UNIVERSITY OF MUMBAI
No.UG/ 266 of 2007.

CIRCULAR :-

A reference is invited to the scheme of papers at the Bachelor of Science (B.Sc.) degree course under the revised pattern **vide** this office Circular No.UG/11 of 2001 dated 9th January, 2001 and the Principals of the affiliated colleges in Science are hereby informed that the recommendation made by the Board of Studies in Biochemistry at its meeting held on 16th March, 2007 has been accepted by the Academic Council at its meeting held on 13th April, 2007 **vide** item No.4.32 and that in accordance therewith, the syllabus in the subject of Biochemistry at the T.Y.B.Sc. (3 Units Interdisciplinary subject) (Theory and Practicals) examination is revised as per **Appendix** and that the same has been brought into force with effect from the academic year 2007-2008.

MUMBAI-400 032
11th June, 2007

for I/c REGISTRAR

To,

The Principals of the affiliated colleges in Science

A.C/4.32/13.04.2007

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No.UG/266 -A of 2007 MUMBAI-400 032, 11th June, 2007

Copy forwarded with compliments to :-

1) The Dean, Faculty of Science
2) The Chairman, Board of Studies in Biochemistry.

for I/c REGISTRAR

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 Personal Assistant to the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information .

The Officer on Special Duty and Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education,(10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar,(PRO) , the Assistant Registrar, Academic Authorities Unit (2 copies)and the Assistant Registrar, Executive Authorities Unit (2 copies) . They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that no separate Action Taken Report will be sent in this connection.

Constituent Colleges Unit (2)

Enclosure to item. No. 442

13/4/07

UNIVERSITY OF MUMBAI

Revised syllabus in the subject of

BIOCHEMISTRY

(3 Units – Interdisciplinary Subject)

at the

T.Y.B.Sc. Examination

(With effect from the academic year 2007-2008)

T.Y.B.Sc. – BIOCHEMISTRY
3 – UNITS INTERDISCIPLINARY SUBJECT

PAPER - 1 : BIO-ORGANIC AND BIOPHYSICAL CHEMISTRY
(MARKS 100)

SECTION I : BIO-ORGANIC CHEMISTRY (MARKS 50)

Unit No.	Topic No.	Contents	* NOL
I	1.0	**Amino acids and Proteins :-**	10
	1.1	Classification of amino acids based on the polarity of R-groups(structure of 20 amino acids)	
	1.2	Chemical reactions of amino acids with following reagents – Ninhydrin, Sanger's, Edman's ,Dansyl chloride. Cleavage of polypeptide- Trypsin, Chymotrypsin, Pepsin, Aminopeptidase, Carboxypeptidase, (S-S bond- Mercaptoethanol).	
	1.3	Proteins.: ASBC-APS Classification on the basis of shape and function. Formation and characteristic of peptide bond.	
	1.4	Primary structure, Secondary structure-alpha helix and beta sheet Tertiary structure - myoglobin, Quaternary structure - hemoglobin.	
	1.5	Forces stabilizing protein structure	
	1. 6	Protein denaturation	
II	2.0	**Enzymes and Vitamins :-**	10
	2.1	Definition - Enzyme, Apoenzyme, Holoenzyme, Prosthetic group, active site, enzyme specificity, Turnover number, Specific activity, Katal, IU, Coenzyme, Cofactor, Allosteric enzymes. (Only definition)	
	2.2	IUB/EC Classification (up to one digit)	
	2.3	Factors affecting enzyme reaction - substrate, pH and temperature.	
	2.4	Enzyme kinetics-Derivation of Michaelis-Menten equation and Lineweaver-Burk plot for monosubstrate reaction and numerical problems based on them.	

