DEPARTMENT OF BIOCHEMISTRY, P.U.CHANDIGARH

OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.Sc. (HONS SCHOOL) (SEMESTER SYSTEM) IN BIOCHEMISTRY 1\textsuperscript{st} to 4\textsuperscript{th} SEMESTER EXAMINATION 2019-2020, 2020-2021 (Under choice Based Credit System)

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Total Credits = 40
Total Marks = 1000

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<th>M.Sc. (HS) 2\textsuperscript{nd} year</th>
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Total Credits = 40
Total Marks = 1000
*Generic Elective (GE) subjects are to be selected by the students from the following pool of subjects available on “Swayam”, free education portal (https://swayam.gov.in/) as recommended by UGC. Courses delivered through SWAYAM are available free of cost to the learners, however students wanting certification shall be registered, shall be offered a certificate on successful completion of the course, with a little fee. At the end of each course, there will be an assessment of the student through proctored examination and the marks/grades secured in this exam could be transferred to the academic record of the student. UGC has already issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM, as per the announcements on the UGC website.

**Research Work**: Research Supervisor will be allotted to the student in Semester III. The work can be carried out on the following:
1. Stress Biology
2. Neuroscience
3. Immunology
4. Cancer Biology
5. Microbial Biochemistry
6. Biosensors
7. Bioinformatics

**SYLLABI OF CORE COURSE OF READING**

Pattern of instructions for Paper Setter:

Question papers will have FOUR sections. Examiner will set a total of Nine questions comprising TWO questions from each PART and ONE compulsory question of short answer types covering the whole syllabus. Students will attempt FIVE questions in all, including ONE question from each PART and the compulsory question. All Questions will carry equal marks, unless specified.
MBCH C-1 : APPLICATION OF BIOCHEMISTRY TO BIOTECHNOLOGY

Credits: 4
Marks: 80+20 (internal assessment) = 100

Objective: The course will focus on providing knowledge and understanding of the current technologies and process.

Unit-I

Micromethods in Protein Chemistry: Isolation of peptides for Sequence analysis. Peptide mapping, chemical and enzymatic hydrolysis of proteins. Extraction and fractionation of RNA and DNA, Isolation of plasmids, plasmid derived vectors, phages and yeast vectors, Enzymes involved in recombinant DNA technology, Genomic and cDNA library. Ti plasmid as tool for genetic engineering in plants, Bacterial transformation screening of transformants.

Unit-II

N-labelling Random labeling of nucleic acid probes, Nick translation, Hybridization and blotting techniques. dot blot. Northern and Southern blot, South-Western blot analysis, biotin-avidin system applications in detection of bio-molecules. Techniques to study DNA protein interactions, Transgenic animals and plants, knockout animals.

Unit-III

Chemical Synthesis of oligonucleotides, Polymerase Chain Reaction (PCR), Basic principle, method, Variations of PCR, Amplification of specific DNA fragments: Applications in medicine and forensic sciences. Techniques to detect polymorphism: RAPD, RFLP, AFLP etc. DNA based diagnosis of genetic disorders, Recombinant DNA technology in medicine and industry. In situ Hybridization, gene therapy.

Unit-IV

Monoclonal Antibodies and Vaccines: Definition and nature of monoclonal antibodies (MCA); Antigen preparation for MCA production; Methodology producing MCA; Immunization and generation of immune response, Myleoma cells for hybridization; cell fusion and selection of hybrids using HAT medium. Cloning and isolation of hybrid cell lines. In vitro and in vivo culture of hybrid cell lines, Screening of specific MCA; Purificatin and labeling of MCA, uses and applications of MCA. T-cell hybridomas and their applications. Vaccines (subunit, live recombinant, attenuated and DNA Vaccines).

Books Suggested:
2. L.Davis et al, Basic Methods in Molecular Biology. Appleton & Lange
4. Winfried Hartmeier, Immobilized Biocatalysts, Spring-Verlager, Berlin,Germany

Journals to be referred:
1. Applied Biochemistry and Biotechnology
2. Biotechnology and Applied Biochemistry
3. American Journal of Biochemistry and Biotechnology
4. Biotechnology Applications
5. Biochemistry and Biotechnology Research.
Objective: To provide understanding and applied knowledge to the theory and practice of clinical biochemistry.

