AC – 11th May, 2017
Item No. 4.187

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc.
Semester I and Semester II
Program: M.Sc. Course
Bio-Chemistry

(Credit Based Semester and Grading System with effect from the academic year 2017–2018) and onwards

SYLLABUS OF M.Sc. CREDIT SYSTEM IN BIOCHEMISTRY

TO BE BROUGHT INTO FORCE FROM THE ACADEMIC YEARS 2017-2018

Objectives

1. To Strengthen the base in fundamental aspects of Biochemistry Viz. Bio-organic and Biophysical Chemistry, Instrumentation, Metabolism, Medical/Clinical Chemistry and Human Nutrition and Dietetics.

2. To introduce soft skills development component to create awareness and develop competence in personality development, communication skills, academic and professional skills. Empower the students with leadership qualities, entrepreneurship and start-ups for employment, stress & time management.

3. To develop broad perspective with respect to the advanced areas of Biochemistry Viz. Genetics and Molecular Biology, Immunology, Recombinant DNA Techniques and Industrial Biochemistry.

4. To familiarize with research methodology to help students develop research aptitude through research projects.

5. To create awareness in Biostatistics for applicability to research.

6. To open up new vistas in the fast emerging and developing areas of Bio-informatics and applications of computers in Bio-chemistry.

7. To sharpen practical skills in performing experiments involving latest protocols.

8. To augment experimental expertise by handling modern instruments.

9. To train young minds for gainful employment in industry, research-oriented career and qualifying examinations like NET and SET.

10. To develop scientific temper and interest by exposure through Internet. Computers, various data bases and industrial visits and study/educational tours.

11. To provide platform for interaction with scientists at research centers/ universities/ industries including internship for training/ summer project for 03 to 06 months and also for the gainful employment.

Scheme for Theory Paper
(4 Credits per Paper per Semester)

M.Sc. Semester I

Course Code	Topic Headings	Credits
PSBCH-101	Advanced Bio-organic Chemistry	4
PSBCH-102	Advanced Instrumentation and Analytical Techniques	4
PSBCH-103	Industrial Biochemistry and Bioinformatics - I	4
PSBCH-104	Research Methodology, Bio-statistics & Soft Skills Development - I	4

M.Sc. Semester II

Course Code	Topic Headings	Credits
PSBCH-201	Advanced Bio-organic Chemistry	4
PSBCH-202	Advanced Instrumentation and Analytical Techniques	4
PSBCH-203	Industrial Biochemistry and Bioinformatics - II	4
PSBCH-204	Research Methodology, Bio-statistics & Soft Skills Development - II	4

Semester-wise Details of Unit I to IV in each theory paper

SEMESTER I

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSBCH101	I	Biochemical Basis of Evolution	4	1
	II	Bioenergetics		1
	III	Protein chemistry& Enzymology		1
	IV	Membrane Biochemistry & Cell Signaling		1
PSBCH102	I	Colligative properties	4	1
	II	Acids, Bases & Buffers		1
	III	Microscopy and Radioactive Techniques		1
	IV	Spectroscopic Techniques		1
PSBCH103	I	Bioprocess Technology & Fermentation	4	1
	II	Technologies in Cell & Tissue Culture		1
	III	Techniques in Food Preservation		1
	IV	Bioinformatics – I		1
PSBCH104	I	Research and Research Design	4	1
	II	Presentation and Processing of Data		1
	III	Analysis of Data and Sampling Techniques		1
	IV	Soft Skills Development - I		
PSBCHP101	Colorimetric, Volumetry, Enzymology, Buffers,Microscopy		2	4
PSBCHP102	Biochemical, Clinical Analysis		2	4
PSBCHP103	Isolation, Preparation, Extraction, Assays. Bioinformatics - I		2	4
PSBCHP104	Research Methodology, Biostatistics & Soft Skills Development-I		2	4

Semester-wise Details of Unit I to IV in each theory paper

SEMESTER II

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSBCH201	I	Plant Biochemistry	4	1
	II	Endocrinology		1
	III	Biochemistry of Tissues		1
	IV	Bioluminescence, Unusual Biomolecules and Natural Bioactive Compounds		1
PSBCH202	I	Centrifugation	4	1
	II	Chromatography		1
	III	Electrophoresis & Sequencing Techniques		1
	IV	Special Instrumental Methods of Analysis		1
PSBCH203	I	Carbohydrates, Proteins and Lipids of Industrial Importance	4	1
	II	Environmental Biotechnology		1
	III	Nanotechnology and other topics		1
	IV	Bioinformatics - II		1
PSBCH204	I	Report writing & Presentation	4	1
	II	Estimation and testing of Hypothesis		1
	III	Non-parametric tests, Diagnostic Tests & Vital Statistics		1
	IV	Soft Skills Development - II		
PSBCHP201	Chromatography and Electrophoresis techniques.		2	4
PSBCHP202	Clinical Estimations		2	4
PSBCHP203	Extraction, Isolation Purification Techniques. Bioinformatics II		2	4
PSBCHP204	Biostatistics, Soft Skills Development-II		2	4

Detail Theory Syllabus
Semester I

Course Code		Title	Credits
PSBCH101		**Advanced Bioorganic Chemistry**	**4**
			No of
			Lectures
Unit I:	**Biochemical Basis of Evolution**		
1.1	**Biochemical Basis of Evolution**		**15**
	1.1.1	Theories of Evolution – Time scale and spontaneous origin of life.	
	1.1.2	Genesis of oxygen generating photosynthesis &aerobic respiration. Methanogens – evolution of prokaryotes, protists & eukaryotes	
	1.1.3	Oparin's Hypothesis, Miller Experiment, Smith's Model, RNA first model. Theories regarding origin of mitochondria and chloroplast	
	1.1.4	Evolution of proteins and nucleic acid – elastic analysis. Evolution of introns.	
	1.1.5	Evolutionary view of exon domain relationships.	
	1.1.6	Process or Origin of life of Eukaryotes, Molecular Evolution of Proteins	
Unit II:	**Bioenergetics**		
2.1	**Bioenergetics**		**15**
	2.1.1	Chemistry of Water. Laws of thermodynamics as applied to biological systems, enthalpy, entropy, free energy, standard free energy	
	2.1.2	Role of High Energy phosphates in Bio-energetics and energy capture, Theories of ATP Biosynthesis	
	2.1.3	Electron Transport Chain in Plants, Eukaryotes and Prokaryotes, Significance or Redox potentials, Mechanism of Oxidative Phosphorylation.Uncouplers and Inhibitors of energy transfer.	
	2.1.4	Numerical problems based on the above	
Unit III:	**Protein Chemistry & Enzymology**		
3.1	**Protein Chemistry**		**06**
	3.1.1	Polypeptide backbone, covalent and non-covalent interactions, end-group analysis by chemical and enzymatic methods, Conformation, Configuration	
	3.1.2	Details of 1^0, 2^0, $3^0$and 4^0structures, problems based on determination of 1^0structure, Ramachandran Plot, structure-function relation of protein (Ex. Hemoglobin)Protein-Protein interaction (actin, tubulin), Leucine zipper, Zinc finger, trans-membrane regions.	