* NOL - Number of Lectures

	2.6	Enzyme inhibition - Reversible and Irreversible -Competitive and Non-competitive	
III	3.0	**Carbohydrates :-**	10
	3.1	Monosaccharides –Definition and classification of carbohydrates (mono, oligo & poly), classification of monosaccharides in terms of – A) aldoses and ketoses. B) Number of carbon atoms. Reactions of monosaccharides – 1) Oxidation to produce aldonic, aldaric and Uronic acid (only w.r.t glucose) , 2) Osazone (only w.r.t glucose and fructose) , 3) Reducing action of sugar in boiling alkaline medium (enediol formation) - only w.r.t glucose and fructose, 4) Orcinol (for ribose)	
	3.2	Dissacarides - Occurrence and structure of maltose, lactose, sucrose	
	3.3	Polysaccharides- Classification based on function (storage & structural) , composition (homo & hetero) giving examples. Storage polysaccharrides (Starch and Glycogen), action of amylase on starch.	
	3.4	Structural polysaccharides - Cellulose, Chitin and Peptidoglycan frame work. (With structures of NAG & NAMA)	
	3.5	Extracellular matrix proteoglcan - Hylaruonate, Chondroitin sulphate and Heparin (function and structure).	
IV	4.0	**Lipid**	10
	4.1	Definition and Bloor's Classification of lipids.	
	4.2	Fatty acids & TAG : Saturated fatty acids – definition, classification of C2 and C20 (only even C chain fatty acids) Unsaturated fatty acids – MUFA, PUFA (2,3,4 db), Omega3, Omega6 and Omega9 fatty acids. Triacylglycerol - Simple and mixed	
	4.3	Chemical reactions - Saponification, Iodination, Ozonolysis, Auto-oxidation. Phospholipases ,action of heat on glycerol and choline, Rancidity of fats. Definition and significance - Acid Number, Saponification Number, Iodine Number and Reichert-Meissel Number.	
	4.4	Compound lipids – Structure and function of Glycerophospholipids (Cephalin,Lecithin and Phosphotidyl inositol), Phosphosphingolipids	

		(ceramide,Sphingomyeline), Glycolipids or Cerebrocides (Galacto and Glucocerebrocides).	
	4.5	Steroids and Lipoproteins Steroids - Cholesterol structure and biochemical significance Lipoproteins –Types (Chylomicron, VLDL, LDL, HDL) and biochemical significance - Schematic depiction of interrelationship.	
V	5.0	**Nucleic Acids and Minerals :-**	10
	5.1	Structure of purine and pyrimidine bases, ribose,deoxyribose, nucleosides and nucleotides.cAMP and formation of polynucleotide strand with its shorthand representation.	
	5.2	RNAs- (various type in pro and eu-karyotes) rRNA, t-RNA(Clover – leaf model), m-RNA (general account) and action of alkali on RNA	
	5.3	DNA-X-ray diffraction pattern (Physical evidence), Chargaff's rules (Chemical evidence), Watson –Crick model of DNA and its characteristic features.	
	5.4	Physical properties of DNA - Ionisation, Viscosity, Buoyant density, UV absorption and Hypochromism, Hyperchromism, Denaturation of DNA, Tm.	

SECTION II : BIOPHYSICAL CHEMISTRY (MARKS 50)

Unit No.	Topic No.	Contents	NOL
VI	6.0	**Acids, Bases, Buffers and Ionic Equilibria:-**	05
	6.1	Definition - pH, pK, Kw, Isoelectric pH, buffer, buffering capacity	
	6.2	Derivation of Hendersen –Hasselbalch equation, ionic product of water and relation between Isoelectric pH, pKa_1 and pKa_2 (for neutral amino acid).	
	6.3	Titration and ionization of Gly, Lys and Asp and relation between IEpH, pHm and pKa values of these amino acids, Sorensen's reaction and formal titration of amino acids (Ala).	
	6.4	Physiological Buffers (Hb – Carbonate buffer, phosphate buffer and protein buffer).	

