UNIVERSITY OF MADRAS

M.SC. DEGREE COURSE IN ADVANCED BIOCHEMISTRY

(CHOICE BASED CREDIT SYSTEM)

REGULATIONS

(w.e.f. 2008-2009)

1. CONDITIONS FOR ADMISSION:

A Bachelor's degree with Biochemistry/Molecular biology/Biotechnology/ Botany /Zoology / Microbiology / Nutrition as the main subject of this University or from any other University accepted as equivalent is eligible for admission to the M.Sc. (Advanced Biochemistry) degree course.

2. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the degree only if he / she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning 91 credits.

3. DURATION OF THE COURSE:

The duration of the course is for two academic years consisting of four semesters. In order to be eligible for the award of the degree, the candidate should have successfully completed the course within THREE years reckoned from the date of enrolment for the first semester of the course.

4. EXAMINATION:

There shall be four examinations: first semester examination at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations will be held at the middle and the end of the second academic year, respectively.

Number of credits to secure from core papers = 60
Number of credits to secure from Five Electives from the same Department = 15
Number of credits to secure from two Electives offered by other Departments = 6
Number of credits to secure from Soft skills = 8
Number of credits to secure from Internship = 2

Minimum total credits to secure a post-graduate degree in Advanced Biochemistry = 91

5. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER:

i) Candidates shall register their names for the first semester examination after the admission in the PG course.

ii) Candidates shall be permitted to proceed from the first semester up to final semester irrespective of their failure in any of the semester examinations, subject to the condition

that the candidates should register for all the arrear subjects of earlier semesters along with current (subsequent) semester subjects.

iii) Candidates shall be eligible to go to a subsequent semester, only if they earn sufficient attendance as prescribed by the syndicate from time to time.

Provided in the case of a candidate earning less than 50% of attendance in any one of the semesters due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the college, shall be permitted to proceed to the next semester and to complete the course of study. Such candidates shall have to repeat the missed semester by rejoining after completion of Final Semester of the course, after paying the fee for the break of study as prescribed by the university from time to time.

6. PASSING MINIMUM:

There is no passing minimum for internal. For external examination, passing minimum of 50% at PG is fixed and grading be based on overall marks obtained (internal + external).To qualify for a degree,a minimum of 50% in the aggregate for PG courses is needed

7. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

Candidates who secured not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in the First Class.All other successful candidates shall be declared to have passed in Second Class.

Candidates who obtain 75% of the marks in the aggregate shall be deemed to have passed the examination in First Class with Distinction provided they pass all the examinations prescribed for the course in the first appearance.

8. GRADING SYSTEM:

GRADE	GRADE POINT	PERCENTAGE EQUIVALENT
‘ O’-Outstanding	5.50-6.00	75-100
‘A’ -Very Good	4.50-5.49	65-74
‘B’- Good	3.50-4.49	55-64
‘C’- Average	3.00-3.49	50-54
‘D’- Below Average	1.50-2.99	35-49
‘E’- Poor	0.50-1.49	25-34
‘F’- Fail	0.00-0.49	0-24

9. RANKING:

Candidates who pass all the examinations prescribed for the course in the FIRST APPEARANCE ITSELF ALONE are eligible for Classification/Ranking/Distinction;

Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First appearance due to the reasons as furnished in the Regulations under REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER are only eligible for Classification/Distinction.

10. QUESTION PAPER PATTERN:

PART A: Answer All Questions (10 X 1 = 10 marks)
PART B: Answer Any 5 Questions (5 x 5 = 25marks)
PART C: Answer Any 4 Questions (4 x 10 = 40 marks)

11. APPEARANCE FOR IMPROVEMENT:

Candidates who have passed in a theory paper is allowed to appear again only once in order to improve his / her marks ,by paying the fee prescribed from time to time. Such candidates are allowed to improve within a maximum period of 10 semesters counting from his/her first semester of his/her admission. If the candidate improves his/her marks, then the improved marks will be taken into consideration for the award of classification only. Such improved marks will not be counted for the award of Prizes/Medals, Rank and Distinction. If the candidate does not show improvement in the marks, his previous marks will be taken into consideration.

No candidate will be allowed to improve marks in the Practicals, Project, Viva-voce, Field work.

12. TRANSITORY PROVISION:

Candidates who have undergone the course of study prior to the academic year 2008-2009 will be permitted to appear for the examinations under those regulations for a period of two years i.e. up to and inclusive of April/May 2012 Examinations. Thereafter, they will be permitted to appear for the examination only under the Regulations then in force.

13. PROJECT EVALUATION:

Project work should be carried out as an individual project and actual bench work. It will begin from the Third semester, and will continue through the Fourth semester. The project report will be submitted at the end of the Fourth semester and evaluated.

For the conduct of the End semester examination and evaluation of project work, the university will appoint external examiners .The concerned supervisor of the Project shall carry out continuous Internal Assessment wherever the candidate works.

