

TYB Sc.
Bio-chemistry

UNIVERSITY OF MUMBAI

No. UG/204 of 2010

CIRCULAR :-

A reference is invited to the Ordinances, Regulations and syllabubs relating to the Bachelor of Science (T.Y.B.Sc.) degree course vide office Circular No.UG/249 of 2008 dated 16th June, 2008 and the Principals of the affiliated Colleges in Science are hereby informed that the recommendation made by the Board of Studies in Bio-chemistry at its meeting held on 6th April, 2010 has been accepted by the Academic Council at its meeting held 10th June, 2010 vide item No.4.26 and that, in accordance therewith, the syllabus for the T.Y.B.Sc. (6 units) in the subject of Biochemistry is revised as per Appendix and that the same has been brought into force with effect from the academic year 2010-2011.

MUMBAI-400 032

21st July, 2010

L. R. Mane
Offg Registrar

To,

The Principals of the affiliated Colleges in Science.

A.C./4.26/10/06/2010

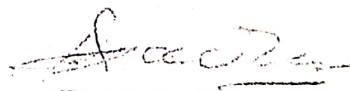
No. UG/204 -A of 2010,

MUMBAI-400 032

21st July, 2010

Copy forwarded with compliment : for information to:-

- 1) The Dean, Faculty of Science,
- 2) The Chairperson, Board of Studies in Bio-chemistry,
- 3) The Controller of Examinations,
- 4) The Co-Ordinator, University Computerization Centre,


(D. N. Jadhav)
Ag. Deputy Registrar
(UG/PG Section)

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Executive Secretary to the Vice-Chancellor, the Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanaagari (copies), the Deputy Registrar, Affiliation Section (2 copies), the Professor-cum- Director, Institute of Distance Education, (10 copies) the Director University Computerization Centre, separate Action :-



10.06.2010

UNIVERSITY OF MUMBAI



Revised Scheme and Syllabus

for the T. Y. B. Sc. (6-Unit) in Biochemistry

(with effect from the academic year 2010 - 2011)

**Revised Syllabus for T.Y.B.Sc. in
Biochemistry (6 unit)**
(with effect from the academic year 2010-2011)

T.Y.B.Sc. – BIOCHEMISTRY (6 units)			
Paper I			
First term			
Unit No	Topic No	Topics	NOS
I	1.0	Carbohydrate metabolism	25
	1.1.1	Catabolism – Cellular location, Sequence of reactions, Labelling of Carbon atoms, and energetics of : Glycolysis (aerobic and anaerobic) ; Oxidation of pyruvate ,Krebs cycle ; Glyoxylate pathway; Glycogenolysis – [schematic – no structures, but with enzymes and coenzymes]	7
	1.1.2	Anabolism – HMP shunt (Cellular location, sequence of reactions, multifunctional nature) ; Gluconeogenesis, Glycogenesis – [schematic – no structures, but with enzymes and coenzymes]	5
	1.2.1	Bioenergetics : Concept of free energy ; Respiratory electron transport chain – Carriers [basic chemistry, redox potentials, orientation on the membrane, sequence}; Q cycle in Complex III ; Inhibitors of electron transport – Antimycin A , Amytal, Rotenone, CN, Azide, CO ; Malate-Aspartate shuttle and Glycerol phosphate shuttle	5
	1.2.2	Oxidative phosphorylation –Chemiosmotic hypothesis, Proton motive force; Structure of ATP synthase , Uncoupler- of ETC and Oxidative phosphorylation [DNP]	4
	1.3	Photosynthesis – Light and dark reactions, Z scheme and electron carriers, photophosphorylation [linear and cyclic]; Calvin cycle – schematic with enzymes	4
II	2.0	Lipid metabolism ; Protein and Amino acid metabolism ; Endocrinology	25
	2.1.1	<i>Lipid metabolism –</i> , Catabolism - Knoop's experiment ; Beta oxidation of even carbon saturated fatty acids (C4 to C20) Energetics of fatty acid oxidation .	5
	2.1.2	Anabolism – Fatty acid biosynthesis (palmitic acid) , Ketone body formation, utilization, and the physiological significance of Ketone bodies in Diabetes mellitus, Starvation, Pregnancy and Alcoholism.	5

