

University of Mumbai



No. UG/ 69 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded by Academic Authority Unit which was accepted by the Academic Council at its meeting held on 27th February, 2013 vide item No. 4.48 relating to the revised syllabus as per (CBSGS) for B.Sc. in Biochemistry (6 Units) Sem. V & VI w. e. f. the academic year 2013-14.

They are hereby informed that the recommendations made by the Board of Studies in Biochemistry at its meeting held on 17th May, 2019 have been accepted by the Academic Council at its meeting held on 26th July, 2019 vide item No.4.1 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.Y.B.Sc. - Biochemistry 6 Units (USBCH) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032

14th August, 2019

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.1/26/07/2019

No. UG/69 -A of 2019-20

MUMBAI-400 032

Copy forwarded with Compliments for information to:-

14th August, 2019,

- 1) The i/c Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Bio-chemistry,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-ordinator, University Computerization Centre.

Ajay
(Dr. Ajay Deshmukh)
REGISTRAR

Cover Page

AC 26/7/19
Item No. 4-1

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	BIOCHEMISTRY- 6 UNITS
2	Eligibility for Admission	SECOND YEAR B.Sc-BIOCHEMISTRY
3	Passing Marks	40/ 100
4	Ordinances / Regulations (if any)	O.2145
5	No. of Years / Semesters	TWO SEMESTERS
6	Level	U.G.
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic Year	From Academic Year : 2019-20

Date: May 2016

Signature :

Name of BOS Chairperson / Dean : Dr. Nupur Mehrotra

*Print
for Rg Deshmukh*

UNIVERSITY OF MUMBAI



Syllabus for the T.Y.B.Sc.

Program: B.Sc.

Course: Biochemistry - 6 units, USBCH

(Choice Based Credit System with effect
from the academic year 2019–2020)

T.Y.B.Sc. –BIOCHEMISTRY-(6 Units) Syllabus

Choice Based and Credit System
To be implemented from the Academic year 2019-2020

SEMESTER V Theory

Course	UNIT	TOPICS	Credits	L / Week
USBCH501	Metabolism & Analytical Techniques-I		2.5	
	I	Role of minerals and vitamins in metabolism		1
	II	Bioenergetics & Oxidative Phosphorylation		1
	III	Carbohydrate metabolism		1
	IV	Chromatography		1
USBCH 502	Environmental Science		2.5	
	I	Air		1
	II	Water & Water treatment		1
	III	Soil & Noise		1
	IV	Energy, Industrial Pollutants and Environmental Monitoring		1
USBCH 503	Genetics & Recombinant DNA Technology		2.5	
	I	DNA Replication & Repair		1
	II	Transcription & Translation		1
	III	Recombinant DNA Technology I		1
	IV	RDT Recombinant DNA Technology		1
USBCH 504	Immunology and Pathophysiology- I		2.5	
	I	Human immune system		1
	II	Antigen- Antibody interactions		1
	III	Pathophysiology of metabolic and other disorders		1
	IV	Cancer		1

Practicals

USBCHP05	Practicals of Course USBCH 501 + Course USBCH 502	3	8
USBCHP06	Practicals of Course USBCH 503 + Course USBCH 504	3	8

T.Y.B.Sc. –BIOCHEMISTRY-(6 Units) Syllabus

Choice Based and Credit System
To be implemented from the Academic year 2019-2020

SEMESTER VI

Theory

Course	UNIT	TOPICS	Credits	L / Week
USBCH601	Metabolism & Analytical Techniques-II		2.5	
	I	Lipid metabolism		1
	II	Amino acid and protein metabolism & Hormone action and Signal transduction		1
	III	Centrifugation and Spectrophotometry		1
	IV	Electrophoresis		1
USBCH 602	Nutrition & Pharmacology		2.5	
	I	Nutrition		1
	II	Diet Management		1
	III	Pharmacology		1
	IV	Mechanism of Drug Action and Therapeutic drugs		1
USBCH 603	Biostatistics & Bioinformatics		2.5	
	I	Biostatistics and descriptive statistics		1
	II	Bioinformatics		1
	III	Hypothesis testing		1
	IV	Hypothesis testing		1
USBCH 604	Immunology and Pathophysiology-II		2.5	
	I	Antigen- Antibody interactions & Complement system		1
	II	Major histocompatibility complex & Transplant immunology		1
	III	Pathophysiology of viral diseases		1
	IV	Endocrine Diseases & Ageing		1

Practicals

USBCHP07	Practicals of Course USBCH 601 + Course USBCH 602	3	8
USBCHP08	Practicals of Course USBCH 603 + Course USBCH 604	3	8

SEMESTER V

T.Y.B.Sc. – BIOCHEMISTRY USBCH501 METABOLISM & ANALYTICAL TECHNIQUES - I

Learning objective:

- The course will be to understand the concepts of metabolism and the role of vitamins and minerals as coenzymes and cofactor in metabolic pathways.
- This paper aims to acquaint the learner with the maintenance of life processes of biomolecule carbohydrates -reactions / pathways involved in oxidation and synthesis.
- This paper also aims to acquaint the learner with oxidative phosphorylation and photophosphorylation and fixation of carbon dioxide, photorespiration and bioluminescence.
- The learner should also comprehend the principle, working and applications of analytical technique of chromatography which serves as an important tool in separation and deciphering the structure and function of biomolecules.