The project dissertation carries a total of 100 marks. The viva-voce examination is a part of dissertation, which carries marks as specified below. The assignment of marks for project is as follows:

Continuous Internal Assessment for project) : **20 marks**
(Two out of three presentations
External Evaluation of the Project work : **80 marks**
Dissertation : 60 marks
viva-voce : 20 marks

14. CONTINUOUS INTERNAL ASSESSMENT FOR THEORY PAPERS:
Internal Marks : 25

Two tests out of three:-15 marks
Attendance :- 5 marks

Assignment :- 5 marks

COURSE STRUCTURE

SEMESTER I

S.No	Course Components	Name of Course	Credits	Exam (Hours)	Max marks		Course Faculty
					CIA	Ext	
1	Paper 1 Core 1	Techniques in Biochemistry	4	3h	25	75	SS & GS
2	Paper 2 Core 2	Chemistry of Biomolecules	4	3h	25	75	GS & AJV
3	Paper 3 Core 3	Clinical Biochemistry	4	3h	25	75	TD& SND
4	Paper 4 Core 4	Lab course in Biochemical Techniques and Clinical Biochemistry	4	6h	40	60	SND & AJV
5	Paper 5 Elective 1	Human Physiology	3	3h	25	75	TD,GS & AJV
6	Soft Skill		2	3h	25	75	

SEMESTER II

S.No	Course Components	Name of Course	Credits	Exam (Hours)	Max marks		Course Faculty
					CIA	Ext	
7	Paper 6 Core 5	Immunology I	4	3h	25	75	SS
8	Paper 7 Core 6	Metabolic Regulation	4	3h	25	75	TD &GS
9	Paper 8 Core 7	Molecular Biology of Gene	4	3h	25	75	SND&AJV
10	Paper 9 Core 8	Lab course in Molecular Biology	4	6h	40	60	SND
11	Paper 10 Elective 2	Metabolic Disorders	3	3h	25	75	TD
12	Paper 11 Elective 3	Enzymology	3	3h	25	75	SND
13	Soft skill		2	3h			

SEMESTER III

S.No	Course Components	Name of Course	Credits	Exam (Hours)	Max marks		Course Faculty
					CIA	Ext	
14	Paper 12 Core 9	Hormonal Biochemistry	4	3h	25	75	TD
15	Paper 13 Core 10	Immunology II	4	3h	25	75	SS & GS
16	Paper 14 Core 11	Microbial Approaches to Industrial and Pharmaceutical Biochemistry	4	3h	25	75	GS & AJV
17	Paper 15 Core 12	Lab course in Microbiology	4	3h	40	60	GS
18	Paper 16 Elective 4	Eukaryotic gene expression	3	6h	25	75	SND
19	Paper 17 Elective 5	Signal Transduction	3	3h	25	75	AJV
20	Soft Skill		2	3h	25	75	
21	Internship		2	3h			

SEMESTER IV

S.No	Course Components	Name of Course	Credits	Exam (Hours)	Max marks		Course Faculty
					CIA	Ext	
22	Paper 18 Core 13	Recombinant DNA Technology	4	3h	25	75	SND,GS & AJV
23	Paper 19 Core 14	Project and viva-voce	8	-	20	80	All Faculty
24	Paper 20 Elective 6	Basics of gene therapy	3	3h	25	75	SND
25	Paper 21 Elective 7	Experimental Induction and Diagnosis of Diseases	3	3h	25	75	SS
26	Soft Skill		2	3h	25	75	

Total Number of Credits: 91

SND : Dr.S.Niranjali Devaraj ; **TD** : Dr.T.Devaki; **SS** : Dr.S.Subramanian;
GS : Dr.G.Sudhandiran; **AJV** : Dr.A.J.Vanisree

ELECTIVES OFFERED TO OTHER DEPARTMENTS:

Semester I : Human Physiology **Semester II :** Enzymology
Semester III : Experimental Induction and Diagnosis of Diseases
Semester IV : Basics of Gene Therapy

SYLLABUS
(2008-2009)

SEMESTER I

Paper 1, Core 1

TECHNIQUES IN BIOCHEMISTRY

Unit I:

Biochemical Separation techniques**:** Principle, procedure and applications of: Chromatography-TLC, ion exchange, gel filtration, affinity, GLC and HPLC. Electrophoresis-SDS-PAGE, 2Dgel electrophoresis, isoelectric focusing, isotachophoresis, Capillary electrophoresis, Pulsed field gel electrophoresis. Ultracentrifugation-preparative and analytical ultracentrifuges, differential centrifugation, Density gradient centrifugation

Unit II:

Principle and application of tracer techniques – Radiation dosimetry, radio diagnosis of diseases, autoradiography, Cerenkov radiation, Liquid scintillation counter, Gamma-counters. Blotting techniques – Western, Southern, Northern blotting

Unit III:

Spectroscopic Analysis of Biomolecules - UV-Visible Absorption Spectrophotometry, Fluorescence Spectrophotometry, X-ray diffraction, ORD, CD, Mass Spectrometry, plasma emission spectoroscopy. Infra red, Raman, ESR and NMR spectroscopy, Atomic absorption spectroscopy

Unit IV:

Cell culture techniques- Preparation of physiological solutions, preparation of media. Plant and animal cell culture, tissue culture, primary cell culture, cell line, cell clones, callus cultures, somaclonal variation, micro propagation, somatic embryogenesis protoplast fusion, Flow cytometry

Unit V :

Miscellaneous Methods-Protein and Enzyme techniques**:** Investigation of Protein structure: amino acid composition, amino acid sequence, protein conformation. Purification and assay of enzymes, Sequencing of DNA, automated sequencing. Principle, technique and applications of Confocal microscopy**,** Biosensors.

References:

- **Wilson K and Walker J**
  Principles and Techniques of Biochemistry and Molecular Biology;
  Cambridge University Press (2005)
- **Skoog DA, West DM, Holler FJ, Nieman TA**
  Principles of Instrumental Analysis; Thomson Asia Pvt Ltd (2005)
- **Boyer RF,** Modern Experimental Biochemistry; Benjamin Cummings (2000)

Paper 2 , Core 2

CHEMISTRY OF BIOMOLECULES

Unit I:

Chemical composition and bonding, 3 dimensional structure, configuration and conformation, chemical reactivity.