Unit-I

Diagnostic Enzymes - enzyme assay in serum/plasma, urine and cells. Clinically important enzymes, use of isoenzymes in diagnosis. Organ function tests: Assessment and clinical manifestation of hepatic, renal, gastrointestinal and pancreatic functions.

Unit-II


Unit-III

Lipids: Hyperlipoproteinemia, Abetalipoproteinemia, Hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick Disease, Gaucher’s Disease, Krabb’s Disease, Metachromatic leukodystrophy and Fabry’s Disease, Wolman’s Disease, Disorders of porphyrin and heme metabolism, Disorders in purine and pyrimidine metabolism.

Unit-IV

Myocardial infarction and atherosclerosis, Electrolytes and acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, Disorders of electrolyte, water and acid-base balance, Quality control in Clinical Biochemistry

Books Suggested:
5. Lieberman, M and Marks, A.D. MARK’S Medical Biochemistry, A Clinical Approach, 3rd Ed. Lippin Williman wilkins

Journals to be referred:
2. Clinical Biochemistry
3. Annual Review of Biochemistry
4. Indian Journal of Clinical Biochemistry
5. Trends in Molecular Medicine.
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
FIRST SEMESTER

MBCH C-3 : BIOCHEMICAL TOXICOLOGY

Credits: 4
Marks: 80+20 (internal assessment) = 100

Objective: A consolidated training on harmful effects of various chemical compounds, effect on biochemical processes, molecular mechanisms of action of toxicants, metabolism and experimental approaches in toxicology.

Unit-I

Definition, scope and relationship of Toxicology to other sciences. Nature of toxic effects. Acute and chronic exposure. Dose: response relationship, Determination of LD-50, no observed effect level (NOEL), acceptable daily intake, bioavailability, volume of distribution, plasma half life, total body burden, total body clearance. Synergism and Antagonism

Unit-II


Unit-III

Toxicity Testing and Target organ toxicity, Ames test, Host mediated assay and dominant lethal test, Drosophillia sex linked recessive lethal test, micronucleus test. Toxicology of Medical devices, Haemotoxicology, Hepatotoxicity.

Unit-IV

Toxicity of Pesticides-Classes of pesticides: Organochlorine, Organophosphates and carbamates. DDT: Metabolism, toxicity, persistence and bioaccumulation. Organophosphate-Metabolism and mechanism of insecticidal action. Metal Toxicity-Toxicity of Lead and its effect on heme synthesis. Toxicology of various forms of mercury, Arsenic Toxicity. Drug Toxicity-Paracetamol, Metabolism and its Toxic effects.

Books Suggested:
1. Frenhe. LY, Lu’s Basic Toxicology 4th Ed. (2002),
2. A.Wallace Hayes, Principle & Methods of Toxicology 5th Ed. (2008)
4. Curtis D. Klassen, Casarett & Doull’s Toxicology, the Basic science of Poisons 7th Ed.
5. Bryan Ballantyne – General and applied Toxicology

Journals to be referred:
1. Journal of Biochemical and Molecular Toxicology
2. Journal of Clinical Toxicology
3. Journal of Drug Metabolism and Toxicology
4. Journal of Biochemical Toxicology
5. Biochemical Journal
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
FIRST SEMESTER
MBCH C-4 COMBINED PRACTICAL

Credits: 6
Marks: 120+30 (internal assessment) = 150

1. Laboratory Safety including Chemical, Biological and Radiations.
3. Hydrolysis of proteins
4. Extraction & Fractionation of Nucleic acids
5. Visualizing and Quantification of nucleic acids
6. Blotting techniques (Slot/ Dot/ Western)
7. Assay of isoenzymes. (LDH/CPK)
8. Estimation of Electrolytes
9. Determination of HCO₃⁻
10. Assay of glutathione transferase
11. Assay for Cytochrome P450
12. Enzyme assays pertaining to liver (Liver Function Test)
13. Renal function tests
14. Amylase assay
15. Quantification of Haemoglobin
16. Lipid profile analysis
17. Estimation of blood glucose
18. Dose response curve
19. Enzymes associated with toxicity: SOD, Catalase, Glutathione peroxidase, Lipid peroxidase
21. Chromatographic techniques
   a. TLC (Separation of sugars/amino acids)
   b. HPLC
   c. GCMS
M.Sc. (CBCS) Biochemistry

