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**)

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 centres/ 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	4
PSBCH-104	Research Methodology, Bio-statistics & Soft Skills Development	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	4
PSBCH-204	Research Methodology, Bio-statistics &Soft skills Development	4

M.Sc. Semester III

Course Code	Topic Headings	Credits
PSBCH-301	Advanced Genetics	4
PSBCH-302	Advanced Immunology	4
PSBCH-303	Advanced Metabolism	4
PSBCH-304	Clinical and Pharmaceutical Biochemistry, Human Nutrition and Dietetics	4

M.Sc. Semester IV

Course Code	Topic Headings	Credits
PSBCH-401	Advanced Genetics	4
PSBCH-402	Advanced Immunology	4
PSBCH-403	Advanced Metabolism	4
PSBCH-404	Clinical and Pharmaceutical Biochemistry, Human Nutrition	4

	and Dietetics	

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 Basic of Evolution	4	1
	II	Bioenergetics		1
	III	Protein chemistry& Enzymology		1
	IV	Membrane Biochemistry & Cell Signalling		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~~& Marine Biotechnology~~		1
	III	Techniques in Food Preservation		1
	IV	Bioinformatics – I		1
PSBCH 104	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		1

PSBCHP101	Colorimetry, Volumetry, Enzymology, Buffers, Microscopy	2	4
PSBCHP102	Biochemical, Clinical Analysis	2	4
PSBCHP103	Bioinformatics - 2	2	4
PSBCHP104	Research Methodology, Biostatistics ,Soft	2	4

	Skills Development-1		

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&Natural Bioactive Compounds		1
PSBCH202	I	Centrifugation	4	1
	II	Chromatography		
	III	Electrophoresis& Sequencing Techniques		
	IV	Special Instrumental Methods of Analysis		
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 And Partial Purification Techniques	2	4
PSBCHP204	Biostatistics & Bioinformatics	2	4

Detail Theory Syllabus

Semester I

Course Code	Title	Credits
PSBCH101	**Advanced Bioorganic Chemistry**	4
Unit I: **1.1 Biochemical Basis of Evolution** 1.1.1 Theories of Evolution – Time scale and spontaneous origin of life. 1.1.2 Genesis of oxygen generating photosynthesis and 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. Evolutionary view of exon domain relationships. 1.1.5 Process or Origin of life of Eukaryotes, Molecular Evolution of Proteins.		**Number of Lectures** **15**
Unit II: **2.1 Bio-energetics** 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 Electron Transport Chain in Plants, Eukaryotes and Prokaryotes, Significance or Redox potentials, Mechanism of Oxidative Phosphorylation.Uncouplers and Inhibitors of energy transfer. 2.1.3 Numerical problems based on the above		**15**

Unit: III

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 4^0 structures, problems based on determination of 1^0 structure, Ramachandran Plot, structure-function relation of protein (Ex. Haemoglobin) Protein-Protein interaction (actin, tubulin), Leucine zipper, Zinc finger, trans-membrane regions,

3.1.3 Chemical modification and cross-linking in proteins, dynamic properties and 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, EinsethalCornish Bowden Plots

3.2.4 Mechanism of Enzyme Action for Acid –Base Electrostatic andCovalent 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 Enzyme Reaction in non-aqueous Media.

3.2.9 Clinical Enzymology- Enzymes as therapeutic agents, diagnostic tools and laboratory agents.

Unit: IV

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 Molecular constituents of Membrane and supra-molecular architecture. Biological and physical membrane models. Specialized features like lipid rafts, caveolae andtight junctions

4.1.3 Principles and Mechanism of Diffusion and Passive, Active & facilitated Transport. Endocytosis, exocytosis.

08

4.1.4 Specialized mechanism for transport of macromolecules, gap junctions, nuclear pores, toxins, control of transport processes, binding proteins, hormone effects
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4.1.5 Role of Na, K ATPase and the passive permeability of the plasma membrane to Na, K and 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 result from abnormalities of 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**

4.2.1 Classes of Cell Receptors, Molecular Mechanism of Cell Signalling via G-protein linked Cell Surface Receptors. Signaling molecules and their receptors Modes of cell-cell signaling (endocrine, paracrineand autocrine) Steroid hormones, thyroid hormones, vit D3 and retinoic acid Steroid superfamily receptors and their functions. Nitric oxide, neurotransmitter, peptide hormones, growth factors, Eicosanoids, plant hormones.