Unit II:

Macromolecules & their monomeric subunits -3 dimensional structures of proteins–peptide bonds, Ramachandran plot, α Helix, parallel and anti parallel β pleated sheets. Bond angles & characteristic amino acid content. Tertiary & quatenary structures Protein stability, denaturation, protein folding and chaperones Structure of fibrous & globular proteins - myoglobin & Hemoglobin - Bohr effect. Structure of collagen, keratin. Complementary interactions between proteins & ligands. Actin, myosin & molecular motors.

Unit III:

Polysaccharides – structure of starch, glycogen, cellulose & chitin, glycoconjugates – proteoglycans, glycoproteins & glycolipids.

Unit IV:

Structure of DNA, A form, B form of DNA, Z DNA, bent DNA, structure of different RNAs, Topology of DNA - linking number, twist and writhe.

Unit V:

Structure of storage lipids, structural lipids in membranes, glycero lipids, sphingolipids & phospholipids & eicosanoids (thromboxanes, Leukotrienes & prostaglandins).

References:

- **Voet D and Voet J**
  Biochemistry ; John Wiley & Sons Inc; (2004)
- **Berg JM, Tymoczko JL, Stryer L**
  Biochemistry; W.H.Freeman & Co Ltd; (2006)
- **Cox M and Nelson DL**
  Lehninger Principles of Biochemistry**;** Palgrave Macmillan; (2004)
- **Mathews CK and van Holde**
  Biochemistry ; Addison Wesley Longman Publishing Co (2000)

Paper 3 , Core 3

CLINICAL BIOCHEMISTRY

Unit I:

Plasma proteins and their variation in diseases. Haemopoiesis and disorders of haemopoiesis, Hemoglobinopathies, anemias, hemorrhagic diseases. Normal and abnormal clotting mechanisms. Plasma lipids and lipoprotein changes in various diseases. Respiratory acidosis and alkalosis. Diseases of the bone with special reference to osteoporosis, osteomalacia, Paget's disease, Renal osteodystrophy.

Unit II:

Clinical manifestations and biochemical changes in liver diseases (a) infectious–Viral hepatitis (b) toxic-alcohol. (c) genetic– hemochromatosis (d) immune – auto-immuno hepatitis and biliary cirrhosis (e) neoplastic– hepatocellular carcinoma. Diagnosis of liver disorders with special reference to jaundice and cirrhosis. Liver function tests Gastric function tests, Malabsorption syndrome, acidity, peptic ulcer , colon cancer.

Unit III:

Renal function tests. Diseases of the kidney (acute and chronic renal failure, diabetes insipidus, glomerulo nephritis, nephrotic syndrome,uremic syndrome renal hypertension, renal calculi, renal tubular acidosis). Drugs and toxins associated with kidney. Hemo dialysis and peritoneal dialysis.

Unit IV:

Clinical enzymology – Enzymes in plasma and their origin, general principles of assay Clinical significance of enzymes and isoenzymes. (phosphatases, 5' nucleotidase, γ-glutamyl transferase, amylase, lipase, serum choline esterase, LDH, transaminases and creatine kinase) measurement of serum enzymes in diagnosis.

Unit V:

Clinical aspects of Hyperglycemia Diabetes mellitus, Diabetes insipidus Galactoseuria, glucose tolerance test, oral hypoglycemic drugs Inborn errors of metabolism- Glycogen storage diseases- VonGierke' disease, Pompe's disease, Anderson's disease, Mcardle's disease, Cori's Forbes disease, Diseases related to Amino acid catabolism- tyrosinemia , Phenylketonuria, Maple syrup urine disease, Histidinemia, hyperprolinemia, Diseases associated with nucleotide metabolism Gout, Lesch-Nyhan syndrome. Immunodeficiency disorders.

References:

- **Beckett GJ, Ashby P, Rae P, Walker SW**
  Lecture Notes on Clinical Biochemistry; Blackwell Publishing (2005)
- **Devlin TM**

Text Book of Biochemistry with Clinical Correlations; Wiley-Liss (2005)

- **Swaminathan R**
  Handbook of Clinical Biochemistry; Oxford University Press, USA (2003)

- **Burtis CA and Ashwood ER**
  Tietz Fundamentals of Clinical Chemistry (2001)**;** Saunders (2001)
- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Illustrated Biochemistry**;** McGraw-Hill Medical (2003)
- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Biochemistry; Rodwell McGraw-Hill Publishing Co (2001)

Paper 4 , Core 4

LAB COURSE IN BIOCHEMICAL TECHNIQUES &

CLINICAL BIOCHEMISTRY

1. Determination of optimum pH and temperature of alkaline phosphatase.
2. Determination of specific activity and Km of alkaline phosphatase.
3. Purification of alkaline phosphatase from goat kidney.
4. Checking the purity using SDS-PAGE
5. Separation of isoenzymes of Alkaline Phosphatase
6. Effect of activators and inhibitors on the activity of purified alkaline phosphatase.
7. TLC separation of lipids
8. Fractionation of sub-cellular organelles by differential centrifugation.
9. Assay of marker enzymes of the sub-cellular fractions.
10. Total count, differential count, erythrocyte sedimentation rate, hemoglobin, blood grouping. Estimation of blood glucose, total protein, A/G ratio, cholesterol, triacylglycerol, phospholipids, bilirubin, calcium and Pi.
11. Assay of serum alkaline phosphatase, acid phosphatase, ALT, AST and lactate dehydrogenase in normal and pathological specimens.
12. Renal, liver, thyroid and gastric function tests
13.Clotting time, bleeding time, prothrombin time, PCV, MCH, MCHC, Platelet count.