	3.1.3	Chemical modification and cross-linking in proteins, dynamic propertiesand mechanisms of protein folding.Domains, motifs, and folds in protein structure. Prion proteins, prion domains. Their role in neurodegenerative disease.	
3.2	**Enzymology**		**09**
	3.2.1	IUB/EC Enzymes classification, active site identification and Conformation.	
	3.2.2	Thermodynamics of catalysis, energy activation, relation of ΔG and $K_{eq.}$ Coupled reactions (endergonic and exergonic) in biochemical pathways.	
	3.2.3	Michaelis-Menten Kinetics of monosubstrate enzyme reaction, LB Plot, Einsethal Cornish Bowden Plots	
	3.2.4	Mechanism of Enzyme Action for Acid –Base Electrostatic& Covalent Catalysis (Ex. Chymotrypsin, Carboxypeptidase-A),factors affecting catalysis. Metal, co-factor, and co-enzyme requirements	
	3.2.5	Enzyme Inhibition-Reversible, Competitive, Non-Competitive, Uncompetitive, Partial, Mixed, Allosteric Irreversible and Feedback Inhibition. Enzyme inhibitors as drugs	
	3.2.6	Allosteric Enzymes-Kinetics, Significance of Sigmoidal Behaviour, Role in Metabolic Regulation.	
	3.2.7	Iso-enzymes – separation and significance	
	3.2.8	Clinical Enzymology- Enzymes as therapeutic agents, diagnostic tools and laboratory agents.	
Unit IV:	**Membrane Biochemistry& Cell Signalling**		
4.1	**Membrane Biochemistry**		**07**
	4.1.1	Biological membrane; structure and assembly: constituents, bacterial cell envelop, asymmetry flip flop, protein lipid interaction, factors affecting physical properties of membranes.	
	4.1.2	Biological and physical membrane models. Specialized features like lipid rafts, caveolae and tight junctions.	
	4.1.3	Principles and Mechanism of Diffusion and Passive, Active & Facilitated Transport. Endocytosis, Exocytosis.	
	4.1.4	Specialized mechanism for transport of macromolecules, gap junctions, nuclearpores, toxins, control of transport processes, binding proteins, hormone effects	
	4.1.5	Role of Na, K ATPase and the passive permeability of the plasma membrane to Na, K, Cl, voltage and ligand gated ion channels, ATP-ADP exchanger. Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism. Disorders resulting from abnormalities in membrane structure and functions. Familial Hypercholesterolemia, Cystic Fibrosis, Hereditary Spherocytosis	
	4.1.6	Artificial Membranes (Liposomes) in Drug Delivery, Kinetics of Super-molecular. Membrane Assembly -Viruses and Ribosomes.	

4.2	**Cell Signalling**		**08**
	4.2.1	Classes of Cell Receptors, Molecular Mechanism of Cell Signalling via G-protein linked Cell Surface Receptors. Signalling molecules and their receptors. Modes of cell-cell signalling (endocrine, paracrine and autocrine) Steroid hormones, thyroid hormones, Vitamin D_3 and retinoic acid. Steroid superfamily receptors and their functions. Nitric oxide, neurotransmitters, peptide hormones, growth factors, Eicosanoids, plant hormones. Trimeric G-proteins and their regulatory mechanism, Role of Ca^{++} as an intracellular signal, Ca^{++} / Calmodulin dependent protein kinase, cAMP- Ca^{++} Pathway	
	4.2.2	Pathways of intracellular signal transduction cAMP, cGMP, Phospholipid and Ca. Ras, Raf and MAP kinase pathways JAK/STAT pathway	
	4.2.3	Signal transduction and cytoskeleton. Integrin and signal transduction; regulation of Actin Cytoskeleton signalling in development and differentiation, using following examples ; mesoderm, induction in xenopus and eye development in Drosophila	
	4.2.4	Programmed Cell Death (apoptosis) involving onco-genes and tumor suppressor genes	

Course Code		Title	Credits
PSBCH102		**Advanced Instrumentation and Analytical Techniques**	**4**
			No of
			Lectures
Unit I:	**Colligative Properties**		
1.1	**Colligative Properties**		**15**
	1.1.1	Definitions, Factors affecting , measurement of and physiological applications of Osmosis, Osmotic Pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity	
	1.1.2	Numerical Problems based on above concepts	
	1.1.3	Medical Imaging: Introduction to CT Scan, MRI, PET , X ray, ultrasound systems, colour flow imaging applications	
Unit II:	**Acids, Base & Buffers**		
2.1	**Acids Bases and Buffers**		**15**
	2.1.1	Ionization, Dissociation, Acidity, Basicity theories of Acid and Bases, Strength of Acids and Bases, Acid-Base Equilibrium in Aqueous and Non-aqueous media	
	2.1.2	pH, pH-dependent functions and structures of bio-molecules, Henderson –Hasselbach Equation, different methods for measurement of pH. ABG Analyzer. Use of Indicators, Buffers, Amino Acid titrations, Formal Titration. Biologically important buffers, Buffering of blood.	
	2.1.3	Numerical problems based on the above	
Unit III:	**Microscopy and Radioactive Techniques**		
3.1	**Microscopy**		**07**
	3.1.1	Basic principles, instrumentation and application of Phase, ultraviolet and interference microscope and Fluorescence microscopy	
	3.1.2	Electron microscope – scanning emission microscopy, transmission emission microscopy	
	3.1.3	Confocal microscopy and Atomic force microscopy	
3.2	**Radioisotope Techniques**		**08**
	3.2.1	Nature of radioactivity & its detection and measurements of Radioactivity, Radioactive decay, Interaction of radioactivity with matter GM Counter, Scintillation Counter, Advantages and Disadvantages of Scintillation Counting Pulse Height Analyser.	
	3.2.2	Isotope Dilution, Analysis, Autoradiography, Application of Radioisotopes in Biological Science	
	3.2.3	Safety Measures in Handling Isotopes.	

Unit IV	Spectroscopic Techniques		
4.1	**Spectroscopic Techniques**		**15**
	4.1.1	Beer-Lamberts Law, its verifications and deviations, concept of Absorptions, Transmission, Scattering, Phosphorescence, Fluorescence, Luminescence, Diffraction Spectra, and interpretation. Infrared Spectra of common functional groups	
	4.1.2	Principle Instrumentation, working and application of – U V, Visible and IR Spectroscopy, Disadvantages of IR spectroscopy, Turbidometry and Nephlometry.	
	4.1.3	Principle, instrumentation, working and applications of – Spectrofluorometric, Flame Spectrophotometry, Atomic Absorption Spectrometry, Luminometry. Fluorescence Spectra and the study of protein structure.	
	4.1.4	Principle, instrumentation, working and application of- Nuclear Magnetic Resonance(NMR), Electron Spin Resonance (ESR), Mass Spectrometry, Mossbauer Spectroscopy, Matrix Assisted LASER Desorption, Ionization, Time of Flight-Mass Spectroscopy (MALDI-TOF-MS), Inductively Coupled Plasma Mass Spectrometer (ICP-MS)	
	4.1.5	X-Ray Diffraction Spectra, Optical Rotatory Dispersion, (ORD), Circular Dichroism (CD)	
	4.1.6	LASER- Principle, applications in Medicine and Biological Sciences	

Course Code		Title	Credits
PSBCH103		**Industrial Biochemistry and Bioinformatics - 1**	**4**
			No of
			Lectures
Unit I:	**Bioprocess Technology & Fermentation**		
1.1	**Bioprocess Technology**		**08**
	1.1.1	Types of Bioreactors- Stirred Tank, Recycle reactors, discontinuous, semi continuous and continuous.	
	1.1.2	Parameters for Bio process – Bio mass, Substrates, product, O_2 and CO_2, Temperature, agitation.	
	1.1.3	Bio process monitoring with respect to O_2 transfer, energy transfer, rate of utilization, efficiency and computer base monitoring.	
	1.1.4	Downstream processing, process for product recovery, recycling of residual raw, by- product recovery, waste/effluent treatment.	
1.2	**Fermentation**		**07**
	1.2.1	Primary and secondary of microbes, inoculums preparation, fermentation media, industrial sterilization, strain improvement, metabolic and genetic regulations during fermentations, pure and mix culture fermentations.	
	1.2.2	Products from microorganisms – enzymes (Amylases, Proteases, Pectinases), Primary metabolites (Glu, vit B12), Antibiotics (Penicillin), Beverages (wine, Beer)	
	1.2.3	Fuels from microbes, microbial polymers and microbial steroid bio transformations.	
Unit II:	**Technologies in cell and tissue culture**		
2.1	**Plant Tissue Culture (PTC)**		**05**
	2.1.1	Principles, Techniques, Methodology and Application of PTC	
	2.1.2	Micropropogation and Protoplast fusion	
	2.1.3	Suspension Cultures for production and secondary metabolites	
	2.1.4	Use of PTC in production of transgenics.	
2.2	**Animal Tissue Culture (ATC)**		**05**
	2.2.1	Principles, Techniques, Methodology and Application of ATC	
	2.2.2	Transfection using eggs, cultured stem cells and nuclei in development of transgenic animals.	
	2.2.3	Frontiers of contraceptive research, cryopreservation of sex Gametes & embryos, Ethical issues in embryo research.	
2.3	**Microbial Tissue Culture (MTC)**		**05**
	2.3.1	Principles, Techniques, Methodology and Application of MTC	
	2.3.2	Commercial production of industrially important microbial strains, role of ATCC and microbial cell banks.	
	2.3.3	Microbes as products, Single Cell Protein (SCP) and Yeast(nutrient)	