Learning outcome

At the end of the course the learner should

- understand simple concepts related to metabolism, metabolic roles played by vitamins and minerals, appreciate the correlation between energy molecules, reducing equivalents and pathways
- comprehend the catabolism and anabolism of carbohydrates and the disorders associated with these biomolecules.
- have learnt the principle, working and applications of chromatography technique and be able to appreciate the contribution of this technique to the study of various biomolecules.

Unit No.	Topic No.	Topics	No. of L
I	1.0	Role of vitamins and minerals in metabolism	15
	1.1	Minerals as cofactors:	
	1.1.1	Iron, Calcium, Magnesium, Zinc, Selenium, Molybdenum.	
		Vitamins as Coenzymes:	
	1.2	Water soluble vitamins –Thiamin, Riboflavin, Niacin, Pyridoxine,	
	1.2.1	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;	
		Fat soluble vitamins A, D, E, K:	

	1.2.2	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 (Vitamins D, E, K no structures)	
II	2.0	Bioenergetics & Oxidative Phosphorylation	15
	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; Barbital Malate-Aspartate shuttle and Glycerol phosphate shuttle	
	2.2.	Oxidative phosphorylation –Chemiosmotic hypothesis, Proton motive force; Structure of ATP synthase, Uncoupler- of ETC and Oxidative phosphorylation [DNP]	
	2.3	Photosynthesis – Light and dark reactions, Z scheme and electron carriers, photophosphorylation [linear and cyclic]; Calvin cycle – schematic with enzymes; Photorespiration	
	2.4	Bioluminescence. Phenomenon and its biological significance. Applications of Bioluminescence	
III	3.0	Carbohydrate metabolism	15
	3.1.	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]	
	3.2	Anabolism – HMP shunt (Cellular location, sequence of reactions, multifunctional nature); Gluconeogenesis, Glycogenesis – [schematic – no structures, but with enzymes and coenzymes]	
	3.3	Disorders of carbohydrate metabolism: <ul style="list-style-type: none"> • Galactosemia, Fructosemia, • Lactose intolerance 	
IV	4.0	Chromatography	15
	4.1 4.1.1	Chromatography Principle, Theoretical plates, Technique and Applications of the following kinds of chromatography : Partition chromatography (Paper), Adsorption Chromatography (TLC and column); Ion exchange chromatography and Gel filtration	
	4.2.	Principle and applications of GLC, HPLC, HPTLC, Affinity chromatography,	
	4.3	Numerical problems based on above concept	

T.Y.B.Sc. – BIOCHEMISTRY
USBCH502
ENVIRONMENTAL SCIENCE

Learning objective:

- To familiarize the learners with our environment
- To create awareness about the effect of human activities on the environment and impact of pollution on living organisms.
- To teach the learner to harness alternate ecofriendly sources of energy.
- To acquaint the learner with the tools and techniques employed for environmental monitoring.

Learning outcome:

At the end of the course the learner should be

- aware of our environment
- sensitized to the challenging environmental issues and problems.
- motivated to address the environmental problems and to work towards finding solutions to these problems.

Unit No.	Topic No.	Topics	No. of L
I	1.0	Air	15
	1.1	Atmosphere	
	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]	
	1.2.1	Air Pollutants – CO, Oxides of Nitrogen, SO ₂ , hydrocarbons and photochemical smog, Greenhouse gases, suspended particulate matter [sources and effect of] , depletion of ozone	
II	2.0	Water & Water treatment	15
	2.1	Water	
	2.1.1	Hydrosphere- characteristics and the water cycle	
	2.2	Water Pollution	
	2.2.1	Organic pollutants [pesticides, insecticides, detergents, oil spills, toxic organic chemicals]	
	2.2.2	Inorganic pollutants [heavy metals – Hg, Pb, As, Cd] Thermal pollution of water	
	2.3	Water treatment:	
	2.3.1	Criteria for water purity, Water purification [preliminary,	
	2.3.2	primary, secondary, tertiary- chlorination, ion exchange]	

III		Soil & Noise	15
	3.1 3.1.1 3.1.2 3.1.3	Soil Composition of soil, Nitrogen cycle Types of soil pollution – acidification, agrochemical pollution, salinization, and contamination by metalliferous wastes	
	3.2 3.2.1 3.2.2	Noise and its measurement Classification of Noise Causes and consequences of Noise pollution	
IV	4.0	Energy, Industrial Pollutants and Environmental Monitoring	15
	4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5	Energy 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)	
	4.2 4.2.1 4.2.2 4.2.3 4.2.4	Industrial pollutants (Sources and remedial measures) Polymers and Plastics Asbestos Poly Chlorinated Biphenyls Mining – Acid mine drainage	
	4.3 4.3.1 4.3.2	Environmental monitoring Approaches used to monitor the environment-air, water and soil. [Principles and Significance only. Protocols for each factor – not required] Remote Sensing	

T.Y.B.Sc. – BIOCHEMISTRY (6 units)

USBCH503

GENETICS & RECOMBINANT DNA TECHNOLOGY

Learning Objectives:

The main objective of the course will be to understand the concepts genetics, in terms of DNA replication i.e. perpetuation of life, mutation, the changes in the DNA, its implications and the inbuilt repair systems in the cell to prevent the heritable changes.