II	2.2.1	<i>Amino acid and protein metabolism –</i> Reactions of amino acids – Transamination [GOT/GPT and mechanism of transamination] ; Decarboxylation [His, Trp, Glu, and mechanism of decarboxylation] , Deamination [oxidative – NAD(P) linked dehydrogenases and D & L - Amino acid oxidases, Non oxidative – Asp, Cys, Ser]	7
	2.2.2	Urea cycle – Cellular location, sequence of reactions, Labeling of N atom, transport of NH ₃	2
	2.3.1	<i>Endocrinology :</i> Chemistry, synthesis , secretion and physiological effects of Thyroxine and Insulin [synthesis from preproinsulin], Diabetes mellitus , Hypothyroidism [cretinism and myxedema], Hyperthyroidism [goiter – simple & toxic] Physiological role of Glucocorticoids, Oxytocin and ADH	5
	2.2.2	Mode of action of steroid hormones, Effect of epinephrine on glycogen synthesis and breakdown [amplification cascade with G proteins, cAMP, adenylate cyclase, kinases]	3
	3.1	Vitamins & Coenzymes; Buffers and Chromatography	25
III	3.1	<i>Vitamins and Coenzymes :</i>	5
	3.1.1	Water soluble vitamins –Thiamin, Riboflavin, Niacin, Pyridoxine, Biotin, Lipoic acid :- Chemistry of the Vitamin and its coenzyme form [structure not to be done, only group involved in its activity] and one biochemical role;	
	3.1.2	Fat soluble vitamins A,D,E,K :- Vitamin A – Chemistry, Wald's Visual cycle and role of Rhodopsin (with structure), Transducin, cGMP in vision ; Vitamin D – role in Ca absorption and mobilization; Vit E and Vit K– physiological role (Vits D,E,K no structures)	
	3.2	<i>pH and Buffers</i>	8
	3.2.1	Derivation of Hendersen- Hasselbalch equation ; Numericals	
	3.2.2	Ionization of Gly, Asp, Lys (pKa values required)	
	3.2.3	Titration curve of Glycine , Valine and Lysine	
	3.2.4	Derivation of the relationship between pI, pKa1 and pKa2 for Glycine	
	3.2.5	pH meter and Glass electrode	
	3.3	Chromatography	10
	3.3.1	Principle, Technique and Applications of the following kinds of chromatography : Partition chromatography (Paper), Adsorption Chromatography (TLC and column); Ion exchange chromatography and Gel filtration	2
	3.3.2	Principles of GLC, HPLC, Affinity chromatography	

IV	4.0	Centrifugation ; Electrophoresis and Spectroscopy	25
	4.1	<i>Centrifugation :</i>	
	4.1.1	RCF , RPM and derivation of an equation relating the two ; Nomogram ; Sedimentation coefficient	8
	4.1.2	Types and applications of centrifuges – Clinical, High speed, Ultra centrifuge - preparative and analytical.	
	4.1.3	Types of centrifugation and its applications– Differential, Rate zonal, Isopycnic (Centrifugation with and without density gradients)	
	4.2.	<i>Electrophoresis ;</i>	
	4.2.1	Principle ; Factors affecting the rate of migration of sample in an electric field	10
	4.2.2	Supporting media – paper, cellulose acetate, agar, agarose and polyacrylamide	
	4.2.3	Discontinuous electrophoresis – Native PAGE	
	4.2.4	Applications of electrophoresis - Separation of proteins and Nucleic acids with one staining method for each; molecular weight determination	
	4.3	<i>Spectroscopy :</i>	
	4.3.1.	Beer-Lambert law, derivation , limitations, application – estimation of sugar(DNSA) and protein(Biuret); concepts of Lambda max; determination of molar extinction coefficient	7
	4.3.2	Construction and working of a simple colorimeter and spectrophotometer	
	4.3.3	Applications of Beer-Lambert law in the estimation of sugar[DNSA] and protein[Biuret]	
	4.3.4	Numericals based on the above concepts	