	6.5	Numerical problems based on above concepts.	
	6.6	pHmeter, glass electrode.	
	6.7	Radioactivity	05
	6.71	Definition – Radioactivity, radioisotope with 2 examples (^{14}C, ^{15}N) , decay constant, Half-life period, Applications of radioisotopes in biological studies (w.r.t ^{14}C, ^{15}N) – Metabolic pathway (glycolysis, TCA, Urea), Molecular biology studies (w.r.t ^{32}P, Clinical studies (^{131}I in hypo/hyperthyroidism detection)	
VII	**7.0**	**Spectroscopy Techniques:-**	10
	7.1	Definition , derivation and limitations of Beer-Lambert Law. Concepts of Lambda max, Definition and determination of molar extinction coefficient.	
	7.2	Construction and working of simple colorimeter (single beam) and a spectrophotometer.	
	7. 3	Application of Beer Lambert Law in estimation Of proteins (Biuret method), Sugars (DNSA method).	
	7.4	Numerical problems based on above concepts	
VIII	**8.0**	**Chromatography Techniques:-**	10
	8.1	Principle, requirements and working of-Partition chromatography (Paper), Adsorption chromatography (TLC and Column), Ion exchange chromatography (Column) and Gel filtration.	
	8.2	Introduction to GLC, HPLC and Affinity chromatography - Principles only	
	8.3	Applications of partition, adsorption, ion exchange and gel filtration chromatography techniques	
	8.4	Numerical problems based on above concepts	
IX	**9.0**	**Electrophoresis Techniques :-**	10
	9.1	Principles of electrophoresis, Factors affecting the rate of migration of sample in electric field	
	9.2	Supporting media - paper, cellulose acetate, agar, agarose and polyacrylamide.	
	9.3	Discontinuous electrophoresis – Native, PAGE.	
	9.4	Application of electrophoresis - Seperation of proteins and nucleic acids.(one staining method each).Molecular weight determination using PAGE.	

	9.5	Isoelectric focusing	
X	**10.0**	**Centrifugation Techniques :-**	10
	10.1	Definition of RCF and RPM, derivation of equation relating RCF and RPM, Nomogram	
	10.2	Types of centrifuges - Clinical, High Speed, Ultra –preparative and Analytical	
	10.3	Components and working of - Analytical Ultracentrifuge – (with diagram).	
	10.4	Applications of centrifugation – Use of preparative centrifuge in the separation of cell organelles by differential centrifugation, proteins by rate zonal centrifugation and nucleic acids by isodensity centrifugation.	
	10.5	Use of Analytical Ultracentrifugation in the determination of molecular weights (sedimentation velocity method), conformational studies and purity of a sample.	
	10.6	Numerical problems based on above concepts	

PAPER II : METABOLISM, NUTRITION AND ADVANCED BIOCHEMICAL CONCEPTS
(MARKS 100)

SECTION 1 : METABOLISM (MARKS 50)

Unit No.	Topic No.	Contents	NOL
I	1.0	**Carbohydrate metabolism :-**	10
	1.1	Definition of Glycolysis, glycogenesis, glycogenolysis. Catabolism - Cellular location, sequence of reactions, labeling of C-atoms and energetics of glycolysis (aerobic and anaerobic) and Krebs cycle.	
	1.2	Anabolism - HMP Shunt (Synthesis of pentose phosphates)- Cellular location, sequence of reactions, oxidative and non-oxiodative phases of pathway and multifunctional nature. Schematic account of gluconeogenesis, Glyoxylate pathway.	
	1.3	Anaplerotic reactions – Definition, Role of Pyruvate carboxylase, PEP carboxykinase, Malic enzyme.	
II	2.0	**Lipid Metabolism**	10
	2.1	Catabolism - Knoop's experiment, Beta – Oxidation of even – Carbon saturated fatty acids and its energtics from C4 to C20	
	2.2	Anabolism - Fatty acid biosynthesis (only Palmitic acid) and role of fatty acyl synthetase complex. Ketone bodies formation, utilization, and physiological significance in Diabetes mellitus, starvation, alcoholism and pregnancy.	
III	3.0	**Bioenergetics**	10
	3.1	Definition of Free energy, respiratory electron transport chain, - basic chemistry, electron carriers, sequence - redox potentials, location of these electron carriers on mitochondrial memebrane, Inhibitors of ETC –Antimycin A, Amytal, Rotenone, CN, Azide, CO.	
	3.2	Definition of Oxidative Phosphorylation, Structure of ATPase (F_oF_1 ATPase), Chemiosmotic hypothesis, Proton motive force.	