Unit III:	**Techniques in Food Preservation**		
3.1	**Bio Chemistry of Food Spoilage**		**05**
	3.1.1	Factors causing food spoilage during food ripening, vegetable maturation and their control.	
	3.1.2	Post mortem changes in meat and their control.	
3.2	**Food Preservation**		**05**
	3.2.1	General principles of food preservation	
	3.2.2	Preservation by use of high and low temperatures, drying, radiations, natural & chemical preservatives, inert gases, mechanical preservation techniques (vacuum packaging, tetra packs), pulse electric field special packaging.	
3.3	**QC, GMP and other topics**		**05**
	3.3.1	General principles of Quality Control and Good Manufacturing Practices in food industry.	
	3.3.2	Determination of shelf – life of food products, transport of perishable food items.	
	3.3.3	Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection.	
	3.3.4	Role of ISI Agmark FDA & Food Safety and Standards Authority of India (FSSAI), Food and Agricultural Organisation (FAO) in food industry..	
Unit IV:	**Bioinformatics - I**		
4.1	**Introduction to Bioinformatics**		**08**
	4.1.1	Central Dogma of Molecular Biology	
	4.1.2	Human Genome Project- Ethical, legal and social issues	
	4.1.3	Bioinformatics- Need and applications on various fields of Biology	
	4.1.4	Introduction to Next-Generation Sequencing technology (NGS)	
	4.1.5	Introduction to Databases- Biological application and Classification	
4.2	**Biological Databases and retrieval techniques**		**07**
	4.2.1	Nucleotide Databases- Genbank, Unigene	
	4.2.2	Literature Database- Pubmed, Medline	
	4.2.3	Protein Sequence Databases- Swissprot, PIR	
	4.2.4	Protein Structural Databases- PDB, SCOP, CATH	
	4.2.5	Metabolic pathway database- KEGG, Metacyc	
	4.2.6	Other databases- OMIM, Taxonomy	

Course Code		Title	Credits
PSBCH104		**Research Methodology, Biostatistics and Soft Skills Development**	**4**
			No of
			Lectures
Unit I:	**Research &Research design**		
1.1	**Research**		**08**
	1.1.1	Meaning of research, Research Process, Types of research	
	1.1.2	Formulating research problem	
	1.1.3	Criteria for good research. Significance of research.	
1.2	**Research Design**		**07**
	1.2.1	Meaning, features of good research design, types of research designs.	
	1.2.2	Basic principles of experimental designs.	
	1.2.3	Prospective, retrospective, prospective & retrospective, observational, clinical trials, RCT, Cohort, cross sectional and case controlled studies.	
Unit II:	**Presentation & Processing of Data**		
2.1	**Scales of Measurement**		**05**
	2.1.1	Nominal, Ordinal, Interval, Ratio, Discrete, Continuous	
2.2	**Descriptive Statistics: Presentation of Data**		**06**
	2.2.1	Diagrammatic Presentation: Graphs and Charts; Tabular presentation	
	2.2.2	Skewness, Kurtosis, Quantiles, Outliers	
	2.2.3	Measures of Dispersion: Quartile deviation, Mean deviation	
	2.2.4	Standard deviation, Standard error, Variance, Coefficient of variation. Measures of skewness (Karl Pearson, Bowley)	
2.3	**Normal Distribution.**		**04**
	2.3.1	Probability mass/density function, cumulative mass/density function	
	2.3.2	Properties of Normal distribution	

Unit III:	Analysis of Data and Sampling Techniques		
3.1	**Sampling**		**05**
	3.1.1	Representative sample, sample bias	
	3.1.2	Sampling techniques- Simple, random, systematic, Stratified, Cluster, multistage	
	3.1.3	Correlation and regression analysis. Simple correlation and regression. Multiple correlation and regression, partial correlation, logistic regression. Partial correlation analysis.	
3.2	**Diagnostic Tests**		**04**
	3.2.1	Importance of diagnostic tests	
	3.2.2	Sensitivity, specificity, positive predictive value, negative predictive value, accuracy, probability and odds ratio, likelihood ratio(LR), LR of positive test, LR of negative test Receiver operating characteristics (ROC) curves	
3.3	**Demography & Vital Statistics**		**06**
	3.3.1	Collection of demographic data, vital statistics at state & National levels, reports of special demographic surveys.	
	3.3.2	Measures of vital statistics: Rate of mortality, fertility, reproduction, morbidity, comprehensive indicators, indices of health population growth rates and density of population.	

Unit IV:	**Soft Skills Development - I**		
4.1	**Personal Skills**		**07**
	4.1.1	Personality Development- Self Esteem, Positive Thinking, Johari Window, Physical Fitness.	
	4.1.2	Emotional Intelligence (EI) & Quotient (EQ)- Meaning, Components of EI, IQ v/s EQ, Components of EI, Skills to develop EI	
	4.1.3	Etiquettes & Manners – Meaning, Professional & Technology etiquettes.	
	4.1.4	Communication Skills – Process & Significance of Communication, Verbal, Non- verbal, formal & informal communication, Barriers, Techniques to improve LSRW, Intercultural & Digital Communication	
4.2	**Interpersonal Skills and Entrepreneurship**		**08**
	4.2.1	Leadership & Team Building- Leadership Types/ Styles/ Trails/ Trends, Types of Teams & Team Building, Group Dynamics.	
	4.2.2	Decision Making - Introduction, Steps/ Techniques/ Process of Decision Making, fundamentals/ Styles/ Major Concepts of Negotiations.	
	4.2.3	Stress & Time Management - Sources of & ways to cope with stress, Planning & scheduling of work/ professional/ rewinding/ refreshing/ hobbies.	
	4.2.4	Entrepreneurship & Start-ups – Employment v/s self employment, Govt. Schemes & funding Agencies for start – ups.	

Detail Syllabus for
Semester- I Practical

PSBCHP101: Colorimetry, Volumetry, Enzymology, Buffers and Microscopy

1. Estimation of:
    a. Proteins by Bradford &Folin-Lowry methods
    b. Amino acids by Ninhydrin method
    c. Glucose by Anthrone &Folin-Wu methods.
    d. Percentage Purity of Start from Starch Hydrolystate by Willstatter's method.
2. Enzymology:
    a. Amylase (Km, optimum pH, optimum temperature) from Sweet Potatoes.
3. Buffers and Microscopy:
    a. pka values of Ala or Gly by Titration Curve
    b. Microscopy: (Permanent Slides may be used)
        i. Gram Staining
        ii. Spores Staining
        iii. Capsule Staining
        iv. Acid Fast Staining

PSBCHP102: Biochemical/ Clinical Analysis

1. Estimation of: (from blood/plasma/serum/urine)
    a. Glucose by GOD-POD Method
    b. Triglycerides
    c. Cholesterol by Zak and Zaltsky Method
    d. Calcium (Ca) by Clark and Collip Method/ Trinder Method
    e. Iron (Fe) by Dipyridyl Method
    f. Copper (Cu) by Dithiocarbonate Method
    g. Phosphorus (P) by Fiske- Subbaraow Method

Experiments for Semester End Practical Examination (50Marks)

PSBCHP103: <u>Isolation, Preparation, Extraction Assays& Bioinformatics – I</u>

A) Proteins:Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following.
   a. Casein from milk
   b. Albumins and globulins from egg white
   c. Proteins from germinating seeds

B) Enzymes: Extraction, Partial Purification of the following enzymes and determination of their Km values
   a. GPT from Germinating Moong Seeds
   b. Alkaline Phosphatase from Germinating Moong Seeds

C) Estimation of Sodium Benzoate from Jam/ Jelly

D) Bioinformatics –I: Biological information retrieval from databases

   a. Data retrieval from NCBI- Pubmed, Medline, Nucleotide, UniGene, Protein, Mapviewer, SNP, OMIM
   b. Data retrieval from EBI- SwissProt, PIR, ENA, Taxon
   c. Data retrieval using InterPro, SCOP