T.Y.B.Sc. – BIOCHEMISTRY (6 units)
Paper II

First term

Unit No	Topic No	Topics	NOS
I	1.0	Air	25
	1.1	Atmosphere	5
	1.1.1	Composition and structure of atmosphere	
	1.1.2	Particles , ions and radicals in the atmosphere	
	1.1.3	Chemical and photochemical reactions in the atmosphere [reactions of oxygen, ozone, sulphur dioxide , nitrogen oxide and organic compounds]	
	1.2	Air pollution	6
	1.2.1	Air Pollutants – CO, Oxides of Nitrogen, SO ₂ , hydrocarbons and photochemical smog, Green house gases, suspended particulate matter[sources and effect of] , depletion of ozone	
	1.3	Water	2
	1.3.1	Hydrosphere- characteristics and the water cycle	
	1.3.2	Water Pollution Organic pollutants[pesticides, insecticides, detergents,oil spills, toxic organic chemicals] Inorganic pollutants [heavy metals – Hg, Pb, As, Cd] Thermal pollution of water	7
	1.3.3	Water treatment -: Criteria for water purity, Water purification [preliminary, primary, secondary, tertiary- chlorination, ion exchange]	5
II	2.0	Soil & Noise Pollution and Industrial Pollutants and Environmental Monitoring	25
	2.1	<i>Noise and its measurement</i> Classification of Noise Causes and consequences of Noise pollution	5
	2.2	<i>Soil</i> Composition of soil, Nitrogen cycle Types of soil pollution – Acidification, Agrochemical pollution, Salinization, and contamination by metalliferous wastes	5
	2.3	<i>Energy</i> Conventional Sources : Coal, Coke, Natural gas (CNG), Petroleum products (Petrol, Diesel, Kerosene, Oils, Naphtha) Non Conventional Sources : Solar , Geothermal, Tidal, Hydroelectric power, Nuclear energy, Biofuels , Natural gas (Synthetic Natural Gas)	5

	2.4	<i>Industrial pollutants</i> (Sources and remedial measures) Polymers and Plastics Asbestos Poly Chlorinated Biphenyls Mining – Acid mine drainage	5
	2.5	<i>Environmental monitoring</i> Approaches used to monitor the environment-air, water and soil. [Principles and Significance only. Protocols for each factor – not required] Remote Sensing	5

III	3.0	Nutrition	25
	3.1	Principles of nutrition	7
	3.1.1	Nutrients[Proximate principles, vitamins and minerals(macro and micro- role of Ca, Mg, Na, K and Fe, Zn)] , dietary fibre.	
	3.1.2	Nutritional status [malnutrition (protein energy and protein calorie) and over nutrition]	
	3.1.3	Balanced diet	
	3.2.1	Energy Assessment - RQ, BMR ;	8
	3.2.2	Anthropometry – BMI, Waist:hip ratio ;	
	3.2.3	Protein quality indices : Chemical score of Amino Acids, Protein Deficiency Corrected Amino Acid Score, Net Protein utilization	
	3.3	Dietary Management in :- Obesity, Diabetes Mellitus, Hypertension, Peptic ulcer , Obstructive Jaundice	10
IV	4.0	Pharmacology	25
	4.1	<i>General pharmacology</i>	2
	4.1.1	Pharmacodynamics, Physicochemical properties of drugs, Drug absorption : through-GIT, pulmonary, renal, placental and blood-brain barrier	
	4.1.2	Bioavailability and Bioequivalence	2
	4.1.3	Drug Distribution, Metabolism and Excretion	2
	4.1.4	Mechanism of action of drugs : i. Specific interaction – receptor mediated ii. Partially specific – drugs via enzymes iii. Non specific interactions – antimetabolites and antiseptics iv. Through Antibodies v. Placebo effects	4
	4.2	<i>Bioassays</i> : Preclinical and clinical evaluation, Therapeutic drug monitoring	3
	4.3	<i>Pharmacokinetics</i> : LD ₅₀ , ED ₅₀ , Half Life , Loading dose, Maintenance dose, Therapeutic dose, Therapeutic Index, Drug plasma concentration, Volume of distribution, Clearance	2

4.4	Therapeutic drugs : (Mechanism of action and adverse effects)	10
4.4.1	Anti inflammatory – non steroid anti inflammatory NSAID [Ibuprofen], Salicylates – [Aspirins]	
4.4.2	Cardiovascular drugs- CVS [Ca channel blocker-Amlodipine, and Beta blocker – Propranolol]	
4.4.3	Antibiotic – Penicillin and Sulphonamide	
4.4.4	Antacid- Proton pump blocker –Omeprazole	