Paper 5 , Elective 1

HUMAN PHYSIOLOGY

Unit I:

Composition of body fluids. Homeostasis. Plasma proteins and its function. Formed elements:RBC, WBC and Platelets Haemostasis and coagulation of blood, Mechanism of clotting – Clotting factors, clot retraction, fibrinolysis, disorders of clotting. CSF formation, composition and function.

Unit II:

Muscle & NerveMuscle tissue – varieties – voluntary, involuntary and cardiac, structure and functions.Nervous tissue – medullated and non medullated. Structure of Neuron – Classification, functions and properties of nerve fibre. Autonomous nervous system – Sympathetic and Parasympathetic functions, Neurotrasmitters. Mechanism of conduction of nerve impulse. Synapse – Types, properties and functions, synaptic transmission. Functions of hypothalamus.

Unit III:

Chemistry of Respiration and Respiratory Control–Functional Anatomy of Respiratory tract, pulmonary ventilation. Mechanism of ventilation. Surfactant Nature and function. Respiratory membrane and its importance. Transport of gases (O2, CO2)

Unit IV:

Renal Function:Structure and function of nephron, Renal blood flow and its importance, composition of urine, , Functions of tubules, Nerve supply to urinary bladder, Micturition, Water, Electrolyte and Acid base balance.

Unit V

Digestion and Absorption: Composition of saliva, Gastric and Pancreatic Secretion. Composition of Gastric and pancreatic juice, Factors affecting the secretions. Mechanism of secretion.

Liver Structure and function, secretions, composition and secretion of bile, gastrointestinal hormones and their actions, Absorption of carbohydrates, fats and proteins, vitamins, water and electrolytes.

References:

- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Illustrated Biochemistry **;** McGraw-Hill Medical (2003)
- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Biochemistry; Rodwell McGraw-Hill Publishing Co (2001)
- **Guyton AC**
  Textbook of Medical Physiology; Saunders WB (2000)

SEMESTER II

Paper 6, Core 5

IMMUNOLOGY I

Unit I

History and scope of immunology: Innate and acquired immunity – Theories of immunity – Components of immunity – Physical and mechanical factors – Biochemical factors – Cellular factors – Genetic factors – Active and passive immunity – Lysozyme – Interferons – Mononuclear phagocytic systems – Phagocytosis – Natural killer cells – Properdin – Lymphoid organs – Primary lymphoid organs – Thymus – Bone marrow – Lymphatic system. Secondary lymphoid organs – Lymph node, Spleen, Mucosal associated lymphoid tissue and cutaneous associated lymphoid tissue.

Unit II

Cells of the immune system: Introduction – Stem cells – Lymphocytes – B cells, T cells, Macrophages, Null cells, Natural Killer Cells. Eosinophils, Basophils, Neutrophils, Mast cells, Platelets. B-cell and T-cell maturation – Antigen recognition, Processing and Presentation.

Unit III

Antigens: Immunogens – Complete and incomplete antigens – Particulate antigens – Autoantigens – Superantigens – Somatic antigens – Capsular antigens – Properties of antigens – Haptens – Epitopes – B-cell epitope and T-cell epitope – Paratopes. Antigenicity and Immunogenicity – Essential factors for antigenicity – Adjuvant – Freund's incomplete antigen and Freund's complete antigen.

Unit IV

Antibodies: Immunoglobulin – Basic structure of immunoglobulins – Heavy chain, light chain, constant region, variable region, hinge region. Immunoglobulin classes and their properties – antigenic determinants – Isotype, allotype and idiotype. Generation of antibody diversity by gene rearrangement and class switching. Antigen-Antibody interactions: General features, affinity, avidity and cross reactivity. Precipitation – Agglutination – Cytolysis – Complement fixation – Opsonization.

Unit V

Tumor Immunology: Tumors of the immune system – Tumor antigens – Tumor specific antigens and tumor associated antigens – Immune response to tumors – Cancer immunotherapy – Immunodiagnosis of tumors – Cancer vaccines.

References:

- **Delves PJ, Martin S, Burton D, Roitt I**
  Roitt's Essential Immunology ; Blackwell Publishing (2006)
- **Male D, Brostoff J,Roth D Roitt I**
  Immunology ; Mosby (2006)
- **Travers JP, Walport M , Shlomchik MJ**
  Immunobiology: The Immune System in Health and Disease; Garland Science; (2004)

Paper 7, Core 6

METABOLIC REGULATION

Unit I:

Metabolic flux**:** Control of metabolic flux, flux generation, rate determining step in the control of pathway flux, Allosteric control, covalent modification, substrate cycles. Glycolysis & Gluconeogenesis: E.M pathway, PFK Role in Glycolysis, regulation of Glycolysis, Rapaport-Lawnberg cycle, Role of Fructose 2,6 bis phosphate in muscle and Liver. Fate of pyruvate, Gluconeogenesis regulation. Role of inhibitors. Pyruvate dehydrogenase regulation.

Unit II:

Glycogen Metabolism **:**Glycogenesis regulation, cAMP dependent protein kinases. Phosphorylase activation and inactivation. Co-ordinated control of Glycogenesis and Glycogenolysis. HMP Shunt, TCA cycle, G6pD Role in pentose cycle, oxidative-non oxidative phase, HMP regulation, lens metabolism. TCA–Amphibolic nature. TCA and Glyoxalate regulation.