4.2.1 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

4.2.3Signal transduction and cytoskeleton Integrin and signal transduction, regulation ofActin CytoskeletonSignalingindevelopment 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 tumour suppressor genes

Course Code	Title	Credits
PSBCH102	**Advanced Instrumentation and Analytical Techniques**	4

Unit I: **1.1 Colligative Properties** 1.1.1 Definitions, Factors affecting and Physiological Applications of Osmosis, Measurement of osmotic pressure, Osmoregulation,Adsorption, Colloids, Surface Tension and Viscosity 1.1.2 Numerical Problems based on above concepts	**Number of Lectures** **15**
Unit II: **2.1. Acid, Bases and Buffers** 2.1.1Ionization, 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 off bio-molecules, Henderson –Hasselbach Equation,Different methods for measurement of pH. Use of Indicators, Buffers, Amino Acid titrations, Formal Titration.Biologically important buffers, Buffering of blood. 2.1.3 Numerical Problems based on above concepts	**15**
Unit: III **3.1 Microscopy** 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 **3.1 Radioisotope Techniques** 3.2.1 Nature of radioactivity & its detection and measurements of Radioactivity, Radioactive decay, Interaction of radioactivity with matterGM 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.	**07** **08**

Unit: IV **4.1 Spectroscopic Techniques** 4.1.1Beer-Lamberts Law, Its verifications and Deviations, Concept of Absorptions, Transmission, Scattering, Phosphorescence, Fluorescence, Luminescence, Diffraction Spectra. Infrared Spectra of common functional groups. 4.1.2Principle 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 application of – Spectrofluorometric, Flame Spectrophotometry, Atomic AbsorptionSpectrometry, 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), Mossbauer Spectroscopy, Matrix Assisted LASER Desorption, ionization, Time of Flight-Mass Spectroscopy (MALDI-TOF-MS) 4.1.5X-Ray Diffraction Spectra, Optical Rotatory Dispersion, (ORD), Circular Dichroism (CD) 4.1.6 LASER- Principle, applications in Medicine and Biological Sciences	**15**

Course Code	Title	Credits
PSBCH103	**Industrial Biochemistryand Bioinformatics - 1**	4
Unit I: Bio Process Technology and Fermentation **1.1 Bioprocess Technology** 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** 1.2.1 Primary and secondary of microbes, inoculums preparation, fermentation media, industrial sterilization, strain improvement,	**Number of Lectures** **08** **07**

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 Cultures and Marine Bio Technology. **2.1 <u>Plant Tissue Culture (PTC)</u>** 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 <u>Animal Tissue Culture (ATC)</u>** 2.2.1Principles, 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 <u>Microbial Tissue Culture (MTC)</u>** 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) 2.3.4 Bioremediation, Oil spills, Degradation of waste water, Chemicals and heavy metals, microbial leaching (Cu, Zn, Fe, Ag, Mn, Hg, As, Sb)	**05** **05** **05**
Unit: III Techniques in Food preservation **3.1 <u>Bio Chemistry of Food Spoilage</u>** 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 <u>Food Preservation</u>** 3.2.1 General principles of food preservation 3.2.2 Preservation by use of high and low temperatures, drying, radiations, chemical preservatives, inert gases, mechanical preservation techniques (vacuum packaging, tetra packs).	**05** **05**

3.3 <u>QC, GMP and other topics</u> 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 and FDA in food industry.	**05**
Unit: IV Bioinformatics - I **4.1 Introduction to Bioinformatics** 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 4.1.4Introduction to Next-Generation Sequencing technology (NGS) 4.1.5 Introduction to Databases- Biological application and Classification **4.2 Biological Databases and retrieval techniques** 4.2.1 Nucleotide Databases- Genbank, Unigene 4.2.2 Literature Database- Pubmed, Medline 4.2.2 Protein Sequence Databases- Swissprot, PIR 4.2.3 Protein Structural Databases- PDB, SCOP, CATH 4.2.4 Metabolic pathway database- KEGG, Metacyc 4.2.5 Other databases- OMIM, Taxonomy	**08** **07**

Course Code	Title	Credits
PSBCH104	**Research Methodology, Biostatistics &Soft Skills Development - 1**	4