GENETICS, BIOSTATICSTICS AND BIOINFORMATICS

Unit No.	No	Contents	NOL
I	1.1	Genetics : Replication of DNA (in prokaryotes) - Models of DNA replication : Semi-conservative, Dispersive & Conservative; Modes of DNA replication: Theta & rolling circle; Enzymes (pol I, II and III) and accessory proteins; Mechanism of semi-conservative replication;	7
	1.2	<i>DNA repair:</i> Direct, Photoreactivation, O6 methyl guanine, DNA methyl transferase, Excision repair, Mismatch repair, Recombination repair, SOS-error prone repair	4
	1.3	Transcription - in prokaryotes, prokaryotic RNA polymerase and promoter; Mechanism of RNA transcription: Initiation, elongation and termination; Processing of tRNA , rRNA, mRNA (prokaryotes and eukaryotes)- concept of split genes, Reverse transcription. Role of Inhibitor- Rifampicin , Actinomycin D	7
	1.4	Translation (protein biosynthesis) in prokaryotes – Genetic code, Mechanism of translation: Activation of amino acids, chain initiation, elongation & termination: Post translational modifications of proteins Role of Inhibitor- Puromycin	7
II	2.0	Recombinant DNA Technology (RDT)	25
	2.1	Basics of DNA cloning: Tools for RDT (a) Enzymes- Restriction endonucleases, ligases, terminal transferases, reverse transcriptase: (b) Cloning and Expression Vectors- Plasmid, pBR 322, PUC-19, Bacteriophage – Lambda phage;; Cosmid; Artificial Chromosomes(BAC and YAC); Shuttle vectors; (c) Probes- DNA probes	12
	2.2	RDT	13
		Isolation of gene: Gene library and c-DNA library; Southern blot; Chimeric DNA Gene Transfer: Transformation, Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief) Selection and screening- Antibiotic and colony hybridization DNA Amplification by PCR Applications of RDT- Agriculture (Bt Cotton); Medicine (Insulin); GM food	

	3.0	BIOSTATISTICS DESCRIPTIVE STATISTICS AND PROBABILITY	25
	3.1	Introduction: scope and applications of biostatistics	15
	3.1.1	Common statistical terms: Sources, nature and presentation of data; Measurement and scales of measurement	
	3.1.2	Descriptive statistics: Measures of central tendency- Mean, Median and mode	
	3.1.3	Measures of dispersion- Range, percentiles, variance, SD, Mean deviation,	
	3.2	Probability:	10
	3.2.1	Concept of probability: definition Probability distribution: normal distribution and normal curve, Asymmetric distribution	
	3.2.2	Statistical problems based on the above concepts	
		HYPOTHESIS TESTING AND BIOINFORMATICS	25
	4.0	Hypothesis testing- Introduction; Single population mean, difference between population means	20
	4.1	Type I and Type II errors,	
	4.1.1	One-tailed and two tailed tests	
	4.1.2	Z-test	
	4.1.3	t-test- Paired and unpaired	
	4.1.4	Chi-square	
	4.1.5	Statistical problems based on the above concepts	
	4.2		
	4.2.1	Bioinformatics:	05
	4.2.2	Definition, Aims and History of Bioinformatics Applications of Bioinformatics in – Sequence analysis, Molecular modeling and drug designing, Phylogeny/evolution, Ecology & population studies, Medical informatics and agriculture.	
	4.2.3	Introduction to Genomics and Proteomics	
	4.2.4	Databases- Definition & types – Public domain database, Sequence database, Structural database, Motif database, Genome database, Proteom database, Annotated, sequence database. Full form & function in brief of - GenBank, EMBL, PIR, SWISS PROT, PDB, GDB.	
	4.2.5	Sequence analysis Tools - Explain the following terms in brief - BLAST, FASTA, L-ALIGN, CLUSTAL- X & W, RASMOL,	
	4.2.6	Software for protein sequencing - PROPECT , AMMP, COPIA (Explanation of the terms in brief) Micro-array analysis-concept and applications	

T.Y.B.Sc. – BIOCHEMISTRY (6 units)

