management – Segregation, composting of organic waste

Hospital waste – incineration

Chemical processes: flocculation, precipitation, ion exchange.

Bioremediation : Concept and technologies.

Biological systems – plants, bacteria and fungi; microbial consortia.

Microbial processes – enzymic transformations, cometabolism, microbial adhesion, biofilms, production of extracellular polymers and emulsifiers.

Degradation of agricultural polymers such as cellulose, lignin, chitin, pectin;

xenobiotic organic molecules such as hydrocarbons and phenolics; fossil fuels. Removal of metal pollutants through sedimentation, sorption, precipitation, speciation conversion

PRACTICALS **45 hours**

1. Assessment of water quality – analysis of BOD,COD, dissolved oxygen
2. Composting of organic waste.
3. Analysis of indicator of pollution such as *E. coli*.
4. Biotransformation of xenobiotics.
5. Biosorption of metal from solution.

References

1. A text book of Environmental Chemistry and Pollution Control. Dara, S.S., S.Chand Publishers.
2. Environmental Chemistry. Moore J. W., Moore, E. A. Elsevier.
3. Environmental Science: A study of Interrelationships. Enger, E. D., Smith, B. E., , WCB publication, McGraw-Hill Higher Education.
4. Elements of Environmental Chemistry: For Undergraduate Science Students of Indian University. Jadhav, H.V. Himalaya Publishing House.
5. Environmental Pollution Analysis. Khopkar, S. M., John Wiley & Sons.
6. Environmental Chemistry. Satake, M., Sethi, S.,Eqbal, S.A.
7. Environmental Microbiology. Mitchell, R., Cu, J. D., Wiley-Blackwell Publication
8. Environmental Microbiology. Ramesh, K. V., MJP Publishers, India.
9. Environmental Microbiology. Maier, R., Pepper, I., Gerba, C., Academic Press

BCO 107 INDUSTRIAL BIOCHEMISTRY
Course credit: 4 – Three Credit Theory and One Credit Practicals

I Industrial bioreactor designs (15)

1. Fermenters: design of fermenters, types of fermenters.
2. Fermentation process, maintenance of aseptic conditions, aeration and agitation.
3. Fermentation: batch, fed-batch and continuous. Scale up and scale down. Solid state fermentation.
4. Control of various parameters – online and offline monitoring, rheological properties of fermenter, computerization offementer operation.
5. Downstream processing, recovery and purification of fermentation products. Effluent treatment

II Food technology (15)

1. Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; Cultivation of microorganisms.
2. Processed foods – cheese, cold meats
3. Fermentations – wine, beer, vinegar.
4. Oriental fermented foods: Soy sauce, tofu, tempeh
5. Indian fermented foods: Idli, dosa, dokhla.
6. Probiotics – yoghurt/ curd

III Industrial productionof biochemically important products (15)

1. Production of protein/ carbohydrate/ lipids

(a) Proteins from milk and SCP; Industrially important enzymes
(b) Production of dextrins, glucose.
(c) Preparation of fatty acids, lecithins; Production of essential oils and their fractionation

2. Production of pharmaceuticals/neutraceuticals/ biochemicals

(a) Antibiotics: penicillins
(b) Vitamins: B_1, B_6, B_{12}; A, D, E concentrates.
(c) Amino acids: lysine.
(d) Alcohol: ethanol
(e) Organic acid: citric acid

Practicals (45)

1. Fermentor:

(a) Designing of fermentor – stirred tank reactor
(b) Aeration efficiency using dissolved oxygen analysis
(c) Rheology of substrate solutions, culture broth and harvested cell suspension

2. Fermentation processes – production of ethanol
3. Production of biochemically important products

(a) Casein from milk
(b) Sugar from sugarcane
(c) Lecithin from egg yolk

Reference Books:

1. Industrial Microbiology – AH Patel, McMillan India Ltd, 1st Edition
2. Food Microbiology – Frazier &Westhoff, Tata McGraw Hill Publishers, New Delhi
3. Food Microbiology by J. M. Jay

4. Total synthesis of natural products, Vol I-John Apsinon
5. Chemical Process Industries – Norris Shreeve& Joseph Brink
6. Roger's Industrial Chemistry Vol I & II – Edited by CC Furnas
7. Merck Index, 10th Edition
8. Chemistry of Natural Products – Agarwal& Sharma
9. Industry chemistry of Fats and Waxes – JP Hilditch
10. Essential Oils, Vol I – Ernst Guenther

BCO 108 FRONTIERS IN BIOTECHNOLOGY
Course credit: 4 – Three Credit Theory and One Credit Practicals

THEORY **(45 hours)**

1. Introduction **(5)**

(a) Biotechnology: concept and principles.
(b) Hybrid technology
(c) Tissue culture
(d) Transgenics.
(e) Metabolomics
(f) Prospects and concerns
(g) Biosafety management
(h) Bioethics in application of biotechnology