PSBCHP104: <u>Research Methodology, Biostatistics And Soft Skills Development</u>

1. Preparation of Research Proposal for Minor / Major Research Projects to be submitted to the funding agencies
2. Review of Research work being carried out at any five National/ International Research Centers or Institutes
3. One numerical problem each on
   a. Measurement of Central Tendency (Mean, Median, Mode)
   b. Measurement of Dispersion/variability (Mean Deviation, Standard Deviation efficient of variation)

4. Soft Skills Development: Case Study / Role Play / Quiz.

Experiments for Semester End Practical Examination (50Marks)

Detail Theory Syllabus
Semester II

Course Code		Title	Credits
PSBCH201		**Advanced Bioorganic Chemistry**	**4**
			No of
			Lectures
Unit I:	**Plant Biochemistry**		
1.1	**Photosynthesis**		**07**
	1.1.1	Chlorophylls and accessory pigments	
	1.1.2	Photosynthesis-Light and Dark Phases, Schemes-I, II & Z, Cyclic and Non-Cyclic Photophosphorylation, C-3 & C-4 Pathways, CAM pathway.	
	1.1.3	Biosynthesis of Starch Sugars and Cellulose from Glucose	
1.2	**Plant Physiology**		**08**
	1.2.1	Photorespiration and photoperiodism	
	1.2.2	Plant growth hormones- Auxins-Gibberellins Cytokines Abscisic Acid and Ethylene, artificial plant growth hormones	
	1.2.3	Photosynthesis in Bacteria, Fungi, Algae and Yeast.	
	1.2.4	Nitrogen Fixation and Sulphur Assimilation in Plants	
Unit II:	**Endocrinology**		
2.1	**Endocrine System**		**07**
	2.1.1	Organization of Mammalian Endocrine System, Classification of Hormones.	
	2.1.2	Biosynthesis, Storage, Secretion, Transport and Metabolic effects (including hypo and hyper conditions) of Hormones of Pituitary, Hypothalamus, Parathyroid, Adrenal Medulla, Adrenal Cortex, Gonads, Kidneys and G I Tract.	
2.2	**Mechanism of Hormone action**		**03**
	2.2.1	Role of Secondary Messengers-cAMP, cGMP, Ca and Calmodulin.	
	2.2.2	Cell membrane and intracellular receptors for hormones. Regulatory pathways (positive, negative, feedback loops)	
2.3	**Endocrine regulation**		**05**
	2.3.1	Regulation of growth, stress, hunger, digestion, obesity, renal function, cardiovascular system [angiotensin, BNP, endothelin 1 (ET-1)]	
	2.3.2	Endocrinology of fertility (Changes in menstruation, pregnancy & menopause). Medical uses of steroid hormones (contraception, HRT, hydrocortisone, anabolic steroids). Erythropoietin, Adipocytokines, Orexins	

Unit III:	Biochemistry of Tissues		
3.1	**Muscle**		**04**
	3.1.1	Muscles- Structure and composition of muscle fibres, mechanism of muscle contraction and relaxation.	
	3.1.2	Energy source for muscular work, muscular dystrophies	
3.2	**Bone**		**03**
	3.2.1	Composition, formulation, Structure and functions.	
	3.2.2	Factors affecting bone metabolism, bone remodelling, osteoporosis, osteomalacia	
3.3	**Nerve Tissue**		**05**
	3.3.1	Nerves- Structure of Neuron, chemistry of nerve tissue, mechanism of nerve impulse transmission, synapse and synaptic transmission,	
	3.3.2	Synthesis and actions of neurotransmitters (GABA, Acetylcholine, Dopamine), disorders related to defects in neurotransmission– (Parkinson's disease, stroke, Alzheimer's disease) Biochemistry of memory mechanisms, Blood Brain Barrier, Sensory Receptors of Taste, Vision, Odour, Hearing, Touch	
3.4	**Connective Tissue**		**03**
	3.4.1	Connective Tissue- Biosynthesis, composition, structure.	
	3.4.2	Metabolism of Collagen and its Disorders-Ehler's Syndrome (Type I to VII), Osteogenesis Imperfecta (Type I to IV), Paget's disease	

Unit IV:	**Bioluminescence, Unusual Bio-moleculesand Natural Bioactive Compounds**		
4.1	**Bioluminescence**		**05**
	4.1.1	History, Source of Bioluminescence material, examples of bioluminescence organism	
	4.1.2	Mechanism of Bio-luminescence in specific organisms, Evolution and Bioluminescence.	
	4.1.3	Use and applications of bioluminescence	
4.2	**Unusual Bio-molecules**		**05**
	4.2.1	Prions, Fullerenes, Small Nuclear Riboproteins (SNURPNs), Lectins, Antifreeze proteins, Stress Proteins, Chaperons, Ionophores (Crown ethers, Cryptans)	
	4.2.2	Biomimetic Chemistry- Mimicking of Ion Channels, Enzyme receptor carriers, antibodies, Vesicles and Sensors, Enzyme Mimicking-Cram's Protease Model, Rebok's allosteric Model and Flavinophores for NAD	
	4.2.3	Host-guest Chemistry-Cyclophanes, Calixanes, Cyclodextrins, Cyclopeptides.	
4.3	**Natural Bioactive Compounds**		**05**
	4.3.1	Industrially & pharmacologically important primary &secondary metabolites from living cells	
	4.3.2	Occurrence/ Source, Chemistry, Isolation, Biosynthesis(Schematic) mode of action and physiological significance/ importance/ application of Antibiotics, Toxins & Glycolipids from bacteria, enzymes, isoprenyl glycerol ethers from Archaea, Antibiotics, anticancer agents & ACE Inhibitors from fungi, Venoms (snakes & scorpions), ω-conotoxin (marine snail), ecteinascidin (tunicate), discodermolide (sponge) aleutherobin (coral) and biostalins (bryozoan) from animals Phytochemicals (phenols, polyphenols, tannins, terpenes &alkaloids) from plants.	

Course Code		Title	Credits
PSBCH202		**Advanced Instrumentation and Analytical techniques**	**4**
			No of
			Lectures
Unit I:	**Centrifugation**		
1.1	**Centrifugation**		**15**
	1.1.1	Basic principles of sedimentation, relation between g, rpm and Svedberg constant.	
	1.1.2	Principles, Instrumentation, Working and Applications of Preparative and Analytical Ultracentrifugation, Isopycnic Centrifugation, Rate Zonal Centrifugation	
Unit II:	**Chromatography**		
2.1	**Chromatography**		**15**
	2.1.1	Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), Absorption Chromatography (TLC, HPTLC, Column), Affinity Chromatography, Ion Exchange Chromatography,	
	2.1.2	Basic Principles, Instrumentation, working and applications of Permeation Chromatography, Gas-Liquid Chromatography (GLC), High Pressure Liquid Chromatography (HPLC), High Resolution Liquid Chromatography Mass Spectrometry (HR LC-MS)	
Unit III	**Electrophoresis & Sequencing Techniques**		
3.1	**Electrophoresis**		**08**
	3.1.1	Basic principles, factors affecting electrophoresis, support media used	
	3.1.2	General principles, instrumentation, working and applications of electrophoretic techniques-zone, Disc, Capillary, 2-D, Pulsed Field Gel, Diagonal, Isoelectric Focussing, immune-electrophoresis	
	3.1.3	Gel Documentation System	
3.2	**Sequencing Techniques**		**07**
	3.2.1	Basic Principles and Instrumentation, working and applications of-Purification of Proteins/ Enzymes Protein Sequencing Techniques, DNA Sequencing Techniques Sequencing Techniques Blotting Techniques	
Unit IV:		**Special instrumentation- Methods and Analysis**	
4.1	**Special instrumentation- Methods and Analysis**		**15**
	4.1.1	Basic Principles, Instrumentation, working and applications of Flow Cytometry Electroporation, Autoclave, Inspissator	
	4.1.2	Basic Principles, Instrumentation, working and application of Conductometry, Potentiometry, Selective Ion Meters, High Frequency Titrations, Polarography, Anode Stripping Voltammetry, Neutron Activation Analysis.	