Unit I: Research & Research Design **1.1 Research** 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** 1.2.1 Meaning, features of good research design, types of research designs.Descriptive, analytical. 1.2.2 Basic principles of experimental designs. Prospective, retrospective, prospective & retrospective, observational, experimental, clinical trials, RCT,Cohort, cross sectional and case controlled studies.	**Number of Lectures** **08** **07**
Unit II: Presentation & Processing of Data **2.1 Scales of measurement** 2.2.1Nominal, Ordinal, Interval, Ratio, Discrete, Continuous **2.2 Descriptive Statistics: Presentation of Data** 2.2.1 Diagrammatic Presentation: Graphs and Charts; Tabular presentation 2.2.2 Skewness, Kurtosis, Quantiles, Outliers 2.2.3Measures of Dispersion: Quartile deviation, Mean deviation, 2.2.4 Standard deviation, Standard error, Variance, Coefficient of variation Measures of skewness (Karl Pearson, Bowley) **2.3Normal Distribution.** 2.3.1 Probability mass/density function, cumulative mass/density function 2.3.2 Properties of Normal distribution	**05** **10**
Unit:III:Analysis of Data and Sampling Techniques **3.1 Correlation and regression analysis** 3.1.1 Simple correlation and regression. 3.1.2 Multiple correlation and regression, partial correlation, logistic regression. 3.1.3 Partial correlation analysis. **3.2 : Analysis** 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, hypothesistests	**07** **08**

with ANOVA, constructing F Ratios, ANOVA Tables, Analysisof categorical data, two way contingency tables, Chi-square & G-Test **3.3 Power Analysis** 3.3.1 Power analysis for contingency tables, t tests, ANOVA, correlation & regression models. Sample size calculation. **3.4 : Measures of Association** 3.4.1 Yule's coefficient of association 3.4.2 Spearman's Rank correlation coefficient **3.5 : Sampling** 3.5.1 Representative sample, sample bias 3.5.2 Sampling techniques- Simple random, Systematic, Stratified, Cluster, Multistage	
Unit:IV Soft Skills - I 4.1 : Introduction to Soft Skills 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 : Other Topics 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.	**07** **08**

Detail Syllabus for

Semester- I Practical

PSBCHP101: Calorimetry, Volumetry, Enzymology, Buffers and Microscopy

1. Estimation of : **Φ**
    a. Proteins by Biuret, 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: **Φ**
    a. Amylase (Km, optimum pH, optimum temperature) from Sweet Potatos
    b. Urease (Km) from Jack Beans Meal/ Soya been Seeds
    c. Lipase (Km) from Ground Nut Seeds
    d. Transaminase (Km) from Germinating Moong Seeds
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. Tryglycerides **§**
    c. Cholesterol by Zak and Zaltsky Method **§**
    d. Calcium (Ca) by Clark and Collip Method/ Trinder Method **Φ**
    e. Iron (Fe) by Dipyridyl Method **Φ**
    f. Copper (Cu) by Dithiocarbonate Method **Φ**
    g. Phosphorus (P) by Fiske- Subbaraow Method **Φ**

Φ Experiments for Semester End Practical Examination (30Marks)
§ Experiments for Internal Assessment in Practical (20Marks)

PSBCHP103: Isolation, Preparation, Extraction and Assays

Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following (for serial nos. 1 to 4)

1. Proteins :
    a. Casein from milk **Φ**
    b. Albumins and globulins from egg white **§**
    c. Proteins from germinating seeds **§**
2. Enzymes: Extraction, Partial Purification of the following enzymes and determination of their Km values
    a. GPT from Germinating Moong Seeds **Φ**
    b. Alkaline Phosphatase from Germinating Moong Seeds **Φ**
3. Estimation of Sodium Benzoate from Jam/ Jelly **§**

PSBCHP104: ResearchMethodology and Biostatistics

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 **Φ**
    a. Measurement of Central Tendency(Mean, Median,Mode)
    b. Measurement of Dispersion/variability(Mean Deviation, Standard Deviation,Co efficient of variation)

Φ Experiments for Semester End Practical Examination (30Marks)
§ Experiments for Internal Assessment in Practical (20Marks)