Unit III:

Electron Transport Chain **:**Electron transport and production of ATP. Mitochondrial structure and enzyme distribution. Electron carriers, their redox potential, their sequence, oxidative phosphorylation, regulation, inhibition of oxidative phosphorylation, chemiosmotic theory, mechanism of ATPsynthase reaction, transport of substrates in and out of the mitochondria, uncouplers.

Unit IV:

Fatty acid metabolism**:**Regulation of fatty acid metabolism, Hormonal Regulation. Sites of regulation. Control of cholesterol biosynthesis and transport. LDL-receptor activity and

cholesterol homeostasis. Biosynthesis of Thromboxanes, prostaglandins, Leukotrienes and bile acids.

Unit V:

Nitrogen Metabolism**:** Urea cycle- regulation, role of Gultamate dehydrogenase, purine and pyrimidine - feedback control and recycle by salvage pathway.

Heme Metabolism: Regulation of heme biosynthesis in Erythroid and hepatic tissue.

Integration of metabolism: Metabolic interrelationships among Brain, Adipose tissue, Liver.Integration of carbohydrate, protein and lipid metabolism, metabolism in the well-fed state, metabolism in starvation, diabetes mellitus and injury.

References:

- **Voet D and Voet J**
  Biochemistry ; John Wiley & Sons Inc; (2004)
- **Berg JM, Tymoczko JL, Stryer L**
  Biochemistry; W.H.Freeman & Co Ltd; (2006)
- **Cox M and Nelson DL**
  Lehninger Principles of Biochemistry; Palgrave Macmillan; (2004)
- **Mathews CK and van Holde**
  Biochemistry ; Addison Wesley Longman Publishing Co (2000)

Paper 8 , Core 7

MOLECULAR BIOLOGY OF THE GENE

Unit I:

DNA replication and repair **:**Enzymes of replication, prokaryotic replication mechanisms, the cellular replisome, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS response, eukaryotic repair systems.

Unit II:

Prokaryotic gene expression**:** Transcription – subunits of RNA polymerase, σ factor and promoter recognition, alternative σ factors, *E. coli* promoters, Rho-dependent and independent termination of transcription. Translation – organization of the ribosome, the genetic code, its universality, deciphering the genetic code, wobble hypothesis, activation, initiation, elongation

and termination of translation in *E. coli.* The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis.

Unit III:

Regulation of prokaryotic gene expression**:** The *lac* operon, identification of operator and regulator sequences by mutations, induction and repression, Foot-printing and gel-shift assays for identification of protein-DNA interactions. Catabolite repression. Trp operon – Attenuation,alternative secondary structures of trp mRNA. Regulation of translation by small RNA molecules, Control of lytic development in λ phage.

Unit IV:

Recombination and mobile genetic elements**:** The Holliday model, general recombination in *E. coli*, site-specific recombination, transposons, transposition, phase variation in *Salmonella*, Retroviruses and retroposons.

Unit V:

Cell cycle and growth regulation**:** Cyclins, cyclin – dependent kinases, molecular basis of cell cycle regulation, role of p53 and Rb proteins, checkpoints in cell cycle regulation, Apoptosis – various stimuli and pathways.

Oncogenes and cancer **:** Molecular Mechanisms-Proto-oncogenes, activation of proto-oncogenes, regulation of gene expression by oncoproteins, viral oncogene products, growth factor receptor kinases, components of signal transduction cascade

References:

- **Lewin B:**Genes 8**;** Prentice Hall; International Ed edition (2004)
- **Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R** Molecular Biology of the Gene; Addison Wesley; (2004)
- **Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P :** Essential Cell Biology; Garland Science (2003)
- **Lodish H, Darnell JE:**Molecular Cell Biology; W.H.Freeman & Co Ltd; (2003)

Paper 9 , Core 8

LAB COURSE IN MOLECULAR BIOLOGY

Isolation of plasmid DNA and Genomic DNA, Restriction enzyme cleavage of chromosomal DNA and plasmid DNA

Agarose gel electrophoresis of DNA

Preparation of competent *E. coli* cells, Transformation of plasmid DNA.

SDS-PAGE, Western blotting, Southern blotting ,ELISA

PCR, RT-PCR

Basic BLAST search, Sequence analysis using computer software

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Paper 10 , Elective 2

METABOLIC DISORDERS

Unit I :
Definition and introduction to metabolism
Overview of important metabolic pathways carbohydrate, lipids, protein and nucleic acids

Unit II:
Integration of Metabolism

Unit III:
Alterations in Carbohydrate metabolic pathways in diseases with special reference to diabetes mellitus

Unit IV: Alterations in lipid metabolism: Hyperlipidemia, Atherosclerosis

Unit V: Alterations in Nucleic Acid metabolism-, gout, Lesch-Nyhan syndrome

References:

- **Voet D and Voet J:Biochemistry ;** John Wiley & Sons Inc**; (2004)**
- **Devlin TM :** Text Book of Biochemistry with Clinical Correlations; Wiley-Liss (2005)
- **Murray RK, Granner DK, Mayes PA, Rodwell VW:** Harper's Biochemistry; Rodwell McGraw-Hill Publishing Co (2001)

Paper 11 , Elective 3

ENZYMOLOGY

Unit I:

Active site of an enzyme, Determination of active site, Mechanism of action of enzymes-Serine proteases

Unit II :

Importance of enzymes kinetics, Enzyme kinetics of single – substrate reactions – Michaelis-Menten kinetics, Determination of K_m and V_{Max}, Catalytic efficiency, turnover number, Line-Weaver Burk plot and Eadie-Hofstee plot

Unit III:

Factors influencing enzyme avtivity – effect of pH, temperature, substrate concentration

Unit IV :

Enzyme induction, Enzyme inhibition – Competitive, Uncompetitive and non-Competitive inhibition

Unit V:

Bisubstrate reaction kinetics,Single displacement and double-displacement reactions, allosteric regulation –MWC and KNF models.