The learner will also be acquainted with the application based branch, Recombinant DNA Technology with a detailed insight into the various tools and techniques.

Learning outcome

At the end of the course the learner should

- be able to appreciate the experiments carried out by various scientists to prove DNA as the genetic material, understand the mechanism of DNA replication and comprehend how DNA damage can lead to detrimental effects and how DNA repair systems in the cells try to prevent mutations before being inherited.
- understand the mechanisms of DNA transcription and translation in prokaryotes
- understand the basic tools required and know the techniques of recombinant DNA technology, their applications and the use of the technology for the benefit of society.

Unit No.	No.	Topics	No. of L
I	1.0	DNA Replication & Repair	15
	1.1	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;	
	1.2	Mutations: Point and Gross- Structural (Deletion, Duplication, Inversion, Translocation, insertion); Numerical (Euploidy, Aneuploidy)	
	1.3	DNA repair: Direct, Photoreactivation O6 - methyl guanine DNA methyl transferase, Excision repair, Mismatch repair, Recombination repair, SOS-error prone repair	

II	2.0	Transcription & Translation	15
	2.1	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	
	2.2	Translation (protein biosynthesis) in prokaryotes – Genetic code, mechanism of translation: Activation of amino acids, chain initiation, elongation & termination: Post translational modifications of proteins Inhibitors and mode of action: Puromycin, Chloramphenicol, cycloheximide, tetracycline	
III	3.0	Recombinant DNA Technology I	15
	3.1	Introduction to RDT	
	3.2	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	
	3.3	Applications of RDT- Agriculture (Bt Cotton); Medicine (Insulin); GM food	
IV	4.0	Recombinant DNA Technology II	15
	4.1	Isolation of gene: Gene library and c-DNA library; Southern blot; Chimeric DNA	
	4.2	Gene Transfer: Transformation, Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief) Selection and screening- Antibiotic and colony hybridization	
	4.3	DNA Amplification by PCR (Steps, Types, Applications)	
	4.4	DNA fingerprinting, DNA sequencing (any one method)	

T.Y.B.Sc. – BIOCHEMISTRY (6 units)
USBCH504
IMMUNOLOGY & PATHOPHYSIOLOGY -I

Learning Objectives:

- Reveal to the learner the understanding of basic immune cells, organs and their characteristics, antigen antibody reactions along with the types of immune responses.
- Guide the learner to develop the skills necessary for the critical analysis of contemporary literature on topics related to diseases and health problems associated with metabolic disorders of the macromolecules including; Carbohydrates, Lipids, proteins and hormones.
- Help the learner understand the basic objective of studying cancer biology to translate basic findings into diagnostics, treatments and ultimate cures.

Learning outcome:

At the end of the course the learner should

- understand the overall organization of the immune system, appreciate the structure and function of antibodies, relationship between innate and adaptive systems and humoral and cell mediated immunity.
- learn the normal and abnormal metabolic pathways of bio-molecules (carbohydrates, proteins, lipids) and diseases related.
- be able to discuss pathophysiology and etiology of different diseases and in born errors.
- understand basic aspects of cancer biology and familiarize with elementary facets of carcinogenesis and types of cancer along with therapy to treat the cancer.

Unit No.	Topic No.	Topics	No. of L
I	1.0	Human immune system	15
	1.1	Types of Immunity	
	1.1.1	Innate immunity – Anatomical barriers, physiological barriers,	
	1.1.2	Characteristics of Inflammation, phagocytosis [no mechanism]	
	1.1.3	Adaptive immunity – Active & Passive	
	1.1.4	Humoral & Cell mediated immunity	
	1.2	Organs of the immune system:	
	1.2.1	Primary lymphoid organs: Thymus, Bone marrow	
	1.2.2	Secondary lymphoid organs: Lymphatic system, Lymph nodes, Spleen, MALT.	
	1.3	Cells of the immune system:	
	1.3.1	Lymphocytes – B cells and T cells, Natural killer cells – Mononuclear phagocytes, Granulocytes, Antigen presenting cells.	
	1.3.2	Clonal selection & immunologic memory.	

	1.3.3	Cytokines: biological functions of IL1, tumor necrosis factor-alpha, interferon –alpha, IL2, interferon-gamma.	
II	2.0	Antigen- Antibody interactions	15
	2.1	Antigens: Antigenicity, immunogenicity, epitope, factors determining immunogenicity, Haptens. Antibodies: Fine structure of immunoglobulin, Antibody-mediated functions, Antibody classes, Monoclonal antibodies (concept, production and applications)	
	2.2	Antibody diversity: Multigene organization of immunoglobulin genes – Lambda, kappa & heavy chain Light chain DNA – VJ rearrangements Heavy chain DNA - VDJ rearrangements	
III	3.0	Pathophysiology of metabolic and other disorders	15
	3.1	Metabolic disorder	
	3.1.1	Inborn error: With respect to Etiology and Clinical manifestations	
	3.1.2	Carbohydrate Metabolism: Glycogen storage disease Type I & III.	
	3.1.3	Amino acid Metabolism: Albinism, Phenylketonuria, Maple syrup urine disease, Alkaptonuria	
	3.1.4	Lipid Metabolism: Tay Sach's disease, Niemann–Pick diseases, Fabry's disease	
	3.2	Blood related diseases:	
	3.2.1	Iron deficiency anemia.	
	3.2.2	Sickle cell anemia.	
	3.2.3	Thalassemia.	
	3.2.4	Pernicious anemia	
	3.2.5	Hemophilia A and B	
	3.3	Cardio Vascular System and related diseases:	
	3.3.1	Hypertension, Arteriosclerosis and Atherosclerosis	
IV	4.0	Cancer	15
	4.1	Biology of Cancer.	
	4.2	Physiology of Cancer cells.	
	4.3	Causes of cancer Carcinogens: Types (Physical, Chemical and Biological, Environmental Factor); AMES test	
	4.4	Oncogenes and activation of oncogenes	
	4.5	Genetics of cancer with reference to p53 and Bcl2.	
	4.6	Cancer therapy (Chemo – purine, pyrimidine and folate analogs)	
	4.7	Cancer and the cell cycle	