Detail Theory Syllabus

Semester II

Course Code	Title	Credits
PSBCH201	**Advanced Bioorganic Chemistry**	4

Unit I: **1.1 Plant Biochemistry** 1.1.1 Chlorophylls and accessary pigments 1.1.2 Photosynthesis-Light and Dark Phases, Schemes-I, II & Z, Cyclic and Non-cyclic Photophosphorylation, C-3 & C-4 Pathways 1.1.3 Biosynthesis of Starch Sugars and Cellulose from Glucose 1.1.4 Photorespiration and photoperiodism 1.1.5 Plant growth hormones- Auxins-Gibberellines Cytokines *Abscisic* Acid and Ethylene 1.1.6 Photosynthesis in Microbes, Bacteria, Fungi, Algae and Yeast 1.1.7 Nitrogen Fixation and Sulphur Assimilation in Plants.	**Number of Lectures** **15**
Unit II: **2.1 Endocrinology** 2.1.1 Organization of Mammalian Endocrine System, Classification of Hormones. Biosynthesis, Storage, Secretion, Transport and Metabolic effects (including hypo and hyper conditions) of Hormones of Pituitary, Hypothalamus, ~~Thyroid,~~Parathyroid, ~~Pancreas,~~ Adrenal Medulla, Adrenal Cortex, Gonads, Kidneys and G I Tract. 2.1.2 Mechanisms of Hormone action, Role of Secondary Messengers-cAMP, cGMP, Ca and Calmodulin Cell membrane and intracellular receptors for hormones Regulatory pathways (positive, negative, feedback loops) 2.1.3 Endocrine regulation of growth, stress, hunger, digestion, obesity, renal function, cardiovascular system (angiotensin, BNP, endothelin 1 (ET-1)Endocrinology of fertility (Changes in menstruation, pregnancy & menopause). Medical uses of steroid hormones (contraception, HRT, hydrocortisone, anabolic steroids). Erythropoietin, Adipocytokines, Orexins	**05** **05** **05**

Unit: III **3.2 Biochemistry of Tissues** 3.1.1 Muscles- Structure and composition of muscle fibres, mechanism of muscle contraction and relaxation, energy source for muscular work, muscular dystrophies 3.1.2 Bones- Composition, formulation, Structure and functions, factors affecting bone metabolism, bone remodelling, osteoporosis, osteomalaciaNerves- Structure of Neuron, chemistry of nerve tissue, mechanism of nerve impulse transmission, synapse and synaptic transmission, 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 3.1.3 Connective Tissue- Biosynthesis, composition, structure and metabolism of Collagen and its Disorders-Ehler's Syndrome (Type I to VII), OsteogenesisImperfecta (Type I to IV), Paget's disease	**15**
Unit: IV **4.1 Bioluminescence** 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** 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** 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	**05** **05** **05**

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
Unit I: **1.1 Centrifugation** 1.1.1 Basic principles of sedimentation, relation between g and rpm 1.1.2 Principles, Instrumentation, Working and Applications of Preparative and Analytical Ultracentrifugation, Isopycnic Centrifugation, Rate Zonal Centrifugation		**Number of Lectures** **15**
Unit II: **2.1 Chromatography** 2.1.1 Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), Absorption Chromatography (TLC, HPTLC, Column), Affinity Chromatography, Ion Exchange Chromatography, Permeation Chromatography, Gas-Liquid Chromatography (GLC), High Pressure Liquid Chromatography (HPLC)		**15**
Unit: III **3.1 Electrophoresis** 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** 3.2.1 Basic Principles and Instrumentation, working and applications of- • Purification of Proteins/ Enzymes		**08** **07**

• Protein Sequencing Techniques • DNA Sequencing Techniques • RNA Sequencing Techniques • Blotting Techniques	
Unit: IV **4.1 <u>Special Instrumentation Methods and Analysis</u>** 4.1.1 Basic Principles, Instrumentation, working and applications of experimental techniques in Flow Cytometry Electroporation, Autoclave, Inspissator 4.1.2 Basic Principles, Instrumentation, working and application of instrumental methods of analysis in environmental methods of analysis in environmental biochemistry- Conductometry, Potentiometry, Selective Ion Meters, High Frequency Titrations, Polarography, Anode Stripping Voltammetry, Neutron Activation Analysis, Inductively Couples Plasma Emission Spectrometry	**15**

Course Code	Title	Credits
PSBCH203	**Industrial Biochemistryand Bioinformatics - 2**	4

Unit I: Carbohydrates, lipids and proteins of Industrial Importance	**Number of Lectures**
1.1 <u>Carbohydrates of industrial importance</u> 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.	**04**
1.2. <u>Lipids of industrial importance</u> 1.2.1 Extraction and refining of vegetable oils and animal fats in general. 1.2.3 Extraction and applications of chlorophyll, carotene, lycopene Turmeric, and essential oils.	**03**
1.3 <u>Proteins of industrial importance</u> 1.3.1Isolation 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)	**03**
1.4 <u>Enzyme Immobilization</u> 1.4.1 Methods of immobilization	