Course Code		Title	Credits
PSBCH203		**Industrial Biochemistry and Bioinformatics - 2**	**4**
			No of
			Lectures
Unit I:	**Carbohydrates, lipids and proteins of Industrial Importance**		
1.1	**Carbohydrates of industrial importance**		**04**
	1.1.1	Manufacturing and refining of cane sugar, starch, pectin & cellulose	
	1.1.2	Manufacturing of polysaccharides. Plant polysaccharide (Gum Arabic), microbial polysaccharides, modified carbohydrates – modified starches, modified celluloses.	
1.2	**Lipids of industrial importance**		**03**
	1.2.1	Extraction and refining of vegetable oils and animal fats in general.	
	1.2.2	Extraction and applications of chlorophyll, carotene, lycopene Turmeric and essential oils.	
1.3	**Proteins of industrial importance**		**03**
	1.3.1	Isolation and purification of Proteins & Enzymes – Source identification, isolation, recovery, concentration.	
	1.3.2	Partial/total purification by salting in, salting out, precipitation, ion exchange, dialysis, ultra-filtration, column chromatography(Gel filtration, Affinity, HPLC)	
1.4	**Enzyme Immobilization**		**02**
	1.4.1	Methods of immobilization	
	1.4.2	Applications in industry and medicine	
1.5	**Production of vaccines, hormones and industrial proteins**		**03**
	1.5.1	Vaccines & Anti – toxoid Technology for measles, poliomyelitis, typhoid, Hepatitis B, AIDS, anti-tetanus.	
	1.5.2	Hormones – conventional & engineered Insulin, Erythropoietin, Growth hormones	
	1.5.3	Non – catalytic industrial proteins – casein, whey proteins, Egg proteins, wheat germ proteins.	

Unit II:	**Environmental Biotechnology**		
2.1	**Air Pollution**		**04**
	2.1.1	Air pollution – classification & effects of air pollutants on human health, Gases containing the oxides of carbon, sulphur and nitrogen, ozone and CFC. Measures to control air pollution and suspended particulate matters in air.	
	2.1.2	Greenhouse effect & Global warming – sources, consequences & remedial measures.	
2.2	**Water Pollution**		**04**
	2.2.1	Sources and effects of water pollutants on human health, quality standards for drinking water, waste water treatment and recycling.	
	2.2.2	Concept and significance of BOD, COD and dissolved oxygen	
2.3	**Noise Pollution**		**02**
	2.3.1	Sources, measurement, health hazards, prevention & control of noise pollution.	
2.4	**Toxins in environment**		**05**
	2.4.1	Chemical toxicology – Biochemical effects of heavy metals (Pb, As, Hg, Cd), pesticides, insecticides, herbicides, weedicides, larvicides, polyaromatic hydrocarbons, dyes, monomeric and polymeric organics.	
	2.4.2	Emerging eco-friendly alternatives for chemical industry – Green chemistry and Green Technology.	
Unit III	**Nanotechnology and other topics**		
3.1	**Nano biotechnology**		**07**
	3.1.1	Definition and methods of preparation of nano-bioparticles.	
	3.1.2	Applications in drug designing, drug delivery & protein engineering	
3.2	**Other Topics**		**08**
	3.2.1	Biosensors – Construction, uses in industrial and environmental processes and medical applications.	
	3.2.2	Principles, techniques and applications of – Liposome formation, natural & synthetic biofilms.	
	3.2.3	Clinical diagnostics – Diagnostic Kits and their applications.	
	3.2.4	Concept and significance of Bio safety, Bio Hazards and Bio ethics.	
	3.2.5	Concept of QC, QA, GMP, GLP in labs & production processes. Lab/process validation & Accreditation.	
	3.2.6	Maintenance & Management of Lab/Experimental animals and Animal House CPCEA guidelines.	

Unit IV:	**Bioinformatics - II**		
4.1	**Genomic and Protein Sequence Analysis**		**08**
	4.1.1	Pair wise sequence alignment, gaps, gap-penalties, scoring matrices- PAM, BLOSUM, Local and global sequence alignment	
	4.1.2	Nucleotide and Protein sequence analysis using BLAST and variants	
	4.1.3	Introduction to multiple sequence alignment- Progressive algorithms- Clustal programs.	
4.2	**In-silico Protein structure prediction**		**07**
	4.2.1	Introduction to protein structure	
	4.2.2	Protein-protein interaction	
	4.2.3	Computational methods in protein Secondary structure prediction	
	4.2.4	Computational methods in protein Tertiary structure prediction Homology modelling	

Course Code		Title	Credits
PSBCH204		**Research Methodology, Biostatistics & Soft Skills Development.**	**4**
			No of
			Lectures
Unit I:	**Report Writing & Presentation**		
1.1	**Report Writing**		**08**
	1.1.1	Significance of report writing, different steps in report writing types of report.	
	1.1.2	Mechanics and precautions of writing research reports for scientific journals, popular magazines, seminars/symposia/ conferences/workshops	
	1.1.3	Layout of research paper, Layout for poster.	
1.2	**Presentation**		**07**
	1.2.1	Presentation – Oral & Written. Use of digital media.	
	1.2.2	Presentations in classrooms, scientific meets & public audience.	
	1.2.3	Defence of research thesis.	
Unit II			
2.1	**Estimation and testing of Hypothesis**		**09**
	2.1.1	Properties and use of Normal Tables	
	2.1.2	Testing of Hypothesis – Type I and Type II errors, Level of Significance. Confidence Interval. Z- Test for testing population mean(s) and proportion(s). t- test for testing population mean. Paired & Unpaired t-test for testing population means	
2.2	**Estimation and Testing of Population Parameters**		**03**
	2.2.1	Estimator of population proportion and mean and their sampling distribution	
2.3	**Measures of outcome of clinical interventional studies:**		**03**
	2.3.1	Relative Risk(RR), Relative Risk Reduction(RRR) and Odds Ratio(OR)	

Unit III:	Non-Parametric tests & Analysis of Data		
3.1	**Non-parametric tests**		**05**
	3.1.1	Importance of non-parametric tests.	
	3.1.2	Chi square test of goodness of fit.	
	3.1.3	Chi square test for independence of attributes & yate's correction.	
3.2	**Analysis**		**06**
	3.2.1	Univariate and multivariate analysis. Brief introduction to three main frameworks: Monte-Carlo analysis, Parametric analysis, Bayesian analysis	
	3.2.2	Data Analysis: Computing sums of squares, standard error of differences between means, fitting data to linear model, variances and covariances, least square parametric estimation, hypothesis test with regression	
	3.2.3	ANOVA and partitioning of sum of squares, assumptions, hypothesis tests with ANOVA, constructing F Ratios, ANOVA Tables, Analysis of categorical data, two way contingency tables, Chi-square & G-Test	
3.3	**Power Analysis**		**02**
	3.3.1	Power analysis for contingency tables, t tests, ANOVA, correlation & regression models. Sample size calculation.	
3.4	**Measures of Association**		**02**
	3.4.1	Yule's coefficient of association	
	3.4.2	Spearman's Rank correlation coefficient	

Unit IV	**Soft Skills Development – 2**		
4.1	**Professional Skills**		**07**
	4.1.1	Creativity at Workplace – Types of Workplace, Creativity/ Motivation/Innovativeness/ Initiative at Workplace	
	4.1.2	Ethical Values – Ethics/ Values/ Morals, Nurturing work ethics, Gender, neutrality, Human Rights	
	4.1.3	Capacity Building – Learn, Unlearn & Relearn, Skills for capacity building, Zones & Ideas for Learning, Strategies for capacity building.	
4.2	**Employment Skills**		**08**
	4.2.1	Employment Communication – CV & Resume Building, Scanable CV, Formats of CV/ Resume/ Job Application/ Covering Letter, professional presentations.	
	4.2.2	Job Interviews – Background information, Types & preparatory steps for Interviews, developing interview Skills, Mock Interviews, FAQs in Interviews.	
	4.2.3	Group Discussion – Ambience & Seating arrangements for GD, Importance & significance of GD, GD/ Panel Discussion/ Debate, Types of GD (Topics – based & Case- based), Analysis of personal traits in GD.	