2. Biotechnology in Agriculture **(5)**

(a) Green revolution and Crop yield increase
(b) Rice –addition of β-carotene (golden rice), iron, amino acids, flavour, pigment.
(c) Plant growth enhancement through use of genetically modified plant growth promoting Rhizobacteria
(d) Crops/plants –resistance to draught, salinity, cold, pathogens (bacteria, fungi, virus), insects (Bt cotton, Btbrinjal).
(e) Plants/fruits – delayed ripening
(f) Plants – tissue culture for obtaining desirable characteristics

3. Biotechnology in Aquaculture **(5)**

(a) Aquaculture – to meet demand, improve productivity and quality. Concept of sustainable development.
(b) Transgenic Fish – to increase growth factors and defence against microbialinfections. Aquaculture Health Management – Microbial Technology for production of fast growingdisease resistant varieties through development of vaccines, disease diagnostic methods, cell linesand probiotics.

4. Biotechnology in Animal Husbandry **(5)**

(a) White revolution andRed revolution
(b) Transgenic cows – production of milk: suited for lactose intolerance, or to contain high levels of "healthy" fat found in fish; insertion of human gene so as to produce milk with same properties as human breast milk.
(c) Transgenic poultry for disease resistance and animals with increased levels of growth hormones for higher production of meat.

5. Biotechnology in Food Industry **(5)**

(a) Genetically modified Foods (GMFs): Benefits and concerns
(b) Genetically engineered microbes (GEMs) in the food industry for process improvement, enhancednutritional value and flavor, and increased shelf life.
(c) Role of GEMS in the dairy, bakery and brewery industry

6. Biotechnology in Medicine **(10)**

(a) Edible vaccines and therapeutic proteins, plants as bioreactors for antibodies, polymers, proteins)
(b) Recombinant insulin, human growth hormone.

(c) Microbiome studies through metagenomics in understanding human-microbial interactions towards improved health (probiotics, oncogenic viruses).
(d) Gene therapy in treatment of genetic diseases – gene targeting and anti-sense therapy, with background of Human genome project.
(e) Proteomics and drug discovery
(f) Lab on Chip technology for diagnosis of diseases: Chip based PCR and Microfluidic System
(g) Stem cell research: Source of stem cells. Development of tissue and organs

7. Bioprospecting (10)

(a) Novel Enzymes from marine and extremophilicorganisms
(b) Novel bioactive compounds from marine organisms: anti-tumour, anti-bacterial, anti-fungalanti-diabetic, anti-inflammatory, cholesterol-lowering.
(c) Novel archaeal biomolecules - Bacteriorhodopsin for bioelectronic devices, optical switches, photocurrent generator, and cell wall S-layer for ultrafiltration, electronics, polymers
(d) Novel bioproducts through metagenomic approach.
(e) Biotechnology in space– The use of microgravity as a tool for separation processes and techniques (including protein crystal growth), and production of cells for medically significant enzymes, hormones, vaccines

PRACTICALS 45 hours

1. Plant tissue culture.
2. Isolation of marine derived or extremophilicarchaea/bacteria/fungi for bioprospecting.

(a) Screening isolates for a biomolecule of choice (antimicrobial/pigment).
(b) Determination of factors affecting production of the metabolite.
(c) Effect of physicochemical parameters on activity of the metabolite.

References

1. Gene Biotechnology. Jogdand, S.N. Himalaya publishing house.
2. Advances in Biotechnology. Jogdand, S.N. Himalaya publishing house.
3. Advances inBiotechnology. Ravi,I., Baunthiyal, M., Saxena, J., (Eds.). Springer.
4. Biotechnology. Satyanarayana. Books & Allied (P)Ltd.
5. Biotechnology in Agriculture and Forestry. Widholm, J. M., Kumlehn, J., Nagata, T.,
6. Plant Biotechnology and Agriculture. Altman, A., Hasegawa, P. Elsevier.
7. Biotechnology. Clark, D.,Pazdernik, N.
8. Food Biotechnology. Bielecki, S., Tramper, J., Polak, J.
9. Medical Biotechnology. Pongracz, J., Keen, M.,
10. Aquaculture Biotechnology. Fletcher, G. L., Rise,M. L., (Editors), Wiley.
11. Plant Biotechnology and Genetics: Principles, Techniques and Applications. Stewart, N. C., Jr. (Editor),
12. Animal Biotechnology. Shenoy, M., Laxmi Publication.
13. Animal Biotechnology Models in Discovery and Translation. Verma, A., Singh, A.

BCO 109 STUDY TOUR / FIELD TRIP
Course credit: 1

45 hours

1. Visits to Research Institutes / Laboratories / Industries in Goa
2. Report writing.
3. Seminar presentation

BCD DISSERTATION
Course credit: 12

1. Research to be carried out under the guidance of an assigned guide.
2. Periodic reports (as determined at the initiation of the research work).
3. Dissertation.
4. Viva-Voce.