M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
FIRST SEMESTER

MBCH GE-1 (SWAYAM-I)

Credits: 2
Marks 50
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
SECOND SEMESTER

MBCH C-5: MOLECULAR CELL BIOLOGY

Credits: 4
Marks: 80+20 (internal assessment) = 100

Objective: This course will provide in depth knowledge of cell cycle, cell proliferation and apoptosis, synthesis of function of diverse molecules in cell growth, mechanisms of nuclear control of cellular processes and cellular communications & system cells.

Unit-I

Cell Cycle: Cell cycle control system, cell cycle events in S. pombe, S. cerevisae, and mammalian system, M phase kinase, protein phosphorylation and dephosphorylation, p34 as key regulator in yeast, CDC 28, function of CDK-cyclin complex. CDK inhibitors, reorganization of the cell at mitosis.

Unit-II


Unit-III

Signaling molecule and cell surface receptors: Intracellular signal transduction, second messengers, protein functioning as signal transducers, localization of receptors and signal transducers, G-protein coupled receptors and downstream signaling, TGF receptors and activation of SMADS, cytokine receptors and JAK-STAT signaling, receptor tyrosine kinases and activation of Ras, Raf, MAP kinase signaling, phosphoinositide as signal transducer, pathways that involve signal induced protein cleavage (NF-KB and NOTCH), Hedge hog and wnt signaling pathways (classical and nonclassical) down regulation of receptor signaling.

Unit-IV

Specialized tissues and stem cells: Renewal of epidermis, sensory epithelia, airways and the gut, blood vessels, multipotent stem cells, connective tissue cell family, stem cell engineering

Books Suggested:

Journals to be referred:
1. Molecular and Cellular Biology
2. Biochimica et Biophysica Acta
3. Molecular Cell
4. Critical reviews in Biochemistry and Molecular Biology
5. Journal of Molecular Biology
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
SECOND SEMESTER

MBCH C-6: ADVANCED ENZYMEOLOGY

Credits: 4
Marks: 80+20 (internal assessment) = 100

Objective: The course aims to provide advanced education in enzymology so as to comprehend practical aspects of enzyme studies, measurement of rate constants, study of active site and enzyme turn over.

Unit-I

Concept of convergent and divergent evolution of enzymes; Purification of enzymes: strategy & criteria of enzyme purity, judging the success of purification procedure; Kinetics of multi substrate enzyme catalyzed reactions: classification, kinetics of multisubstrate reactions, Investigation of reaction mechanism by using initial velocity, inhibition and isotope exchange studies; Practical aspects of kinetic studies: Enzyme assays, coupled assays, Reaction conditions optimization (pH, temperature, substrate concentration), Design of inhibition experiments.

Unit-II

Methods of pre-steady state analysis: Rapid mixing and sampling techniques, Relaxation methods, Absolute concentration of enzymes, Sigmoidal Kinetics: Cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.

Unit-III

Identification of active site of enzymes: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with class-specific inhibitors and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, Structures & mechanisms of selected enzymes: Dehydrogenases, proteases, ribonuclease and lysozyme. Practical applications of protein inhibitors.

Unit-IV

Enzyme turnover: Kinetics of turnover, methods for measuring rates of enzymes turnover, Correlation between rates of turnover and the structure and functions of enzymes, Mechanism of enzyme degradation, significance of enzyme turnover.

Books Suggested:

Journals to be referred:
1. Analytical Biochemistry
3. Biochemistry
4. Journal of Biochemistry
5. Protein Chemistry and Enzymology.
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
SECOND SEMESTER

MBCH C-7: MOLECULAR & CELLULAR IMMUNOLOGY

Credits: 4
Marks: 80+20 (internal assessment) = 100

Objective: This intensive course will impart an insight of the immune response in relation to different disease etiologies, focusing on clinically applied and modern immunological concepts.

Unit-I
Diversity/ Polymorphism of receptors; T cell receptor, Immunoglobulins, Major histocompatibility complex. Homing, migration and homeostasis of cells of the immune system. Immune mechanisms at: immune privilege sites, mucosal lining materno-fetal interface; immune senescence.