PRACTICALS

USBCHP05 (501)

- 1) Determination of the optimum pH of β -Amylase.
- 2) Determination of K_m of β -Amylase from sweet potato.
- 3) Determination of the activity and specific activity of β -Amylase from sweet potato.
- 4) Effect of an inhibitor (eg. EDTA) on Amylase activity.
- 5) Estimation of glucose by Benedict's method.
- 6) Separation of sugars by circular paper chromatography

Demonstration Experiments

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

USBCHP05 (502)

- 1) Determination of the pH of water/effluent/soil using a pH meter.
- 2) Determination of the conductance of water / effluent.
- 3) Estimation of organic content of soil –Diphenylamine method.
- 4) Estimation of lead by the EDTA method.
- 5) Estimation of copper by the Isoamyl alcohol method.
- 6) Determination of salinity of / chlorides in water - Silver nitrate method.
- 7) Determination of the Chemical Oxygen Demand of water/effluent by the potassium dichromate method

USBCHP06 (503)

- 1) Estimation of glucose by DNSA method.
- 2) Estimation of glucose by the Folin Wu method.
- 3) Determination of the Hemoglobin content by the Sahli's hemoglobinometer.
- 4) Determination of blood groups.
- 5) Detection of Ca^{+2} and Mg^{+2} ions in by the Eriochrome Black T-EDTA method.
- 6) Estimation of phosphorus by Fiske and Subbarao method

USBCHP06 (504)

- 1) Isolation of starch from sweet potato.
- 2) Extraction of lipid from oil seeds by the cold percolation method.
- 3) Estimation of DNA by the Diphenylamine method
- 4) Isolation and spooling of DNA from onion / moong

SCHEME OF EXAMINATION

Biochemistry, as an interdisciplinary subject, consists of 06 (Six) Units of T.Y.B.Sc. Carrying 400 marks in Fifth Semester, as follows:

COURSE CODE	Title of Paper	Semester end Examination marks	Total Marks
USBCH501	Metabolism & Analytical Techniques	100	100
USBCH502	Environmental Science	100	100
USBCH503	Genetics & Recombinant DNA Technology	100	100
USBCH504	Immunology & Pathophysiology	100	100
	TOTAL		400

PRACTICALS:		
COURSE CODE	Marks per course	Total per semester
USBCHP05	100	
USBCHP06	100	
TOTAL		200

**SCHEME OF PRACTICAL EXAMINATION
SEMESTER V**

Course USBCHP05 & USBCHP06	Experiments	Marks
Day 1	a. Chromatographic separation	20
	b. Enzymology	30
	c. Volumetric estimation	20
	d. pH and conductance	10
	e. Certified Journal*	10
	f. <i>Viva voce</i>	10
	TOTAL	100

Course USBCHP05 & USBCHP06	Experiments	Marks
Day 2	a. Colorimetric estimation	20
	b. Isolation	20
	c. Volumetric estimation	20
	d. Hematology (two experiments)	20
	e. Certified Journal*	10
	f. <i>Viva voce</i>	10
	TOTAL	100

SCHEME OF EXAMINATION FOR PRACTICAL OF SEMESTER V

1. The Semester V practical examination shall be conducted by respective colleges on behalf of the University
 2. There shall be 02 (Two) examiners to conduct the practical examination –one Internal examiner and other external examiner
 3. The external examiner shall be on the panel of examiner approved by the University of Mumbai.
 4. The college shall invite one such examiner from approved panel as an external examiner
 5. Duration for the Practical examination for Semester V
 - a) Two days of 02 sessions on each day
 - b) Total no. of sessions = 4
 - c) Each session: 3½ hours.
 - d) Morning session: 9.00 am to 12.30 pm
Afternoon session: 1.00 pm to 4.30 pm.
- * Candidate without duly certified journals SHALL NOT be allowed to appear for the University practical examination.

SEMESTER VI
T.Y.B.Sc. – BIOCHEMISTRY (6 units)
USBCH601
METABOLISM & ANALYTICAL TECHNIQUES - II

Learning objective:

The paper will help to understand the concepts of metabolism and its importance in the proper functioning of each cell. This paper also aims to acquaint the learner with the maintenance of life processes of various biomolecules like lipids and proteins - reactions / pathways involved in oxidation and synthesis of biomolecules.

The Paper aims to teach the learner the action, signal transduction and physiological role of important hormones.