Paper IV

First term

Unit No	Topic No	Topics	NOS
I	1.0	Human immune system, Antibodies, & Antigen-Antibody reactions.	25
	1.1.1	Innate immunity – Anatomical barriers, physiological barriers, Characteristics of Inflammation, phagocytosis [no mechanism] Adaptive immunity – Active & Passive Humoral & Cell mediated immunity	5
	1.1.2	<i>Organs of the immune system :</i> Primary lymphoid organs: Thymus, Bone marrow Secondary lymphoid organs : Lymphatic system, Lymph nodes, Spleen, MALT.	3
	1.1.3	Cells of the immune system: Lymphocytes – B cells and T cells , Natural killer cells -Mononuclear phagocytes, Granulocytes, Antigen presenting cells. Clonal selection & immunologic memory. Cytokines : biological functions of IL1 , Tumor necrosis factor-alpha, interferon –alpha, IL2, interferon-gamma.	7
	1.2.1	Antigens: Antigenecity, immunogenecity, epitope, factors determining immunogenecity, Haptens. Antibodies : Fine structure of immunoglobulin, Antibody-mediated functions, Antibody classes, Monoclonal antibodies.	5
	1.2.2	<i>Antibody diversity:</i> Multigene organization of immunoglobulin genes – Lambda , kappa & heavy chain Light chain DNA – VJ rearrangements Heavy chain DNA - VDJ rearrangements	5
II	2.0	Antigen- Antibody interactions ,Complement system, Major histocompatibility complex & Immunological tolerance.	25
	2.1	Antigen- Antibody interactions :	8
	2.1.1	Forces involved, antibody affinity, antibody avidity.	
	2.1.2	Precipitation reactions – Oudins, Ouchterlony	
	2.1.3	Agglutination reactions : Blood typing, bacterial agglutination, Passive agglutination, agglutination inhibition, Coomb's test. Immunoelectrophoresis ;	
	2.1.4	Principles of Radioimmunoassay, ELISA, Immunofluorescence	
	2.1.5		
	2.2	<i>Complement</i>	5
	2.2.1	Components of complement;	
	2.2.2	Complement activation – Classical & alternate pathway ; formation of membrane attack complex.	

	2.2.3	Biological consequences of complement activation.[in brief]	
	2.3	<i>Major histocompatibility complex :</i>	6
	2.3.1	MHC polymorphism & organization of MHC genes- class I & class II ; Cellular distribution & structure of class I & II molecules ; Self MHC restriction of Tcells.	
	2.3.2	Role of antigen presenting cells.	
	2.4	<i>Transplant immunology:</i> Types of transplant ; immunological basis of allograft rejection.	3
	2.5	<i>Autoimmunity :</i> Organ specific –Myasthenia gravis , Systemic – Rheumatoid arthritis (immunological basis of these autoimmune diseases)	3

1II	3.0	Pathophysiology and Biochemistry of diseases	25
	3.1	<i>Metabolic disorders and ageing:</i> Inborn error: With respect to Etiology and Clinical manifestations Carbohydrate Metabolism: Glycogen storage disease Type 1. Protein Metabolism: Albinism. Lipid Metabolism: Tay Sach's disease.	4
	3.2	<i>Endocrine diseases:</i> Diabetes mellitus. Diabetes insipidus.	2
	3.3	<i>Blood related diseases:</i> Iron deficiency anemia. Sickle cell anemia. Thalassemia.	4
	3.4	<i>Cardio Vascular System and related diseases:</i> Atherosclerosis.	1
	3.5	<i>Ageing:</i> Definition of ageing. Molecular changes during ageing. Theories of Ageing.	3
	3.6	<i>Alzheimer's disease</i>	

	4.0	Virology and Cancer	
	4.1	<i>Virology and AIDS</i>	
	4.1.1	General Structure of Virus	
	4.1.2	<i>Structure and mechanism of replication in:</i> 1. Vaccinia 2. Polio 3. Influenza	

4.1.3	AIDS: Structure and genetics basis of AIDS virus. Replication of AIDS Virus. Symptoms and Causes of AIDS. AIDS Therapy.	
4.2 4.2.1 4.2.2 4.2.3 4.2.4 4.2.5 4.2.6	Cancer: Biology of Cancer. Physiology of Cancer cells. Carcinogens: Types (Physical, Chemical and Biological): Environmental Factor. Cause of cancer. Genetics of cancer with ref. to p53 and oncogenes. Cancer therapy (Chemo – purine, pyrimide and folate analogs)	8

Practicals - Paper I

1. Estimation of lactose by Cole's ferrieyanide method
2. Estimation of glucose by Benedict's method.
3. Estimation of Ascorbic acid Iodometrically
4. Estimation of glucose Iodometrically
5. Separation of amino acids by circular paper chromatography
6. Separation of sugars by circular paper chromatography
7. Determination of the optimum pH of β -Amylase.
8. Determination of K_m of β -Amylase from sweet potato..
9. Determination of the activity and specific activity of β -Amylase from sweet potato.
10. Effect of an inhibitor (eg. EDTA) on Amylase activity.
11. Determination of the optimum pH of Acid phosphatase / Urease.
12. Determination of the K_m of Acid phosphatase / Urease.