References:

- **Palmer T:** Understanding Enzymes; Prentice Hall (2005)
- **Voet D and Voet J:** Biochemistry : John Wiley & Sons Inc; (2004)
- **Berg JM, Tymoczko JL, Stryer L**: Biochemistry; W.H.Freeman & Co Ltd; (2006)
- **Cox M and Nelson DL:** Lehninger Principles of Biochemistry**;** Palgrave Macmillan; (2004)
- **Mathews CK and van Holde:** Biochemistry ; Addison Wesley Longman Publishing Co (2000)

SEMESTER III

Paper 12,Core 9

HORMONAL BIOCHEMISTRY

Unit I:

Hormones – Classification, Biosynthesis, circulation in blood, modification and degradation. Mechanism of hormone action, Target cell concept – Feedback control and regulation. Hormones of Hypothalamus and pituitary – Vasopressin and oxytocin, Hypothalamic releasing factors. Anterior pituitary hormones – actions and feedback regulation of synthesis. Growth promoting, Lactogenic hormones. Glysoprotein hormones, the POMC family, Endorphins.

Unit II:

Pancreatichormones – cell types of the islets of Langerhans. Insulin – structure, Biosynthesis, regulation of secretion, Biological actions and mechanism of action. Glucagon, somatostatin and pancreatic polypeptide. Insulin like growth factors – structure, biological action. Gastrointestinal hormones – secretin, gastrin, cholecystokinin – biological action, regulation of secretion.

Unit III:

Thyroid hormones – synthesis, secretion, transport, biological action, metabolic fate and mechanism of action, regulation. Parathyroid hormone – biological action, regulation of calcium and phosphorus metabolism and the role of calcitonin. Calcitriol – Biosynthesis, transport, functions, mechanism of action.

Unit IV:

Adrenal hormones – Glucocorticoids, mineralocorticoids, synthesis, secretion, transport, metabolism and excretion. Biological effects. Mechanisms of action, adrenal androgens, metabolic effects and functions. Adrenal medulla – Catecholamines, biosynthesis, storage, metabolism, regulate of synthesis. Chemical nature and biological action of prostaglandlins.

Unit V:

Gonadal Hormones – Chemical Nature. Biosynthesis, metabolism and metabolism of action of androgen, estrogen and progesterone. Factors involved in the regulation of gonadal hormone activities. Ovarian cycle. Pregnancy, biochemical changes in pregnancy.

References:

- **Murray RK, Granner DK, Mayes PA, Rodwell VW**

Harper's Illustrated Biochemistry **;** McGraw-Hill Medical (2003)

- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Biochemistry; Rodwell McGraw-Hill Publishing Co (2001)
- **Williams RKH:**Textbook of Endocrinology; W.B.Saunders (2000)
- **Francis & Greenspan, Baxter JD:**Basic and Clinical Endocrinology; Prentice Hall (2002)

Paper 13,Core 10

IMMUNOLOGY II

Unit I

Complement system: Introduction – Salient features of complement – complement components – complement activation – classical pathway, alternative pathway and lectin pathway – formation of membrane attack complex – regulation of complement system – complement fixation – biological functions of complements.

Unit II

Autoimmune diseases: Introduction – pathogenesis – classification – common autoimmune diseases – AIDS – Hashimoto's thyroiditis – Autoimmune hemolytic anemia – Goodpasture's syndrome – Insulin dependent diabetes mellitus – Grave's disease – Myasthenia gravis – Systemic Lupus Erythematosus – Rheumatoid arthritis – Multiple sclerosis. Diagnosis and treatment of autoimmune diseases.

Immunization – active and passive immunization – vaccines – bacterial vaccines – viral vaccines – polysaccharide vaccines – recombinant vaccines – DNA vaccines.

Unit III

Hypersensitivity: factors governing hypersensitivity – types of hypersensitivity – immediate and delayed type hyper sensitivity – methods of detection – common hypersensitivity reactions – anaphylaxis – transfusion reactions – erythroblastosis foetalis – arthus reaction – serum sickness – mantoux reaction – contact dermatitis – graves disease.

Immunity and malnutrition – role of nutrients in immunological disorders.

Unit IV

Major histocompatibility complex: organization and inheritance of the MHC – H-2 complex – HLA complex – functions of MHC.

Transplantation immunology: types of graft – graft versus host rejection – molecules involved in rejection – mechanism of graft rejection – immunosuppressive treatment – prevention of graft rejection.

Unit V

Immunological techniques: Radioimmunoassay – ELISA – immunofluorescence – immunodiffusion – immunoelectrophoresis – western blot – immunoprecipitation – flow cytometry – immunoelectron microscopy – immunohistochemistry. Production of polyclonal and monoclonal antibodies and their applications – Hybridoma technology.