1.4.2 Applications in industry and medicine **1.5 Production of vaccines, hormones and industrial proteins** 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 **3.1 Air Pollution** 3.1.1 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. 3.1.2 Greenhouse effect & Global warming – sources, consequences & remedial measures. **3.2 Water Pollution** 3.2.1 Sources and effects of water pollutants on human health, quality standards for drinking water, waste water treatment and recycling. 3.2.2 Concept and significance of BOD, COD and dissolved oxygen. **3.3 Noise Pollution** 3.3.1 Sources, measurement, health hazards, prevention & control of noise pollution. **3.4 Toxins in environment** 3.4.1 Chemical toxicology – Biochemical effects of heavy metals (Pb, As, Hg, Cd), pesticides, insecticides, herbicides, weedicides, larvicides, polyaromatic hydrocarbons, dyes, monomeric and polymeric organics. 3.4.2 Emerging eco-friendly alternatives for chemical industry –Green chemistry and Green Technology.	**04** **04** **02** **05**
Unit : III Nanotechnology and other topics **4.1 Nano biotechnology** 4.1.1 Definition and methods of preparation of nano-bioparticles. 4.1.2 Applications in drug designing, drug delivery & protein engineering. **4.2 Other Topics** 4.2.1 Biosensors – Construction, uses in industrial and environmental processes and medical applications. 4.2.2 Principles, techniques and applications of – Liposome formation,	**07** **08**

natural & synthetic biofilms. 4.2.3 Clinical diagnostics – Diagnostic Kits and their applications. 4.2.4 Concept and significance of Bio safety, Bio Hazards and Bio ethics. 4.2.5 Concept of QC, QA GMP, GLP in labs & production processes. Lab/process validation & Accreditation. 4.2.6 Maintenance & Management of Lab/Experimental animals and Animal House CPCEA guidelines.	
Unit:IV - Bioinformatics II **4.1 Genomic and Protein Sequence Analysis** 4.1.1 Pair wise sequence alignment, gaps, gap-penalties, scoring matrices- PAM250, BLOSUM62, 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** 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	**08** **07**

Course Code	Title	Credits
PSBCH204	**Research Methodology, Biostatistics &Soft Skills Development.**	4

Unit I: Report Writing & Presentation **1.1 <u>Report Writing</u>** 1.1.1 Significance of report writing, different steps in report writing, typesof 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 <u>Presentation</u>** 1.2.1 Presentation – Oral & Written. Use of digital media. 1.2.2 Presentations in classrooms, scientific meets & public audience.	**Number of Lectures** **08** **07**

1.2.3 Defence of research thesis.	
Unit II:Estimation and Testing of Hypothesis. **2.1.Properties and use of Normal Tables** **2.2 Estimation and Testing of Population Parameters** 2.2.1 Estimator of population proportion and mean and their sampling distribution 2.2.2 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 **2.3. Measures of outcome of clinical interventional studies:** 2.3.1 Relative Risk(RR), Relative Risk Reduction(RRR) and Odds Ratio(OR)	**07** **08**
UnitIII:Non-parametric tests, Diagnostic Tests & Vital Statistics. **3.1 Non-parametric tests** 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 Diagnostic tests** 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** 3.3.1 Collection of demographic data,vitalstatistics 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.	**05** **04** **06**
Unit: IVSoft Skills Development – 2 **4.1 : Professional Skills** 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	**07**

building. **4.2 <u>Academic Skills</u>** 4.2.1 : Employment Communication – CV & Resume Building, Scan able 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.	**08**

<u>Detail Syllabus for</u>

<u>Semester- II Practical</u>

PSBCHP201: Chromatography and Electrophoresis Techniques

1. Extraction of Plant Pigments from Spinach Leaves and their separation by Column Chromatography **Φ**
2. Assay of Hormone
3. Chromatography: **Φ**
    a. Ascending and Circular paper for Amino Acids and Sugars
    b. TLC of Oils
4. Electrophoresis: **Φ**
    a. Serum Proteins Electrophoresis (Agar/Agarose)
    b. Haemoglobin 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 **Φ**

b. Blood Urea Nitrogen (BUN)by DiacetylMonoxime Method **Φ**
c. Uric Acid by Caraway method **Φ**
d. Haemoglobin 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 **Φ**
    c. Starch from Potato **Φ**
    d. Pectin from apples/bananas/oranges **§**