The learner should also comprehend the principle, working and applications of analytical technique of centrifugation, spectrophotometry, electrophoresis, radioactivity that serve important tools in deciphering the structure and function of biomolecules.

Learning outcome

At the end of the course the learner should

- understand breakdown and synthesis of fatty acids and amino acids and appreciate experiments carried out by scientists to enable understand the pathways and cycles of metabolism.
- understand basic concepts related to metabolism, be familiar with the various metabolic pathways and should be able to appreciate the importance of enzymes and coenzymes in pathophysiology of diseases.
- be able to appreciate the various hormones, their actions, regulations and clinical significance.
- have learnt the principle, working and applications of various analytical techniques and be able to appreciate the contribution of these techniques (colorimeter/ spectrophotometer, Centrifuges, electrophoresis and radioisotopes) as tools in understanding the structure and function of biomolecules.

Unit No.	Topic No.	Topics	No. of L
I	1.0	Lipid metabolism	15
	1.1	Lipid metabolism – Catabolism - Knoop's experiment; Beta oxidation of even carbon saturated fatty acids (C4 to C20) Energetics of fatty acid	

		oxidation. Beta oxidation of odd carbon chain fatty acid	
	1.2	Anabolism – FAS complex; Fatty acid biosynthesis (palmitic acid); Ketone body formation, utilization, and the physiological significance of Ketone bodies in Diabetes mellitus, Starvation, Pregnancy and Alcoholism.	
II	2.0	Amino acid & protein metabolism and Hormones & Signal transduction	15
	2.1	Amino acid and protein metabolism – 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]	
	2.1.2	Glucogenic and ketogenic amino acids	
	2.1.3	Urea cycle – Cellular location, sequence of reactions, Labeling of N atom, transport of NH ₃	
	2.2	Hormone action and signal transduction	
	2.2.1	Hormone receptors (membrane and intracellular)	
	2.2.2	Introduction to G protein, G protein coupled receptor, Effect of epinephrine on glycogen synthesis and breakdown: amplification cascade with G proteins, cAMP (as second messenger), adenylate cyclase, kinases	
	2.2.3	IP3 and Calcium as second messenger	
III	3.0	Centrifugation and Spectrophotometry	15
	3.1	Centrifugation	
	3.1.1	RCF, RPM and derivation of an equation relating the two; Nomogram; Sedimentation coefficient and factors affecting; Derivation of sedimentation velocity, Wall effect	
	3.1.2	Types and applications of centrifuges – Clinical, High speed, Ultra centrifuge - preparative and analytical.	
	3.1.3	Types of centrifugation and its applications– Differential, Rate zonal, Isopycnic, Types of rotors Preparation of density gradient, Sample application, choice of rotors, Recovery of sample	
	3.1.4	Numerical problems based on above concepts	
	3.2	Spectrophotometry	
	3.2.1.	Beer-Lambert law, derivation, limitations & applications in the estimation of sugar [DNSA] and protein [Biuret]; concepts of Lambda max; determination of molar extinction coefficient	
	3.2.2	Construction and working of a simple colorimeter and UV/ Vis spectrophotometer	
	3.2.3	Numerical problems based on the above concepts	

IV	4.0	Electrophoresis & Radioactivity	15
	4.1	Electrophoresis	
	4.1.1	Principle: Factors affecting the rate of migration of sample in an electric field	
	4.1.2	Moving boundary and Zone electrophoresis; Components of electrophoresis unit/apparatus	
	4.1.3	Various support media - paper, cellulose acetate, agar, agarose and polyacrylamide	
	4.1.4	Technique of electrophoresis with staining/visualization method	
		<ul style="list-style-type: none"> • agarose electrophoresis for separation of DNA • Native PAGE for separation of proteins 	
	4.1.5	<ul style="list-style-type: none"> • SDS PAGE for molecular weight determination; • Discontinuous electrophoresis • Other applications of electrophoresis: blotting techniques- Southern, Northern, and Western 	
	4.1.6	Isoelectric Focusing of protein	
	4.2	Radioactivity- Isotopes, Radioactive decay; Decay constant; Half-life; Measurement of radioactivity (principle)	

T.Y.B.Sc. – BIOCHEMISTRY (6 units)
USBCH602
NUTRITION & PHARMACOLOGY

Learning objectives:

- Gain knowledge about proximate principles, nutritional status and balanced diet.
- Assess energy and anthropometric parameters.
- Introduce the concept of diet management, nutrition at various stages of life and diseases related to diet.
- Give basic insights in pharmacology, pharmacokinetics and mechanism of action of therapeutic drugs.

Learning outcomes:

At the end of the course a learner should

- be able to appreciate the role of nutrients in diet to understand nutritional status and concept of balanced diet which will help to identify the overall nutrition to be given to men and women at various age groups.
- be familiarized with dietary management in diseases.
- be able to utilize critical thinking skills in discussing the concept of pharmacokinetics and pharmacotherapy.
- be able to explain various therapeutic drugs in use.