Unit-II

Unit-III
Immunodeficiency: Primary & Secondary; Neuroimmunology: immune functions (blood brain barrier, etc) Glycosylation- In health and disease, cell adhesion; Tumor Immunology; vaccine strategies for diverse pathogens, cancer.

Unit-IV

Books Suggested:

Journals to be referred:
1. Journal of Immunology
2. European Journal of Immunology
3. Nature Immunology
4. Molecular Immunology
5. Nature Reviews Immunology
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
SECOND SEMESTER

MBCH C-8 COMBINED PRACTICAL

Credits: 6
Marks: 120+30 (internal assessment) = 150

1. Molecular Docking.
2. Preparation of proteins by acetone extraction method and also ammonium sulfate fractionation method and running the gel.
3. Fermentation
4. Immobilization of Cell / Enzymes
5. Assay of cell apoptosis by flow cytometry.
6. HPLC
7. GC-MS
8. Zone inhibition analysis-antimicrobial activity
10. Column Chromatography
11. ANOVA post-hoc test
12. Analysis of cell cycle phases (mammalian, yeast etc.)
13. Basics of cell culture technique
14. Enzyme kinetics
15. Enzyme purification from different sources
16. In-silico: 3-D structure of enzymes active sites
17. Primer designing using various softwares
18. Polymerase Chain Reaction
19. Restriction Enzyme Digestion
20. Yeast (S. cerevisiae) Culture-maintenance & growth
21. Yeast (S. cerevisiae) genomic DNA isolation
22. Plasmid purification
23. ELISA
24. Analysis of cell types by cell counting & flow cytometry
25. Magnetic Cell sorting
26. Affinity Chromatography for isolating types of Immunoglobulins.
27. Bisulfite Conversion of DNA
M.Sc. (H.S.) 1st Year in BIOCHEMISTRY
SECOND SEMESTER

MBCH GE-2 (SWAYAM - II)

Credit: 2
Marks: 50
MBCH C-9: GENOMICS AND BIOINFORMATICS

Credit: 4
Marks 80+20 (internal assessment) = 100

Objective: Introduction to genomics and bioinformatics

Unit-I


Unit-II

Nucleotide and Protein databases: Primary, secondary and composite database (genbank, EMBL, DDBJ, Uniprot, Swissprot, PIR, PDB, Genpepts). NCBI, EBI, DDBJ. nucleotide sequence flat files. Sequence formats: Genbank, FASTA,ASN. Introduction to metabolic pathway databases on the web-KEGG, EcoCyc, Metacyc. Enzyme databases- BRENDA, LIGAND database. Molecule visualization softwares: RasMol, Pymol, Cn3D, VMD etc. Information retrieval from biological databases- NCBI resource, Entrez, Pubmed, MEDLINE.

Unit-III

Introduction to sequence alignment: Pairwise Sequence Alignment, Global alignment and Local alignment, general, gap and affine penalty. DotPlot, Scoring functions, Substitution Matrices- PAM and BLOSUM matrices. Heuristic algorithms, Word methods or k-tuple methods, Dynamic Programming- implementation of the Needleman and Wunsch algorithm and Smith Waterman Algorithm for pairwise alignment and testing alignment score

Unit-IV

Multiple Sequence Alignment- consensus sequence, motifs and profiles. SP (Sum of Pairs) measure, Position specific scoring matrices, Hidden Markov Model, Clustal W, Clustal X, Blast and Fasta, Blastp, Blastx, tBlastx, Blastn, PSI-BLAST, Significance of alignment: Scores, E value, p value. Comparative Genomics, Methods for predicting protein structure (secondary and tertiary)

Books Suggested:

Journals to be referred:
1. Journal of Bioinformatics and Genomics
2. Bioinformatics
3. Comparative and functional genomics
4. Genome Medicine
5. Genome informatics.
Objective: To introduce the basic concept of the C programming language and Biostatistics.

**Unit-I**

Overview of C: Brief history of C, general structure of a C program, stages in the development of a C program, Basic building blocks of C Language. Data Types, Operators & Expressions: Constants and variables, data types, declaring variables, storage classes, different types of expressions and their evaluation, conditional expression, assignment statement, enumerated data type, type casting. Console Input/Output: Standard input/output devices, unformatted input/output functions (character I/O functions and string I/O functions), formatted input/output functions (scanf() function and printf() function).