Detail Syllabus for

Semester- II Practical

PSBCHP201: Chromatography and Electrophoresis Techniques

1. Extraction of Plant Pigments from Spinach Leaves and their separation by Column Chromatography
2. Assay of Hormone
3. Chromatography:
    a. Ascending and Circular paper for Amino Acids and Sugars
    b. TLC of Oils
4. Electrophoresis:
    a. Serum Proteins Electrophoresis (Agar/Agarose)
    b. Hemoglobin Electrophoresis (Normal/Abnormal)
5. Separation of Glucose and Starch (Gel filtration)
6. Separation of Starch and Casein (Gel filtration)

PSBCHP202:Clinical Estimations

1. Estimation of: from blood/plasma/serum/urine)
    a. Creatinine by Jaffe's method
    b. Blood Urea Nitrogen (BUN)by Diacetyl Monoxime Method
    c. Uric Acid by Caraway method
    d. Hemoglobin by Drabkin Method
    e. Differential Proteins (A/G Ratio) by Reinhart Biuret Method

PSBCHP203: Extraction, Isolation, Partial Purification Techniques

Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following:

1.Carbohydrates:
   a. Cellulose from Grass
   b. Glycogen from Liver
   c. Starch from Potato
   d. Pectin from apples/bananas/oranges

2.Lipids:
   a. Estimation of Lecithin and cholesterol from egg yolk
   b. Estimation of Essential oils from orange peels

3.Pigments (Separation of the following pigments on TLC slides):
   a. Curcumin from Turmeric
   b. Carotenes from carrots
   c. Chlorophylls from spinach

4.Estimation of
   a. Total Alkalinity of Water Effluent
   b. COD of Waste Water
   c. Total Hardness of Well Water
   d. Chlorides from Water Sample by Schales&Schales Method

5.Bioinformatics II
   a. Sequence and Structure analysis
   b. Database Similarity Search using BLAST variants
   c. Multiple Sequence Alignment- Clustal Omega, T-Coffee
   d. Structure Visualization using RASMOL

PSBCHP204: Biostatistics and Bio-informatics

1. One numerical problem each on
    a. Z-Test
    b. T-Test
    c. Chi-Squares Test
    d. Simple Regression
    e. Multiple Regression

2. Soft Skills Development – II: Group Discussions, Personal Interview (PI), Exercise in resume writing.

3. Research paper given to students to prepare presentation for poster/newspaper(for layman)

4. Student will be required to:

    a. Access at least five scientific websites to collect relevant information with respect to the topics from the syllabus assigned to him or her by the teacher. A one [page summary per website visited (i.e. a total of five pages) should be entered in the journal as a part of practical IV. Teacher should encourage that different topics from the theory syllabus are given to student and student would access as far as possible different web sites form information collection.

    b. Select any two research papers from any leading nation and international scientific journals (not older than two years) and present these papers in his or her biochemistry department as if it his/her own research work. A one page summary per research work. A one-page summary per research paper presented (i.e. a total of two pages) should be entered in Journal as a part of practical IV. (Teacher may help students in selecting such research papers from the scientific journals available at their respective colleges or at other institutions/libraries). A compilation of research papers entitled “Papers in Bio-chemistry” edited by John Herriott, Gary Jacobson, Julius Marmur and William Parson published by Eddison-Wesley Publications Co. Menlo Park, California, USA may be referred to for classical original papers in biochemistry representing milestone discoveries in bio-chemistry such as Krebs Cycles, Structure of Myoglobin and Haemoglobin, etc.

A computer terminal with an internet connection will have to be made available in the department of biochemistry for conducting Practical 204.

Experiments for Semester End Practical Examination (50Marks)

Suggested Readings for Paper 101,201 and Practical 101,201.

Ref:

1. Bioenergetics (Fourth Edition), David G. Nicholls and Stuart Ferguson, Academic Press, 2013.
2. Fundamentals of Enzymology, Price.NC. And Stevens. L., Oxford University Press
3. Enzymes- Biochemistry, Biotechnology, Clinical chemistry- Palmer, T., Affiliated East-West press
4. Fundamentals of Enzyme Kinetics, Segel I H; Wiley Interscience,
5. Biochemical calculations, 2nd Edition by Irwin H. Segel. John Wiley & Sons,
6. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman
7. Enzymology by Dixon and Webb
8. Enzymes by Palmer
9. Biochemistry. Jeremy M. Berg, John L. Tymoczco, and LubertStryer: W.H. Freeman
10. Biochemistry. (4th Ed.). Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
11. Membranes and their cellular functions- IB Filnean, R. Coleman and R.H. Mitchell, 1984, Blackwell Scientific Publishers, Oxford, 3rd ed.
12. The Cell, 2nd edition A Molecular Approach Geoffrey M Cooper.Boston University Sunderland (MA): Sinauer Associates 2000.ISBN-10: 0-87893-106-6
13. Cell and Molecular Biology. D. P. De Robertis. Lippincott Williams & Wilkins ISBN: 9788184734508, 8184734506 Edition: 8th Edition, 2010
14. Harpers Illustrated Biochemistry 30th Edition that complies with legal requirement Jan 2015 by Victor W. Rodwell, David Bender , Kathleen M. Botham , Peter J. Kennelly.
16. Cell and molecular biology by Lippincott's illustrated Reviews
17. Williams Textbook of Endocrinology –Larsen, R.P. Korenberg, H.N. Melmed, S. and Polensky, K.S. Saunders.
18. Human Physiology –Chatterjee.C.C, Medical Allied Agency
19. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, White A, McGraw Hill
20. The metabolic basis of Inherited diseases (Vol I & II) Scriver CR..Valle D, Pub McGraw Hill
21. Vertebrate endocrinology. Norris DO (1985) 2nd Edition.
22. Endocrine Physiology- Martin C.R., (1985). Oxford University Press) N.Y.
23. Biochemistry. Zubay (1983) Addison, Wesley publ. Co.
24. Biochemical Endocrinology. E. Frieden (1983)
25. Chemistry of Natural products by SV Bhat, BA Nagasampagi & M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7)
26. Handbook of Pharmaceutical Natural Products by G Brahamachari,

Wiley-VCH (2010) (ISBN 978-3-52732148-3)
27. The secondary Metabolites Natural Products by JR Hansen, Royal Society of Chemistry (2003) (ISBN 0-85404-490-6)
28. Natural Products from Plants by PB Kaufman, CR press (1999) (ISBN 0-8493-3134-X)
29. Medicinal Chemistry of Bioactive Natural Products by X T Liang, WS Fang (Eds), Wiley Interscience (2006) (ISBN 0471-73933-2)
30. Brocchieri L, Karlin S (2005-06-10). "Protein length in eukaryotic and prokaryotic proteomes". Nucleic Acids Research. 33 (10): 3390–3400. doi:10.1093/nar/gki615. PMC 1150220. PMID 15951512.
31. Sanger, F. (1959-05-15). "Chemistry of Insulin". Science. 129 (3359): 1340–1344. doi:10.1126/science.129.3359.1340. ISSN 0036-8075. PMID 13658959.
32. Pauling L, Corey RB, Branson HR (1951). "The structure of proteins; two hydrogen-bonded helical configurations of the polypeptide chain". Proc Natl AcadSci USA. 37 (4): 205–211. doi:10.1073/pnas.37.4.205. PMC 1063337. PMID 14816373.
33. Chiang YS, Gelfand TI, Kister AE, Gelfand IM (2007). "New classification of supersecondary structures of sandwich-like proteins uncovers strict patterns of strand assemblage.". Proteins. 68 (4): 915–921. doi:10.1002/prot.21473. PMID 17557333.
34. Govindarajan S, Recabarren R, Goldstein RA (17 September 1999). "Estimating the total number of protein folds.". Proteins. 35 (4): 408–414. doi:10.1002/(SICI)1097
0134(19990601)35:4<408::AID-PROT4>3.0.CO;2-A. PMID 10382668.
35. Haynie DT, Xue B (2015). "Superdomain in the protein structure hierarchy: the case of PTP-C2.". Protein Science. 24: 874–82. doi:10.1002/pro.2664. PMC 4420535.
PMID 25694109.
36. Alberts, Bruce; Alexander Johnson; Julian Lewis; Martin Raff; Keith Roberts; Peter Walters (2002). "The Shape and Structure of Proteins". Molecular Biology of the Cell; Fourth Edition. New York and London: Garland Science. ISBN 0-8153-3218-1.
37. Anfinsen, C. (1972). "The formation and stabilization of protein structure". Biochem. J. 128 (4): 737–49. doi:10.1042/bj1280737. PMC 1173893. PMID 4565129.
38. Murzin, A. G.; Brenner, S.; Hubbard, T.; Chothia, C. (1995). "SCOP: A structural classification of proteins database for the investigation of sequences and structures" (PDF). Journal of Molecular Biology. 247 (4): 536–540. doi:10.1016/S0022-2836(05)80134-2. PMID 7723011.
39. Orengo, C. A.; Michie, A. D.; Jones, S.; Jones, D. T.; Swindells, M. B.; Thornton, J. M. (1997). "CATH--a hierarchic classification of protein domain structures". Structure (London, England : 1993). 5 (8): 1093–1108. doi:10.1016/S0969-2126(97)00260-8. PMID 9309224.
40. Zhang Y (2008). "Progress and challenges in protein structure prediction". CurrOpin Struct Biol. 18 (3): 342–348. doi:10.1016/j.sbi.2008.02.004. PMC 2680823. PMID 18436442.
41. Evolution and Diversity of life, E. Mayer Belknap Press Pub, 1976 2)
42. Population species and evolution (1973), E Mayer Press Pub.
43. Biochemistry ,Lehninger (1975) Worth pub 4) Origin of Eukaryotic cells, Margulis L.(1977)
44. Origin of Eukaryotic cells, MargulisL.(1977
45.Bioenergetics (Fourth Edition), David G. Nicholls and Stuart Ferguson,Academic Press, 2013
46. Fundamentals of Enzymology, Price.NC. And Stevens. L., Oxford University Press