Unit No.	Topic No.	Topics	No. of L
I	1.0	Nutrition	15
	1.1	Principles of nutrition	
	1.1.1	Nutrients [Proximate principles, vitamins and minerals (macro and micro- role of Ca, Mg, Na, K and Fe, Zn)], dietary fibre.	
	1.1.2	Nutritional status [malnutrition (protein energy and protein calorie) and over nutrition]	
	1.1.3	Balanced diet	
	1.2.1	Energy Assessment - RQ, BMR;	
	1.2.2	Anthropometry – BMI, Waist:hip ratio;	
	1.2.3	Protein quality indices: Chemical score of amino acids, Protein Deficiency Corrected Amino Acid Score, Net Protein utilization	
II	2.0	Diet Management	15
	2.1	Concepts like Balanced diet, Meal planning.	
	2.2	Nutrition during pregnancy, lactation, infancy, toddlerhood, preschool stage, school going children, and adolescence, adulthood and geriatric	

	2.3	Dietary Management in :- Obesity, Diabetes Mellitus, Hypertension, Peptic ulcer , Obstructive Jaundice	
III	3.0	Pharmacology	
	3.1 3.1.1 3.1.2 3.1.3 3.1.4	General pharmacology Pharmacodynamics, Physicochemical properties of drugs, Drug absorption: through-GIT, pulmonary, renal, placental and blood-brain barrier Bioavailability and Bioequivalence Drug Distribution, Metabolism and Excretion	15
	3.2	Bioassays: Preclinical and clinical evaluation, Therapeutic drug monitoring	
	3.3	Pharmacokinetics: LD ₅₀ , ED ₅₀ , Half Life, Loading dose, Maintenance dose, Therapeutic dose, Therapeutic Index, Drug plasma concentration, Volume of distribution, Clearance	
IV	4.0	Mechanism of Drug Action and Therapeutic drugs	
	4.1 4.2 4.2.1 4.2.2 4.2.3	Mechanism of action of drugs: i. Specific interaction – receptor mediated ii. Partially specific – drugs via enzymes iii. Nonspecific interactions – antimetabolites and antiseptics iv. Through Antibodies v. Placebo effects Therapeutic drugs: (Mechanism of action and adverse effects) Anti-inflammatory – non steroid anti-inflammatory NSAID [Ibuprofen], Salicylates – [Aspirins] Cardiovascular drugs- CVS [Ca channel blocker-Amlodipine, and Beta blocker – Propranolol Antibiotic – Penicillin and Sulphonamide Antacid- Proton pump blocker –Omeprazole	15

T.Y.B.Sc. – BIOCHEMISTRY (6 units)
USBCH603
BIOSTATISTICS AND BIOINFORMATICS

Learning objectives:

- Introduces fundamental concepts and definitions for biostatistics.
- Explain concept of probability and its distribution.
- Presents hypothesis testing
- To understand basic concepts in bioinformatics which is an interdisciplinary program offering substantial training in both the biological sciences and the physical & mathematical sciences.

Learning outcomes:

At the end of the course the learner should

- understand the basic principles of probability and how they relate to biostatistics
- become familiar with the mathematical and statistical theory underlying the applications of biostatistical methods to interpret statistical results correctly, effectively and in context.
- be able to interpret relationships among living things and analyze and solve biological problems, using basic biological concepts, grounded in foundational theories with the help of bioinformatics tools.
- be able to apply existing software effectively to extract information from large databases and to use this information in biological sciences

Unit No	Topic No	Topics	No. of L
I	1.0	BIOSTATISTICS AND DESCRIPTIVE STATISTICS	
	1.1.1	Introduction: scope and applications of biostatistics	
	1.1.2	Common statistical terms: Sources, nature and presentation of data; Measurement and scales of measurement	
	1.1.3	Descriptive statistics: Measures of central tendency- Mean, Median and mode	
	1.2	Measures of dispersion- Range, percentiles, variance, SD, Mean deviation,	15
	1.3	Probability Concept of probability: definition Probability distribution: normal distribution and normal Curve, Asymmetric distribution Statistical problems based on the above concepts	
II	2.0	BIOINFORMATICS	
	2.1	Bioinformatics: Definition, Aims and History of Bioinformatics Applications of Bioinformatics in – Sequence analysis, Molecular modeling and drug designing, Phylogeny/evolution, Ecology &	15

		<p>population studies, Medical informatics and agriculture. Introduction to Genomics and Proteomics Databases- Definition & types – Public domain database, Sequence database, Structural database, Motif database, Genome database, Proteome database, Annotated sequence database. Full form & function in brief of - GenBank, EMBL, PIR, SWISS PROT, PDB, GDB. Sequence analysis Tools - Explain the following terms in brief - BLAST, FASTA, L-ALIGN, CLUSTAL- X & W, RASMOL, Software for protein sequencing - PROSPECT, AMMP, COPIA (Explanation of the terms in brief) Micro-array analysis-concept and applications</p>	
III	3.0 3.1 3.2 3.3 3.4	HYPOTHESIS TESTING - Introduction; Single population mean, difference between population means Type I and Type II errors, One-tailed and two tailed tests Z-test Statistical problems based on the above concepts	
IV	4.0 4.1 4.2	HYPOTHESIS TESTING t-test- Paired and unpaired Chi-square Statistical problems based on the above concepts	15

T.Y.B.Sc. – BIOCHEMISTRY (6 units)
USBCH604-S
IMMUNOLOGY & PATHOPHYSIOLOGY-II

Learning objectives:

- Understand the complement system needed for cytolysis of foreign particles.
- Deal with major histocompatibility molecules which are important for immune responses, also for evoking transplant rejections.
- Explain the structure and pathophysiology of HIV and other viruses
- Understand the disorders of endocrine system and ageing, which include diseases related to endocrine hormones and relation to nonendocrine system.