**Unit-II**

Control Statements: Decision making using if, if - else, elseif and switch statements, Looping using for, while and do - while statements, transferring program control using break and continue statements, programming examples to illustrate the use of these control statements. Pointers: What is pointer? Why pointers? Declaring pointers, accessing values via pointers, pointer arithmetic, types of pointers. Functions: Defining a function, local variables, return statement, invoking a function, specifying and passing arguments to a function, function prototyping, pointer to a function, recursion.

**Unit-III**

Arrays & Strings: Introduction to arrays, declaring arrays, initializing arrays, processing of arrays, pointers & Arrays, introduction to strings, programming examples to illustrate the use of arrays and strings. Discussion on arrays is to be limited up to 2-D arrays only. Structures & Unions: Introduction to structures, declaring structures, initializing structures, accessing elements of structures, pointers to structures, passing structures as arguments to a function, introduction to unions. Data Files: Introduction to data files, different ways of file processing (standard I/O & system I/O), description of various library functions for file handling, updating files, programming examples to illustrate the processing of files.

**Unit-IV**

Biostatistics: Expression and critical evaluation, interpretation and presentation of data, Statistical methods for analysis of data- Probability, Mean, median, frequency, t-test (paired and unpaired), ANOVA and correlations, statistical software

**Books Suggested:**

Journals to be referred:

1. Journal of Biometrics and Biostatistics
2. Statistics and Computing
3. Biochemistry
4. Journal of computational and graphical statistics
5. Journal of Biostatistics
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
THIRD SEMESTER

MBCH C-11 COMPREHENSIVE EXAMINATION (BASED ON UGC/CSIR SYLLABUS)

Credits: 4
Marks: 100
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
THIRD SEMESTER

MBCH C-12 : PAPER PRESENTATION ON RECENT TOPICS IN BIOCHEMISTRY

Credits: 2
Marks: 50
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
THIRD SEMESTER

MBCH C-13 : COMBINED PRACTICAL

Credits: 4
Marks: 100

2. Preparation of ethanolic extract of neem. (Part I)
3. Estimation of total Phenolic content by using Folin Ciocalteau (FC) reagent. (Part II)
4. Determination of free radical scavenging by FRAP Assay (Part III)
5. Isolation and partial purification of urease and determination of specific activity (Urease from red gram); β-amylase from sweet potato; Lipase from Ground Nut Seeds; Transaminase from Germinating Moong Seeds.
7. Estimation of toopherol by bipyridyl.
8. To know the methylation pattern at DNA (By Bisulfite conversion )
9. To estimate the proteases activity by Dye binding method.
10. Estimation of Calcium by OCPC method.
11. Immunodiffusion
12. Investigation of Phosphatases from natural sources in detail/ Phosphatase test for the quality of milk.
13. Estimation of Sodium Benzoate from Jam/ Jelly.
15. Bioinformatics Practicals :
   - PubMed search
   - Search and download gene sequences from GenBank
   - Search and download protein sequences from Uniprot/Swissprot
   - Pair-wise sequence alignment for protein and nucleic acids
   - Multiple sequence alignment for proteins and nucleic acids
   - BLAST search (blastp, blastn, psi-BLAST)
   - Building homology model of proteins using Swiss-Model (or any other homology model building server)
   - Primer designing using Gene Runner (or any other primer designing software)
   - Calculating Mean, SD, SEM using MS-Excel
   - Making bar diagram, histogram, scatter plot, etc using MS-Excel
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
THIRD SEMESTER

MBCH GE-3 (SWAYAM - III)

Credits: 2
Marks: 50
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
FOURTH SEMESTER

MBCH C-14 : SEMINAR ON ADVANCED TOPICS IN BIOCHEMISTRY

Credit: 4
Marks: 50
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
FOURTH SEMESTER

MBCH C-15 : RESEARCH WORK (THESIS)

Credits: 12
Marks: 300
M.Sc. (H.S.) 2nd Year in BIOCHEMISTRY
FOURTH SEMESTER

MBCH C-16 : RESEARCH WORK (VIVA VOCE)

Credit: 4
Marks: 100