References:

- **Delves PJ, Martin S, Burton D, Roitt I**
  Roitt's Essential Immunology; Blackwell Publishing (2006)
- **Male D, Brostoff J,Roth D Roitt I**
  Immunology; Mosby (2006)
- **Travers JP, Walport M , Shlomchik MJ**
  Immunobiology: The Immune System in Health and Disease; Garland Science; (2004)

Paper 14, Core 11

MICROBIAL APPROACHES TO INDUSTRIAL AND PHARMACEUTICAL BIOCHEMISTRY

Unit I:

Structure of bacteria, fungi and viruses and their classification. Types and characteristics of microorganisms used in Industry (a) Food Industry (b) Chemical Industry (c) Pharmaceutical Industry

Unit II:

Fundamentals and principles of microbial fermentation techniques – application in industry and pharmaceutical Biochemistry. Fermentation – types, techniques, design and operation of fermentors including addition of medium. Types and characteristics of microorganisms, environmental conditions required for the growth and metabolism of industrially and pharmaceutically important microbes. Sterilisation methods in fermentation techniques, air, gas, culture medium sterilisation. Steam-filtration and chemicals. Types and constituents of fermentative culture medium and conditions of fermentations, Antifoaming devices.

Unit III:
Recovery and estimation of products of fermentation, waste treatment in fermentation, sewage, tannery and industrial wastes. Tests for water purity, water borne diseases, fresh and marine microbial flora, effects of pollution, BOD, COD. Production of biofertilizers, soil inoculants, methanogenesis and biogas production**.**

Unit IV
Microbial degradation of products of aerobic and anaerobic growth. Production of ethanol, acetic acid, glycerol, acetone, butanol and citric acid by fermentation. Production of pharmaceuticals by fermentation methods and uses– penincillin, streptomycin, tetracycline, riboflavine, vitamin B12.

Unit- V:
Manufacture of bread, malt beverages, wine, vinegar, pickle, cheese and idli, pressed food and fodder yeast.

References:

- **Matthews K, Montville T:** Food Microbiology: An Introduction :American Society for Microbiology (2004)
- **Bamforth C:**Food, Fermentation and Micro-Organisms :Blackwell Science Ltd (2005)

Paper 15 , Core 12

LAB COURSE IN MICROBIOLOGY

1. Preparation, sterilisation and inoculation methods of media.
2. Maintenance and identification of microbes, biochemical characterization and subculturing techniques.
3. Staining techniques
4. Isolation of microorganisms from air, water and soil samples.
5. Antibiotic sensitivity of microbes, use of antibiotic discs.
6. Microbial production of amylase, protease
7. Microbial production of alcohol and citric acid
8. Production and assay of vitamins – Riboflavin

Paper 16 , Elective 4

EUKARYOTIC GENE EXPRESSION

Unit I:

The eukaryotic genome **:**The chromosome structure – Histones, Nucleosome, chromatin organization,chromatin remodeling, DNAase hypersensitive sites, genome organization – the C-value paradox, repetitive sequences, gene amplification, significance of introns, loops, domains and scaffolds in eukaryotic DNA, telomeres, organelle genomes – mitochondrial and chloroplast genome.

Unit II:

Eukaryotic Transcription**:** Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers. Regulation of eukaryotic transcription – Response elements, DNA-binding motifs, steroid receptors, association of methylation and demethylation with gene expression, molecular mechanism of eukaryotic transcription control.

Unit III:

RNA processing : mRNA 5' cap and poly-adenylation, splicing, spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes-hammerhead ribozyme

Unit IV:

Degradation of mRNA, signal-mediated transfer of mRNA through nuclear pores, RNA editing, regulation of mRNA processing, stability of mRNA, RNA interference mechanisms-siRNA and miRNA

Unit V:

Post-and Co-translational modification of proteins: Comparison of prokaryotic translation with eukaryotic translation Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi Sorting, coated vesicles, retrograde translocation, targeting of mitochondrial and nuclear proteins Protein degradation-Ubiquitination of proteins, Protein folding-chaperones

References:

Lewin B: Genes 8**;** Prentice Hall; International Ed edition (2004)

Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R
Molecular Biology of the Gene; Addison Wesley; (2004)

Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P

Essential Cell Biology; Garland Science (2003)
Lodish H, Darnell JE
Molecular Cell Biology; W.H.Freeman & Co Ltd; (2003)

Paper 17 , Elective 5

SIGNAL TRANSDUCTION

Unit I:
General functions and structure of signaling pathways, Mechanism of intracellular and intercellular signal transduction, Hormone and hormone analogues; Recognition and interaction of hormones with receptors , Signal amplification , regulation of inter and intracellular signaling; Receptor superfamilies and subtypes., intra cellular signaling molecules-secondary messengers; Divergence, convergence and cross talk

Unit II:
Protein kinases and protein phosphatases : Classification, structure protein kinases, ser/ thr protein kinases , Regulation of PKA, PKB, PKC, Ca2+/ calmodulin-dependent protein kinases , Structure and regulation of phosphatases, I,2A,2B,PP2A; subcellular localization.

Unit III:
G- protein coupled signal transduction pathways : Transmembrane Receptors–Structure, Major classes of trimeric G proteins based on Gs unit, mechanism of signal transmission, toxins as tools in characterization of G- protein, GTPase switches, G proteins that regulate ion channels; G-protein and gene control

Unit IV:
Signaling and Gene control: TGF receptors; Cytokine receptors and JAK – STAT; Receptor Tyrosine Kinases(RTK), activation of ras, genetic analysis – drosophila eye development; MAPK; Phosphoinositide cascade, NF-kB; signal induced protein cleavage, Down modulation of receptor signaling.