IV	4.0	**Amino acid and Protein Metabolism-**	10
	4.1	Catabolism - reactions of amino acids –Transamination (GOT/GPT and mechanism of transamination), Decarboxylation (His,Trp, Glu and mechanism of decarboxylation). Deamination (Oxidative – Glu, Tyr & Nonoxidative – Asp, Cys, Ser).	
	4.2	Urea Cycle - Cellular location, sequence of reactions, labeling of N-atom, formation and transport of ammonia.	
V	5.0	**Plant Biochemistry and Clinical Biochemistry**	05
	5.1	Plant Biochemistry	
	5.11	Photosynthesis - Light and Dark reactions, Z-scheme and electron carriers, photophosphorylation (linear and cyclic),Calvin cycle (schematic representation only)	
	5.2	Clinical Biochemistry (Endocrine sysytem)	05
V	5.21	Definition of Hormone, hormone receptor, classification of hormone on the basis of chemistry, Hierarchial organisation.Chemistry, synthesis, secrtion and metabolic effects of throxine, insulin. Chemistry & physiological role of oxytocin and vasopressin. Physiological role of Glucocorticoids. Mechanism of action of epinephrine on glycogenolysis and steroid hormone. Endocrine disorders – Diabetes mellitus, Diabetes insipidus, Hypothyroidism (Cretinism & myxedema), Hyperthyroidism (Goitre – Simple & Toxic).	

SECTION II : NUTRITION AND ADVANCED BIOCHEMICAL CONCEPTS (MARKS 50)

(Nutrition, Genetics, Immunology, Biotechnology, Biostatistics and Bioinformatics)

Unit No.	Topic No.	Contents	NOL
VI	6.0	**Nutrition:-**	10
	6.1	Definition-Calorie and Joule	
	6.2	Food calorimetry-Calorific Value by Bomb calorimeter, calorific values of proximate principles, concept of BMI, BV and PER.	
	6.3	BMR- definition, factors affecting BMR, significance of BMR in	

		clinical diagnosis.	
	6.4	SDA - General concept and significance, energy requirement of individuals for various activities-sedentary, moderate and heavy.	
	6.5	Nutritional significance of carbohydrates, protein, lipids, vitamins, minerals and water.	
	6.6	Numerical problems based on above concepts	
VII	**7.0**	**Genetics :-**	**10**
	7.1	Replication of DNA - mechanism of replication, modes of DNA replication, semi-conservative replication, discontinuous DNA synthesis, termination of replication.	
	7.2	Transcription of DNA - in prokaryotes, prokaryotic RNA polymerases, synthesis of RNA species and their processing, concept of split genes, Reverse transcription.	
	7.3	Translation (protein biosynthesis) in prokaryotes - activation of amino acids, chain initiation,chain elongation, chain termination, post translational modifications of proteins.	
VIII	**8.0**	**Immumnology :-**	**10**
	8.1	Definition of immunity, types of immunity, definition of antigen, hapten and antibody.	
	8.2	Cells and organs of immune system. (Types and function)	
	8.3	Immunoglobulins basic structure,Classses and sub-classes-their structure and functions.	
	8.4	Antigen– antibody reactions - Precipitation, agglutination.	
IX	**9.0**	**Biotechnology**	**10**
	9.1	Fermentation processes – Basic components of a typical fermenter, fermentation process for alcohol production.	
	9.2	Plant tissue culture - definition of totipotency, callus regeneration, protoplast fusion and application of plant tissue culture in brief.	
	9.3	Genetic engineering – Basis of DNA cloning, cloning vectors, isolation of gene from cellular chromosomes, gene library, DNA probes, DNA amplification by PCR (Cycle - with diagram , role of TAQ polymerase), Recombinant DNA and its application in medicine (Insulin) and agriculture (BT cotton).	