47. Enzymes- Biochemistry, Biotechnology, Clinical chemistry- Palmer, T., Affiliated East-West press
48. Fundamentals of Enzyme Kinetics, Segel I H; Wiley Interscience,
49. Biochemical calculations, 2nd Edition By Irwin H. Segel. John Wiley & Sons,
50. Enzymology by Dixon and Webb
51. Enzymes by Palmer
52. Membranes and their cellular functions- IB Filnean, R.Coleman and RH Michell, 1984,Blackwell scientific publishers, Oxford, 3rd ed.
53. Chemistry of Natural products by SV Bhat, BA Nagasampagi & MSivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7)
54. Handbook of Pharmaceutical Natural Products by G Brahamachari,Wiley-VCH (2010) (ISBN 978-3-52732148-3)
55. The secondary Metabolites Natural Products by JR Hansen, RoyalSociety of Chemistry (2003) (ISBN 0-85404-490-6)
56. Natural Products from Plants by PB Kaufman, CR press (1999)(ISBN 0-8493-3134-X)
57. Medicinal Chemistry of Bioactive Natural Products by X T Liang, WS Fang (Eds), Wiley Interscience (2006) (ISBN 0471-73933-2)

Suggested Readings for Paper 102,202 and Practical 102,202

1. Van Holde KE – Principles of Physical Biochemistry, Prentice Hall, 1998
2. Wilson K & Walker J – Principles and Techniques of Practical Biochemistry. Cambridge Low Price Edition
3. Frelfelder D- Physical Biochemistry
4. Skoog Douglas A – Principles of Instrumental Analysis Harcourt Brace publishers, London
5. Harvey David – Modern Analytical Chemistry, International edition, McGraw, Hill, Boston
6. Srivastava VK and Kishore K – Introduction to chromatography: Theory & Practice, S Chand & Co, New Delhi
7. Holme David J – Problem solving in analytical biochemistry, H & Longman Sc. And Tech, Essex
8. Brave Robert D – Introduction to Instrumental Analysis, McGraw Hill Book Co, New York
9. Ninfa Alexander J and Ballou David P – Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald Science Press, Bethesda
10. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi
11. Rodney Boyer Experimental Biochemistry Pearson Publ. Sawheny and Singh
12. Practical Biochemistry by David Plummer
13. Physics of Diagnostic images by Dowsett.
14. Medical imaging by Christenson.
15. Greenberg David M – Metabolic Pathways. Vols. 2 and 3, 3rd editions. Academic Press, New York
16. Henry Richard et al – Clinical Chemistry, Principles and Techniques, 2nd edition, Harper and Row, New York
17. Kamal SH – Clinical Biochemistry for Medical Technologies, Churchill Livingston, London

18. Todd et al – Clinical Diagnosis and Management, 17th edition, WB Saunders, Philadelphia
19. Stokes Joan et al – Clinical Microbiology, Edward Arnold, London
20. Gill CV – Short cases in clinical biochemistry, Churchill Livingston, Edinburgh, 1984
21. Rao Ranganathan – Text book of biochemistry 3rd edition, Prentice Hall, New Delhi
22. Rodrigues Fred K Carbohydrate chemistry with clinical correlations, New Age International, New Delhi
23. BayensDominiezak – Medical biochemistry, Mosby Publishers, Harcourt, 1999
24. John Bernard Henry, Clinical Diagnosis and Management by Laboratory Methods, Saunders publications, 20th edition
25. Feitz – Clinical Chemistry
26. Nelson DI, Cox MM – Lehninger Principles of Biochemistry
27. Murrary Robert – Harper's biochemistry, 24th edition, Prentice Hall International UK LTD, 1990
28. Satyanarayanan – Biochemistry
29. Vasudevan Text Book of Medical Biochemistry
30. Voet&Voet – Biochemistry, 2nd edition
31. Chatterjee and RanaShinde Medical - Biochemistry

Suggested Reading for Paper 103,203 and Practical 103,203:

1. Industrial Microbiology – AH Patel, McMillan India Ltd, 1st Edition
2. Food Microbiology – Frazier &Westhoff, Tata McGraw Hill Publishers, New Delhi
3. Total synthesis of natural products, Vol I-John Apsinon
4. Chemical Process Industries – Norris Shreeve& Joseph Brink
5. Roger's Industrial Chemistry Vol I & II – Edited by CC Furnas
6. Merck Index, 10th Edition
7. Encyclopedia of chemical technology, 3rd Edition
8. Chemistry of Natural Products – Agarwal& Sharma
9. Industry chemistry of Fats and Waxes – JP Hilditch
10. Essential Oils, Vol I – Ernst Guenther
11. Natural and Synthetic colouring matter and related fields – JS Gore, Joshi
12. EncyclopediaBritannica, Vol IV & V
13. Principles of Environmental Chemistry – Kothandaram&Swaminathan, BI Publishers, Chennai
14. Environmental Chemistry – AK De, New Age International Publishers, 4th Edition
15. Molecular Biology and Biotechnology – Edited by JM Walker & EB Gingdd, Panima Educational Book Agency, New Delhi, 2nd Edition
16. GMP for pharmaceuticals, A plan for TQC – SH Wiling & JR Stoker, Marul Dekker Inc., New York, 4th Edition, 1997
17. Total Quality Assurance for the Food Industries – WA Gould & RW Gould. CTI Publications Inc., USA 1988
18. Current Good Manufacturing Practices for Food Plan Sanitation – WA Gould, CTI Publications Inc. USA 1980
19. Fundamental Concepts of Environmental Chemistry – Sodhi, Narosa Publishing House, 2002
20. Introduction to plant Biotechnology – HS Chawla, oxford & IBH Publishing Co, New Delhi, 2nd Edition.
21. Nanotechnology, A Genetic Introduction to the next big idea – Mark Ratner & Daniel Ratner, Pearson Education