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

3. Pigments (Separation of the following pigments on TLC slides): **Φ**
    a. Curcumin from Turmetic
    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

PSBCHP204: Biostatistics and Bio-informatics

1. One numerical problem each on **Φ**

a. Z-Test
b. T-Test
c. Chi-Squares Test
d. Simple Regression
e. Multiple Regression

2. Bioinformatics- §
    a. Searches on Medline, PubMed and BioMed Central
    b. Use of Clustal X/W for alignment of protein and nucleic acid sequences
    c. Use of TAXON to classify Microbes and Viruses
    d. Methods of searching databases like BLAST and FASTA

3. Student will be required to:

    a. § Access at least five scientific websites to collectrelevant 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 researchpapers 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.

Φ Experiments for Semester End Practical Examination (30Marks)

§ Experiments for Internal Assessment in Practical (20Marks)

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 Lubert Stryer: 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 by Geoffrey M. Cooper
13. Cell biology Deroberties
14. Illustrated Biochemistry Harpers 30th ed
15. Molecular biology of cell by Alberts 5th ed
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)

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 Biochemisty. 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, Hlll, Boston
6. Srivascava VK and Kishor 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 Hlll 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. Methods in Enzymology – Kaplan

Suggested Readings for Paper 102,202 and Practical102,202:

1. Greenberg David M – Metabolic Pathways. Vols. 2 and 3, 3rd editions. Academic Press, New York
2. Henry Richard et al – Clinical Chemistry, Principles and Techniques, 2nd edition, Harper and Row, New York
3. Kamal SH – Clinical Biochemistry for Medical Technologies, Churchill Livingston, London
4. Todd et al – Clinical Diagnosis and Management, 17th edition, WB Saunders, Philadelphia
5. Stokes Joan et al – Clinical Microbiology, Edward Arnold, London
6. Gill CV – Short cases in clinical biochemistry, Churchill Livingston, Edinburgh, 1984
7. RaoRanganathan – Text book of biochemistry 3rd edition, Prentice Hall, New Delhi
8. Rodrigues Fred K Carbohydrate chemistry with clinical correlations, New Age International, New Delhi
9. BayensDominiezak – Medical biochemistry, Mosby Publishers, Harcourt, 1999
10. John Bernard Henry, Clinical Diagnosis and Management by Laboratory Methods, Saunders publications, 20th edition
11. Feitz – Clinical Chemistry
12. Nelson DI, Cox MM – Lehninger Principles of Biochemistry
13. Murrary Robert – Harper's biochemistry, 24th edition, Prentice Hall International UK LTD, 1990
14. Satyanarayanan – Biochemistry
15. Vasudevan Text Book of Medical Biochemistry
16. Voet&Voet – Biochemistry, 2nd edition
17. 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. Encyclopedia Britannica, 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

Suggested Readings for paper 103,203 and Practical 103,203:

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. Computational methods in Molecular Biology – SL Slazberg (ed), Elsevier Science
13. The Molecular Biology Database Collection, An updated compilation of biological database resources in Nucleic Acid Research 2001, Academic Press
14. Using cluster for multiple sequence alignment – Higgins DG, Methods in Enzymology, 256, Academic Press
15. Modelling cellular behaviours – Endy& Brent, Nature, 409:391-395, 2001
16. Cracking the genome – Kavin Davis, Scientific American Publ.

17. Statistical methods in biological array – Davids J Finney, 3rd edition charles Griffin & co, London
18. Research Methodology – SM Israney, universal Publishing Corporation
19. Bioinformatics, Methods and protocols – edited by Stephen Messens and Stephen Krawetz, humana press, Totowa, New Jersey
20. Bioinformatics, A practical guide to analysis of genes and proteins – Andreas P Baxevanis and BF Francis Quellette, Wiley Interscience, 1998
21. Statistics for Biology – Bishop ON, 1983, Longman
22. A Textbook of Biostatistics by A Annadurai, New Age Publication
23. Bioinformatics- Methods and Applications by S C Rastogi, N. Mendiratta& P. Rastogi, PHI Learning 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	Internal Assessment (Marks)

							Exam. (Marks)	
Each	04	15	60	20	20	Each	30	20

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..
   iii. Only those experiments indicated by symbol **Φ** in practical syllabus shall be asked in semester-end practical examination.
   iv. Only those experiments indicated by symbol **§** in practical syllabus shall be asked in the internal practical examination.
8. Each candidate is required to submit a certified journal for each of the semesters at the time of semester-end practical examination.