Learning outcomes:

At the end of the course the learner should

- understand the pathways that activate the complement system
- be familiar with the MHC; its structure and classes, specific role of each class of MHC and importance in immune response and graft rejection.
- grasp a contemporary understanding of classification, structure and mechanism of replication of viruses along with pathophysiology symptoms and preventive measures of AIDS.
- understand the basic concepts of demography and epidemiology of aging and pathophysiology and issues in common diseases of older people.

Unit No	Topic No	Topics	No. of L
I	1.0	Antigen- Antibody interactions & Complement system	15
	1.1	Antigen- Antibody interactions:	
	1.1.1	Forces involved, antibody affinity, antibody avidity.	
	1.1.2	Precipitation reactions – Oudins, Ouchterlony	
	1.1.3	Agglutination reactions: Blood typing, bacterial agglutination, Passive agglutination, agglutination inhibition, Coomb's test. Immunoelectrophoresis;	
	1.1.4	Principles of Radioimmunoassay, ELISA,	
	1.1.5	Immunofluorescence	
	1.2	Complement	
	1.2.1	Components of complement;	
	1.2.2	Complement activation – Classical & alternate pathway; formation of membrane attack complex.	
	1.2.3	Biological consequences of complement activation.[in brief]	
II	2.0	Major histocompatibility complex & Transplant immunology	15
	2.1.	Major histocompatibility complex:	
	2.1. 1	MHC polymorphism & organization of MHC genes- class I &	

	2.1.2	class II; Cellular distribution & structure of class I & II molecules; Self MHC restriction of T cells. Role of antigen presenting cells.	
	2.2	Transplant immunology: Types of transplant; immunological basis of allograft rejection.	
	2.3	Autoimmunity: Organ specific –Myasthenia gravis; Hashimoto’s thyroiditis, Insulin dependent diabetes mellitus Systemic – Rheumatoid arthritis, Multiple sclerosis, Systemic lupus erythematosus (immunological basis of these autoimmune diseases)	
III	3.0	Pathophysiology of viral diseases	15
	3.1	Structure and mechanism of replication in: 1. Vaccinia 2. Polio 3. Influenza 4. Hepatitis 5. Rabies or Ebola virus	
	3.2	AIDS: Structure and genetics basis of AIDS virus. Replication of AIDS Virus. Symptoms and Causes of AIDS. AIDS Therapy.	
IV	4.0	Endocrine Diseases & Ageing	15
	4.1 4.1.1 4.1.2 4.1.3	Endocrine diseases: Diabetes mellitus. Hyper and Hypothyroidism, Cushing’s syndrome, Acromegaly	
	4.2	Diabetes insipidus.	
	4.2	Ageing: Definition of ageing. Molecular changes during ageing. Theories of Ageing.	
	4.3	Alzheimer’s disease, Parkinson’s diseases	

PRACTICALS - SEMESTER VI

USBCHP07 (601)

- 1) Separation of amino acids by circular paper chromatography
- 2) Estimation of Ascorbic acid Iodometrically.
- 3) Determination of the optimum pH of Acid phosphatase / Urease.
- 4) Determination of the Km of Acid phosphatase / Urease.
- 5) Estimation of lactose by Cole's ferricyanide method
- 6) Estimation of glucose Iodometrically

Demonstration Experiments

Separation of plant pigments/ Oils by Thin Layer Chromatography

USBCHP07 (602)

- 1) Estimation of fluoride in water by the Alizarin red method
- 2) Determination of the Dissolved Oxygen content of water/effluent by the Winkler's Iodometric method - Azide modification.
- 3) Determination of the Biological Oxygen Demand of water/effluent
- 4) Determination of the acidity and alkalinity of water/ effluent.
- 5) Estimation of CaCO₃ of soil - Bromothymol Blue method
- 6) Immunoprecipitation reaction of antigen and antibody.
- 7) Diagnostic test for typhoid - Widal Qualitative
- 8) Diagnostic test for typhoid - Widal Quantitative

USBCHP08 (603)

- 1) Estimation of protein by the Folin-Lowry method.
- 2) Estimation of iron by Wong's method.
- 3) Monograph of acetyl salicylate (identification, assay and purity as per IP)
- 4) Monograph of sucrose (identification, assay and purity as per IP)

Demonstration Experiments

1. Separation of serum proteins by PAGE

USBCHP08 (604)

- 1) Biostatistics – Problems
- 2) Isolation of RNA yeast / liver
- 3) Isolation of casein from milk.
- 4) Estimation of RNA by Orcinol method.