Unit V:
Nuclear receptors, Principles of signaling by nuclear receptors, Classification and structure of nuclear receptors, Mechanism of transcriptional regulation by nuclear receptors, transactivation .Steroid hormone signaling

References:

Lewin B: Genes 8**;** Prentice Hall; International Ed edition (2004)
Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R
Molecular Biology of the Gene; Addison Wesley; (2004)
Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P
Essential Cell Biology; Garland Science (2003)
Lodish H, Darnell JE
Molecular Cell Biology; W.H.Freeman & Co Ltd; (2003)

SEMESTER IV

Paper 18, Core 13

RECOMBINANT DNA TECHNOLOGY

Unit I:
Basic techniques: Cutting DNA molecules, Restriction digestion, isoschizomers, joining DNA molecules – DNA ligase, double linkers, adaptors, homopolymer tailing, selection of recombinants and screening – genetic methods, immuno chemical methods, South-Western screening, Nucleic acid hybridization methods, synthesis of probes, radio-active and non-radioactive labelling of probes, analysing DNA sequences – Maxam and Gilbert and Sanger's methods, *in silico* sequence analysis, pulsed field gel electrophoresis.

Unit II:
Cloning strategies**:**Cloning vectors – plasmids (pBR 322, pUC 18), phage λ and M 13, cosmids, phasmids, expression vectors, yeast vectors – YEP, YIP, YRP, YCP and YAC, Ti plasmid. Genomic DNA libraries, chromosome walking, cDNA cloning, PCR, Inverse PCR, Hot start PCR, RT-PCR, RACE, RAPD. Site directed mutagenesis of cloned genes.

Unit III:
Introduction of genes into animal cells**:** Reporter genes, selectabe markers, viral vectors – SV 40, Retroviruses and Baculovirus, Adenoviruses, Transferring genes into animal cells in culure, oocytes, eggs, embryos and specific tissues, transgenic animals.

Unit IV:
Agro bacterium – mediated gene transfer to plant cells, microprojectiles, transgenic plant technology – for pest resistance, herbicide tolerance, delay of fruit ripening and use of plants to produce commercially important proteins.

Unit V:
Applications of recombinant DNA technology – gene therapy, antisense therapy, production of insulin in *E. coli*.

References:

- **Brown TA:** Gene Cloning and DNA Analysis ; Blackwell Publishing; (2006)
- **Twyman RM, Primrose SB:** Principles of Gene Manipulation and Genomics **;** Blackwell Publishing; (2006)
- **Old RW, Primrose SB:** An Introduction to Genetic Engineering S.B; Blackwell Science (2003)
- **Sambrook J, Fritsch, EF , Maniatis T:**Molecular Cloning – A Laboratory Manual; Cold Spring Harbor Lab Press , (2005).

----------**Paper 20 Elective 6**

BASICS OF GENE THERAPY

Unit I:
Introduction- What is gene therapy, why gene therapy, Ethical issues in gene therapy, Prospects of gene therapy.

Unit II :
Basic process, types of gene therapy, somatic cell gene therapy - in vitro, in vivo, in situ gene therapy.

Unit III :
Vectors in Gene therapy – Viruses, General advantages and disadvantages of viral vectors. Retroviruses, Adeno virus, Adenoassociated virus. Production of safe viral vectors, Non- Viral vectors – Liposomes – cationic and anionic liposomes. Advantages and drawbacks of Non- viral vectors.

Unit IV:
Antisense therapy, RNA interference – SiRNA, MiRNA., Spiceosome mediated RNA trans spilicing. Transposon mediated vectors.

Unit V:
Applications of Gene therapy for ADA-SCID, X-Linked SCID, Familial Hyper cholesterolemia, Suicide gene therapy for cancer, Case studies –Ashanthia de Silva and Jesse Gelsinger.

References:

- **Brown TA:** Gene Cloning and DNA Analysis ; Blackwell Publishing; (2006)
- **Twyman RM, Primrose SB:** Principles of Gene Manipulation and Genomics **;** Blackwell Publishing; (2006)
- **Old RW, Primrose SB:** An Introduction to Genetic Engineering S.B; Blackwell Science (2003)

Paper 21, Elective 7

EXPERIMENTAL INDUCTION AND DIAGNOSIS OF DISEASES

Unit I :
Selection of animal model, routes of administration of drugs, experimental set up – Drug standardization, LD 50, ED 50 determination

Unit II:
Induction of liver disease, jaundice, viral and toxic hepatitis, cirrhosis, diagnosis of liver diseases, liver enzymes, serum bilirubin

Unit III:,
Plasma proteins, proteins in other body fluids, , digestive enzymes, digestive enzymes of pancreatic origin, Non-protein nitrogen metabolites, glycated proteins

Unit IV:
Induction of diabetes, Diabetes mellitus, diagnosis of diabetes, hypoglycemia
Proteinuria, acute and chronic renal failure, glomerular diseases–glomerulo nephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease,

Unit V:
Induction of cardiovascular diseases, Lipids and lipoproteins in coronary heart disease, cardiac enzymes, diagnosis of cardiac disease, C-reactive protein, homocysteine

References:

- **Beckett GJ, Ashby P, Rae P, Walker SW**
  Lecture Notes on Clinical Biochemistry; Blackwell Publishing (2005)
- **Devlin TM**
  Text Book of Biochemistry with Clinical Correlations; Wiley-Liss (2005)
- **Swaminathan R**
  Handbook of Clinical Biochemistry ;Oxford University Press, USA (2003)
- **Burtis CA and Ashwood ER**
  Tietz Fundamentals of Clinical Chemistry (2001)**;**Saunders (2001)
- **Murray RK, Granner DK, Mayes PA, Rodwell VW**
  Harper's Illustrated Biochemistry **;** McGraw-Hill Medical (2003)