X	10.0	**Biostatistics and Bioinformatics:-**	05
	10.1	Biostatistics	
	10.11	Data-collection and presentation.	
	10.12	Frequency distribution, normal distribution	
	10.13	Measures of central tendency – Mean (Arithmatic), Median and Mode.	
	10. 14	Measures of variation - Range, Variance and Standard deviation.	
	10.15	Numerical problems based on above concepts to the biological data.	
	10.2	Bioinformatics	
	10.21	Definition, Aims and History of Bioinformatics	05
	10.22	Applications of Bioinformatics in – Sequence analysis, Molecular modeling and drug designing, Phylogeny/evolution, Ecology & population studies, Medical informatics and agriculture.	
	10.23	Genomics and Proteomics – definition	
	10.24	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.	
	10.25	Sequence analysis Tools - definitions only BLAST, FASTA, L-ALIGN, CLUSTAL- X & W, RASMOL, Softwares for protein sequencing - PROPECT , AMMP, COPIA	
	10.26	Micro-array analysis-concept and applications.	

PRACTICALS
(MARKS 100)

Sr No.	Experiments	Marks
I	**Chromatography techniques:-**	10
	Separation by Circular Paper Chromatography of: 1. Amino acids 2. Sugars	
II	**Colorimetry:-**	10
	1.Proteins by Biuret method 2.Proteins by Folin-Lowry method 3.RNA by Orcinol method 4.Glucose by Folin –Wu method 5.Maltose by DNSA method	
III	**Volumetry:-**	10
	1.Lactose by Cole's method 2.vitamin C by Iodometric method 3.Glucose by Benedict's method	
IV	**Qualitative Analysis:-**	10
	1.Carbohydrates - Glucose, Fructose, Maltose, Lactose, Sucrose, Starch, Dextrin. 2.Proteins - Albumin,Casein,Gelatin,Peptone.	
V	**Prepration:-**	10
	1.Casein from milk 2. Starch from potato.	
VI	**Enzymes:-**	15
	A) AMYLASE : 1.Preperation of amylase extract from sweet potato and qualitative test of action. 2.Optimum pH of amylase 3.Km of amylase B) UREASE : 1.Preperation of urease extract from jackbean meal and qualitative test of	

	action. 2.Optimum pH of Urease 3.Km of Urease	
VII	**Minerals Estimation :-**	10
	1. Calcium by EDTA method 2. Magnesium by Titan Yellow method 3. Iron by Wong method 4. Phosphorus by Fiske-Subbarow method 5.	
VIII	**Biostatistics Problems:-**	10
	Numerical problem based on biological data to calculate the following: 1.Mean 2.Mode 3.Median 4.Standard deviation (Atleast two numerical problems based on each of the above concepts to be entered in the journal).	
iX	**Spots:-**	05
	Based on fundamental co ıcepts covered in theory and practicals.	
X	**Journal:-**	10
	Duly signed by the Teacher –in –charge and certified by the - Head of the department.	
XI	**Demonstartion Experiments:-**	NIL
	(To be entered in the Journal but not to be asked in the university Practical Examination) 1. TLC of oils and plant pigments 2.Column chromatography - seperation of chlorophylls 3.Agar/Agarose/PAGE gel electrophoresis of serum proteins 4.Preparation of buffers and use of pH meter	
XII	It is recommended that the T.Y.B.Sc. students of Biochemistry may be taken for a visit to a research laboratory or an industry - preferably be manufacturing units of pharmaceuticals, bulk chemicals, biochemicals, food and food processing, beverages, oils etc. The summary of the visit can be entered in the journal.	NIL

SCHEME OF EXAMINATION

Biochemistry, as an interdisciplinary subject, consists of 03 units of T.Y. B.Sc. carrying 300 marks as follows:

Paper	Title of Paper	Marks
I	Bio-organic and Biophysical Chemistry	100
II	Metabolism, Nutrition and Advanced Biochemical Concepts	100
	Practicals Practical I – 50 marks Practical II – 50 marks	100
	Total Marks	300

THEORY

1. There shall be two theory papers of 100 marks each. Each theory paper shall be of 03 (three) hours duration.
2. Each theory paper shall be divided in 10 units.
3. Pattern of theory paper:
   a. There shall be 10 (ten) questions of 10 marks each based on Units I to X.
   b. All questions shall be compulsory with internal options provided.
   Each question of 10 marks shall be sub-divided as follows:

Sub-question	Type	Marks
A	Attempt (i) any 2 out of 3 (1 mark each) OR (ii) any 1 out of 2 (2 marks)	2
B	Attempt (i) any 4 out of 6 (2 marks each) OR (ii) any 2 out of 3 (4 marks each) OR (iii) any 1 out of 2 (6 marks) & any 1 out of 2 (2 marks) OR (iv) any 1 out of 2 (8 marks)	8

PRACTICALS :

1. There shall be University Practical Examination of 100 marks to be conducted on two days
2. Each day of University Practical Examination shall consist of two sessions of 3 hours 30 minutes each.
3. Total time required to conduct University Practical Examination shall be 14 hours for each batch of candidates.
4. Distribution of experiments of Practical-I and Practical-II on days 1 and 2 respectively shall be as follows : .

Day	Experiments	Marks
Practical-I on Day-1	a. Chromatography Technique	10
	b. Colorimetry	10
	c. Volumetry	10
	d. Qualitative Analysis	10
	e. Certified Journal*	10
Practical-II on Day-2	a. Preperation / Isolation	10
	b. Enzymes	15
	c. Minerals Estimation	10
	d. Biostatistics Problems**	10
	e. Spots***	05

* Candidate without duly certified Journals **shall not** be allowed to appear for the University Practical Examination.

** Each candidate will be given a biological data and s/he will be required to calculate Mean / Median / Mode / Standard Deviation in 30 minutes.

*** Each candidate will be given Any number of spots for five (5) marks and s/he will be required to identify / explain / write / answers ,draw diagrams / figures / graphs, comment on , justify, substantiate, solve the numerical with respect to given spots in 15 minutes for the said five (5) marks.

(Note : Last one hour in the second session of Day-2 shall be utilized for conducting Biostatistics Problems and Spots Tests).

REFERENCES FOR THEORY AND PRACTICALS

1. Principles of Biochemistry - Lehninger, Nelson & Cox.
2. Outlines of Biochemistry - Conn & Stumpf.
3. Biochemistry – Voet & Voet.
4. Biochemistry - Zubay.
5. Biochemistry - Stryer.
6. A Biologist's guide to Principles and Techniques in Practical Biochemistry - William & Wilson.
7. Introduction to Practical Biochemistry – David Plummer.
8. Human Biochemistry – Orten & Neuhaus.
9. Medical Biochemistry – Guyton.
10. Principles of Biochemistry - White, Handler & Smith.
11. Principles & Techniques of Practical Biochemistry. – Wilson & Walker.
12. Human Nutrition & Dietetics – Davidson & Passmore.
13. Nutrition in health & Disease - Anderson I. et al.
14. Genes - Lewin Benjamin. (latest edition)
15. Genetics – Sanf J. H.
16. Immunology - Janis Kuby.
17. Immunology - Ivan Roitt
18. Fundamentals of Biotechnology – A. H. Patel
19. Industrial Microbiology – Cassida
20. Methods of Biostatistics – B. K. Mahajan
21. Bioinformatics – S. C. Rastogi
22. Modern Experimental Biochemistry – Rodney Boyer
23. Introductory Practical Biochemistry - S. K. Sawhney, Randhir Singh.
24. Gene Biotechnology by Jogdand.
25. Essentials of Biotechnology by Gupta.