Demonstration Experiment

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

SCHEME OF EXAMINATION

Biochemistry, as an interdisciplinary subject, consists of 06 (Six) Units of T.Y.B.Sc. carrying 400 marks in Sixth Semester, as follows :

COURSE CODE	Title of Paper	Semester End Examination marks	Total Marks
USBCH601	Metabolism & Analytical Techniques II	100	100
USBCH602	Nutrition & Pharmacology	100	100
USBCH603	Biostatistics & Bioinformatics	100	100
USBCH604	Immunology & Pathophysiology	100	100
	TOTAL		400

PRACTICALS:		
COURSE CODE	Marks per course	Total per semester
USBCHP07	100	
USBCHP08	100	
TOTAL		200

**SCHEME OF PRACTICAL EXAMINATION
SEMESTER VI**

Course USBCHP07 & USBCHP08	Experiments	Marks
Day 1	a. Chromatographic separation	20
	b. Enzymology	30
	c. Volumetric estimation	20
	d. Immunology	10
	e. Certified Journal*	10
	f. <i>Viva voce</i>	10
	TOTAL	100

Course USBCHP07 & USBCHP08	Experiments	Marks
Day 2	a. Biostatistics	20
	b. Monograph	20
	c. Colorimetric estimation	20
	d. Isolation	20
	e. Certified Journal*	10
	f. <i>Viva voce</i>	10
	TOTAL	100

Scheme of Examination for practical of Semester VI

1. The Semester VI practical examination shall be conducted by the University of Mumbai
2. There shall be 02 (Two) external examiners appointed by the University from the panel of approved examiners
3. Duration for the Practical examination for Semester VI
 - a) Two days of 2 sessions on each day
 - b) Total no. of sessions = 4
 - c) Each session: 3½ hours.
 - d) Morning session: 9.00 am to 12.30 am
Afternoon session: 1.00 pm to 4.30 pm.

*Candidate without duly certified journals SHALL NOT be allowed to appear for the University practical examination.

Scheme of Examination for Third year Science Undergraduate students

Scheme of Theory examination at T.Y.B.Sc. (Sem V and Sem VI)

- 1) Each theory paper will be of **100** marks
- 2) Each theory paper will be of **3** hours duration
- 3) Each theory paper will contain **05** questions of **20** marks each as follows:

T.Y.B.Sc. theory question paper pattern with marks distribution

Q. No.	Unit/s	Sub Q.	Type and Choice	Marks	Total marks per question
1.	I	A	Four objective questions – fill in the blanks, match the columns etc.	04	20
		B	Short answers – any one out of two	04	
		C	Long answers – <ul style="list-style-type: none">• Any two, out of three of 06 marks each• Any one out of two for 12 / 06+ 06 / 08+ 04 marks	12	
2.	II	A	Four objective questions – fill in the blanks, match the columns etc.	04	20
		B	Short answers – any one, out of two	04	
		C	Long answers – <ul style="list-style-type: none">• Any two out of three of 06 marks each• Any one out of two for 12 / 06+ 06 / 08+ 04 marks	12	
3.	III	A	Four objective questions – fill in the blanks, match the columns etc.	04	20

		B	Short answers – any one out of two	04	
		C	Long answers – <ul style="list-style-type: none"> Any two out of three of 06 marks each Any one out of two for 12 / 06+ 06 / 08+ 04 marks 	12	
4.	IV	A	Four objective questions – fill in the blanks, match the columns etc.	04	20
		B	Short answers – any one out of two	04	
		C	Long answers – <ul style="list-style-type: none"> Any two out of three of 06 marks each Any one out of two for 12 / 06+ 06 / 08+ 04 marks 	12	
5.	I - IV	A	Any four definitions etc. of 02 marks each; a or b from unit I, c or d from unit II, e or f from unit III, g or h from unit IV	08	20
		B	Any six true or false with justification of 02 marks each from units I to IV	12	

External Examination for practical

Sr. No.	Particulars for External Practical Examination		Marks
	Particulars for External Practical Examination Semester End Practical Examination		100 Marks
1	Laboratory Work	80 Marks	
2	Journal	10 Marks	
3	Viva	10 Marks	

SUGGESTED READING

- 1) Lehninger's- Principles of Biochemistry by David L. Nelson
- 2) Harper's Illustrated Biochemistry by Robert K. Murray
- 3) Biochemistry by Donald Voet
- 4) Biochemistry by Jeremy M. Berg
- 5) Biochemistry (2 Volume Set): The Chemical Reactions of Living Cells by David E. Metzler
- 6) Modern Experimental Biochemistry by Rodney F. Boyer
- 7) Basic Concepts in Biochemistry: A Student's Survival Guide by Hiram F. Gilbert
- 8) Analytical Biochemistry by David Holme
- 9) International Biochem by Stryer Tymoczko Berg
- 10) Biophysical Chemistry Upadhyay
- 11) Biochemistry by Dr. A.C. Deb
- 12) Essentials of Pharmacotherapeutics by FSK Brara
- 13) Textbook of Medical Biochemistry by M.N. Chatterjea & Ranashinde
- 14) Immunology by Goldsby and Kuby
- 15) iGenetics by Russel
- 16) Gene Biotechnology by Jogdand
- 17) Biostatistics by Arora
- 18) Methods in Biostatistics by Mahajan
- 19) General Principles of Biochemical Investigation by William & Wilson
- 20) Environmental Chemistry by A.K.De
- 21) Biotechnology by U.Satyanarayana
- 22) Advance in Biotechnology by Jogdand
- 23) Biochemical Calculation by Segel
- 24) Biochemical Methods by Sadashivam
- 25) Introductory Practical Biochemistry by Sawhney
- 26) Practical Biochemistry by David Plummer