Demonstration Experiments

Separation of plant pigments/ Oils by Thin Layer Chromatography

Separation of plant pigments by adsorption column chromatography (eg. Silica/Alumina)

Practicals – Paper II

1. Estimation of lead by the EDTA method.
2. Estimation of copper.
3. Determination of salinity of / chlorides in water - Silver nitrate method
4. Estimation of Fluoride in water by the Alizarin red method
5. Determination of the Chemical Oxygen Demand of Water/Effluent by the Potassium dichromate method
6. Determination of the Dissolved Oxygen content of Water/Effluent by the Winkler's Iodometric method - Azide modification.
7. Determination of the Biological Oxygen Demand of water/Effluent
8. Determination of the Acidity and alkalinity of water/ Effluent.
9. Determination of the pH of water/effluent/soil using a pH meter.
10. Determination of the conductance of water / Effluent.
11. Estimation of CaCO_3 of soil - Bromothymol Blue method
12. Estimation of Organic content of soil –Diphenylamine method
13. Monograph of acetyl salicylate (identification, assay and purity as per IP)
14. Monograph of Sucrose (Identification, Assay and purity as per IP)

Practicals – Paper III

1. Detection of Ca^{+2} and Mg^{+2} ions in by the Eriochrome Black T-EDTA method.
2. Estimation of phosphorus by Fiske and Subbarow method
3. Estimation of Iron by Wong's method.
4. Estimation of glucose by DNSA method.
5. Estimation of glucose by the Folin Wu method.
6. Estimation of protein by the Folin-Lowry method.
7. Determination of the Hemoglobin content by the Sahli's hemoglobinometer.
8. Determination of Blood groups.
9. Immunoprecipitation reaction of Antigen and Antibody.
10. Diagnostic test for Typhoid - Widal Qualitative
11. Diagnostic test for Typhoid - Widal Quantitative

Demonstration Experiment

1. Separation of serum proteins by PAGE

Practicals – Paper IV

1. Isolation and Spooling of DNA from Onion / Moong
2. Isolation of RNA from Yeast / Liver
3. Isolation of Casein from milk.
4. Isolation of Starch from Sweet Potato.
5. Extraction of lipid from oil seeds by the cold percolation method.
6. Estimation of DNA by the Diphenylamine method
7. Estimation of RNA by the Orcinol method. :
8. Biostatistics – Problems.

Demonstration Experiment

1. Isolation of plasmids
2. Agarose gel electrophoresis - Chromosomal DNA and Plasmid DNA

Examination : (Provisional Scheme for exams)

Theory:

1. Each paper shall consist of 5 questions, each of 20 marks.
2. Question 1 in each paper, will comprise of objective-type sub questions from all four units of that paper.
3. Questions 2, 3, 4 and 5 shall comprise of questions from Units 1, 2, 3 and 4 respectively.
4. Choice for each question shall be internal.
5. Maximum marks for a single undivided sub-question shall not exceed 10.
6. Each paper shall be for 3 hours and 100 marks.

Practicals: (Provisional Scheme for exams)

Day 1:

- | | |
|---|----|
| 1. Volumetric [Paper I]-- Student to prepare one solution | 15 |
| 2. Chromatography - Circular paper- amino acids/sugars | 10 |
| 3. Enzyme pH / K_M | 15 |
| 4. Enzyme - Specific activity /Inhibitor | 5 |
| 5. Spots | 10 |
| 6. Biostatistic problems | 20 |

Total : **75**

Day 2:

- | | |
|--|-----------|
| 1. Colorimetry / pH and Conductance determination | 15 |
| 2. Volumetric (soil - CaCO_3 / water - acidity, alkalinity, salinity, chlorides, analysis) | 10 |
| 3. Monograph | 15 |
| 4. Immunology - (Blood groups or Widal qualitative) + Hb / Immunoprecipitation / Widal quantitative | 15 |
| 5. Viva | 20 |
| Total : | 65 |

Day 3:

- | | |
|--|-----------|
| 1. Mineral estimation -Volumetric / Colorimetry | 10 |
| 2. Colorimetric estimation (Glucose / Protein /DNA/RNA) | 10 |
| 3. Isolation of DNA /RNA /Starch /Casein / Extraction of oil | 10 |
| 4. Assignment | 10 |
| 5. Journal | 20 |
| Total : | 60 |