22. Animal Biotechnology – Edited by AK Srivastava, oxford & IBH publishing Co, New Delhi, 2005
23. Proteins, Biochemistry & Biotechnology – Gary Walsh, John Wiley & Sons, 2002
24. Biotechnology, An Introduction – Susan R Barnum, Vikas Publishing House, International Student Edition
25. Enzymes, Biochemistry, Biotechnology, Clinical Biochemistry – Trevor Palmer, First East-West Press Ed. 2004
26. Essential Bioinformatics, JinXiong, Cambridge University Press, 2006
27. Introduction to Bioinformatics – Teresa Atwood and David J.Parry, Pearson smith publication (2003)
28. Introduction to Bioinformatics – Lesk, Oxford press (2003)
29. Fundamental Concepts of Bioinformatics - Dan E. Krane, Michael L. Raymer, Pearson education (2004)
30. Bioinformatics: Sequence and Genome analysis by David W. Mount CBS Publishers & Distributors, 2004 reprint
31. Bioinformatics and Functional Genomics;by Jonathan Pevsner;Wiley-Liss 1st edition, 2003
32. Essential Bioinformatics, JinXiong, Cambridge University Press, 2006
33. Fundamental Concepts of Bioinformatics - Dan E. Krane, Michael L. Raymer, Pearson education First edition (2004)
34. Sequence structure and Database – Des Higgins, Willice Taylor, oxford press 1st edition (2003)
35. Sequence and Genome Analysis by David W. Mount - Cold Spring Harbor Laboratory 1stedition ; 2004
36. Bioinformatics and Functional Genomics; by Jonathan Pevsner; Wiley-Liss 1st edition, 2003

Suggested Readings for paper 104,204 and Practical 104,204:

1. Lemeshow S, Homer DW, Klar J and Lwanga SK, (1996) Adequacy o sample size in health studies. John Wiley and Sons, Chichester.
2. Machin, D., Campbell MJ, Fayers P, Pinol A., (1998) Statistical Tables for the design of Clinical Studies, Second Edition, Blackwell Oxford.
3. Quinn &Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press. http://www.lacbiosafety.org/wp-
4. Statistical methods for research workers – RA Fisher, 14th edition, Oliver Boyd publication
5. Statistical methods in research and production – Davelr OL & Goldsmith PL, Longman
6. Methods in biostatistics for medical students and research workers – BK Mahajan, Jaypee Brothers, New Delhi
7. Research methodology, Methods and techniques – CR Kothari Willey Eastern Ltd, Mumbai
8. Research methods – Ram Ahuja, Rawat Publications, New Delhi
9. Genetics and Biostatistics – MeyyanPillai, Saras Publication, Kanyakumari
10. Papers in Biochemistry – Jon Herriott Gary Jacobson, Julius Marmur and William parson, Addison-wesley publication Co, California

11. Experimental Biochemistry, Theory and exercises in fundamental methods – Robert Switzer and Liam Garrity, 3rd edition, WH Freeman & Co. NY
12. Statistical methods in biological array – Davids J Finney, 3rd edition charles Griffin & co, London
13. Research Methodology – SM Israney, universal Publishing Corporation
14. Statistics for Biology – Bishop ON, 1983, Longman
15. A Textbook of Biostatistics by A Annadurai, New Age Publication
16. Soft Skills- An Integrated Approach to Maximize Personality Development by Gajandra S Chavan& Sangeeta Sharma, Wiley India
17. Personality Development and Soft Skills by Barun K Mitra, Oxford.
18. Soft Skills- Enhancing Employability by M S Rao, I K International
19. Cornerstone : Developing Soft Skills by Sheffield, Person India
20. Business Communication by ShaliniKalia and Shailaja Agrawal, Wiley India.
21. Communication Skills by Dr. Nageshwar Rao and Dr. Ranjendra P Das, Himalaya Publishing House.
22. Fred Luthans " Organisational Behaviour", Mc Graw Hill edition
23. Wallace and Masterss, " Personal Development for Life and Work"
24. Bell, Smith, " Management Communication" Wiley India Edition
25. Dr.K. Alex, " Soft Skills " , S. Chand and Company.
26.Rhoda A. Doctor, Aspi H. Doctor, " Business Communication " Sheth Publishes pvt.ltd.

Scheme of University Examination for M.Sc. Degree (by papers) in Theory & Practical in Biochemistry to be brought in force from 2012-2013 & progressively thereafter as Credit Based Semester And Grading System.

A. Distribution of Credits

Credits for Theory		Credits for Practicals	
Paper	Credits per Semester	Practical	Credit per Semester
Each	4	Each	2

Total Number of Semesters	Number of Theory Papers per Semester	Total Number of Theory Papers	Total Number of Credits
4	4	16	16 X 4 = 64 (a)
Total Number of Semesters	Number of Practicals per Semester	Total Number of Practicals	Total Number of Credits
4	4	16	16 X 2 = 32 (b)
Total Number of credits for MSc degree by papers in Biochemistry (a) + (b) = 96			

B. Distribution of Marks

Theory Paper	Theory 100 Marks per paper					Practicals (50 Marks/Practical)	
	Semester End Theory Exam. (60)			Internal Assessment (40)			
	No. of Units	Marks per Unit	Total Marks	Class Test (1 X 20 Marks)	Assessment (2 X 10 Marks)	Practical	Semester End Practical Exam. (Marks)
Each	04	15	60	20	20	Each	50

Year	Semester	Total Theory Marks (a)	Total Practical Marks (b)	Grand Total (a) + (b)
M. Sc. Part I	I	4 Papers X 100 = 400 Marks	4 Practicals X 50 = 200 Marks	600 Marks
	II	4 Papers X 100 = 400 Marks	4 Practicals X 50 = 200 Marks	600 Marks
M. Sc. Part II	I	4 Papers X 100 = 400 Marks	4 Practicals X 50 = 200 Marks	600 Marks
	II	4 Papers X 100 = 400 Marks	4 Practicals X 50 = 200 Marks	600 Marks
				2400 Marks

Use of a simple calculator shall be permitted for solving numerical and statistical problem at theory and practical examination.

1. Duration of practical examination

    a. Semester-end practical examination

    i. One Day practical examination with two sessions of three hours thirty minutes each, i.e. Session I- 9am to 12:30 pm and Session II- 1:30 pm to 4:30 pm. With lunch break from 12:30pm to 1:30pm

    ii. Examination of five experiments (not more than two experiments from each practical) for 20 marks each shall be conducted over two sessions, including viva voce examination..

8. Each candidate is required to submit a certified journal for each of the semesters at the time of semester-end practical examination.

	M.Sc. Biochemistry .Paper IV Semester I		
Unit III:	**Sampling, Diagnostic Tests & Vital Statistics**		
3.1	**Sampling**		**05**
	3.1.1	Representative sample, sample bias	
	3.1.2	Sampling techniques- Simple, random, systematic, Stratified, Cluster, multistage	
	3.1.3	Correlation and regression analysis. Simple correlation and regression. Multiple correlation and regression, partial correlation, logistic regression. Partial correlation analysis.	
3.2	**Diagnostic tests**		**04**
	3.2.1	Importance of diagnostic tests	
	3.2.2	Sensitivity, specificity, positive predictive value, negative predictive value, accuracy, probability and odds ratio, likelihood ratio(LR), LR of positive test, LR of negative test Receiver operating characteristics (ROC) curves	
3.3	**Demography & Vital Statistics**		**06**
	3.3.1	Collection of demographic data, vital statistics at state & National levels, reports of special demographic surveys.	
	3.3.2	Measures of vital statistics: Rate of mortality, fertility, reproduction, morbidity, comprehensive indicators, indices of health population growth rates and density of population.	
	M.Sc Biochemistry, Paper IV Semester II		
Unit III:	**Nonparametric Tests and Analysis of Data**		
3.1	**Non-parametric tests**		**05**
	3.1.1	Importance of non-parametric tests.	
	3.1.2	Chi square test of goodness of fit.	
	3.1.3	Chi square test for independence of attributes & yate's correction.	
3.2	**Analysis**		**06**
	3.2.1	Univariate and multivariate analysis. Brief introduction to three main frameworks: Monte-Carlo analysis, Parametric analysis, Bayesian analysis	
	3.2.2	Data Analysis: Computing sums of squares, standard error of differences between means, fitting data to linear model, variances and covariances, least square parametric estimation, hypothesis test with regression	
	3.2.3	ANOVA and partitioning of sum of squares, assumptions, hypothesis tests with ANOVA, constructing F Ratios, ANOVA Tables, Analysis of categorical data, two way contingency tables, Chi-square & G-Test	

3.3	**Power Analysis**		**02**
	3.3.1	Power analysis for contingency tables, t tests, ANOVA, correlation & regression models. Sample size calculation.	
3.4	**Measures of Association**		**02**
	3.4.1	Yule's coefficient of association	
	3.4.2	Spearman's Rank correlation coefficient	

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