



UNIVERSITY OF CALCUTTA

Notification No. CSR/78/2024

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 12.09.2024 approved the following amendments Pertaining to Syllabus of the following Papers syllabus of Bio-Chemistry, (CSR/13/2023, dt.12.07.2023):

1. Amended syllabus of the following Papers of Bio-Chemistry Syllabus (4-year Honours & Honours with Research):

Core Paper 4 (BCMM-H-CC4-3-TH+P): Metabolism carbohydrates and Bioenergetics;

BCMM-H-SEC1-1-TH+P: Tools and Techniques in Bio-Chemistry;

BCMM-H-SEC2-2-TH+P: Protein purification techniques and

BCMM-H-SEC-3-3-TH+P: Clinical Bio-Chemistry

2. New question pattern for semester-3 of 4-year Honours & Honours with Research) courses of studies and semester-3,4 of 3-year MDC.

The above shall take immediate effect.

SENATE HOUSE

Kolkata-700073

20.09.2024

Prof.(Dr.) Debasis Das

Registrar

Subject- BIOCHEMISTRY

Discipline Specific courses /Core courses

Detailed Syllabus

SEMESTER-3

Core Paper 4 - Metabolism of Carbohydrates and Bioenergetics (Theory)
BCMM-H-CC4-3-Th

3 Credits

UNIT- I

Metabolism of Carbohydrates

Basic design of metabolism

Autotrophs and heterotrophs, Metabolic pathways, catabolism and anabolism, ATP as energy currency, Reducing power of the cell.

Glycolysis, Gluconeogenesis, pentose phosphate pathway and Glycogen metabolism

Glycolysis - a universal pathway, reactions of glycolysis and role of the enzymes involved, net number of ATP molecules formed, fates of pyruvate, fermentation (homolactic and alcoholic), substrate cycling (one example), feeder pathways for glycolysis (fructose, mannose, galactose), galactosemia. Synthesis of glucose from non-carbohydrate sources, Steps in Gluconeogenesis(not exact reversal of glycolysis), role of the enzymes: Pyruvate Carboxylase and PEPCK, Glucose- 6-phosphatase, Fructose bisphosphatase, Reciprocal regulation of glycolysis and gluconeogenesis

Pentose phosphate pathway: pathway, role of enzymes, significance, control of the pathway and Glucose-6-phosphate dehydrogenase deficiency. Glycogenesis and glycogenolysis : pathways, regulation of glycogen metabolism, glycogen storage diseases.

.UNIT II

Citric acid cycle

Production of acetyl CoA (Role of PDC: steps and reactions), Reactions of citric acid cycle : role of enzymes and net ATP count, Amphibolic nature of TCA cycle, Regulation of citric acid cycle, Glyoxylate cycle

Bioenergetics

Introduction to bioenergetics

ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Universal electron carriers.

Oxidative phosphorylation

Mitochondria: Anatomy, Electron transport chain - its organization and function. Metabolite transporters in mitochondria, Inhibitors of ETC and P/O ratio: experimental layouts. Peter Mitchell's chemiosmotic hypothesis. Proton motive force ATP synthase: structure and mechanism of ATP synthesis. Uncouplers and mechanism of hormonally induced uncoupling (Thermogenesis) Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms.

Reference Books:

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.

Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 /ISBN: 10:1-4641-0962-1.

- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4.
- Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN: 10:1-4292-2936-5, ISBN: 13:978-1-4292-2936-4
- Biochemistry Book edited by Hiren Das

Core Paper 4P- Metabolism of Carbohydrates and Bioenergetics (PRACTICAL) 1 credit

List of Practical

1. Estimation of blood plasma glucose by GOD-POD method.
2. Estimation of glycosylated hemoglobin (Demonstration)
3. Estimation of serum amylase activity by kinetic method
4. Estimation of serum creatinine

Skill Enhancement Courses (SEC)

SEMESTER 1

BCMM-H-SEC1-1 Tools and Techniques in Biochemistry(Theory)

3 Credits

Unit I

Basic Lab Practices and Preparation of Solutions

Safety practices in the laboratory, preparation and storage of solutions, concepts of solution concentration and storing solutions: Standard solutions, molar, normal, molal, formal and percent strengths, quantitative transfer of liquids.

Special chemical requirement of biomolecules, factors affecting analyte structure and stability, pH, temperature and solvent polarity, buffering systems used in biochemistry, concept of colligative properties (no derivations), osmolarity, diffusion of solutes in solution.

Pipettes and MilliQ water system.Principle of asepsis and sterilization technique.

Different Biophysical Techniques: Theories of light (wave-particle duality), the electromagnetic spectrum, UV/visible absorption spectroscopy, physical basis, Beer Lambert's law, deviations of Beer Lambert's law, transitions, applications of UV-visible spectroscopy, UV-visible spectroscopy of proteins and nucleic acids.

Unit-II

Basic Instruments and techniques: Working principles, basic operation and application of weighing balance, pH meter, autoclave, laminar air flow, Water Baths, CO₂ Incubators, Shaking Incubators, Hot Air Ovens, Bio-Safety Hoods.

Microscopy – Working principles, basic operation and application of Light and phase contrast microscope.

Centrifugation techniques: Sedimentation (Sedimentation coefficient, Svedberg unit), Centrifugation: Working principles, basic operation and application of micro-centrifuge, ultracentrifuge and density gradient centrifugation, applications (isolation of cell components).

SEC-1P: Tools and Tevhniques in Biochemistry (Practical)

1 Credit

List of Practical

1. Safety measure in laboratories, use and calibration of pipettes
2. Preparation of normal, molar and percent solutions
3. Standardisation of NaOH and acetic acid solutions
4. Concept of pH and preparation of buffers, pH metric titration of a weak acid with a strong base.
5. Determination of extinction coefficient of different BSA solutions by spectrophotometer.

Reference Books:

Physical Chemistry - P. C. Rakshit

Lehninger Principles of Biochemistry - Nelson & Cox Text Book of Physical Chemistry

- K. L. Kapoor

Physical Chemistry-Hrishikesh Chatterjee

Techniques and Methods in Biology - K. L. Ghatak

Physical Biochemistry: Principles and Applications - D. Sheehan,

Physical Biochemistry: Applications to Biochemistry and Molecular Biology – D. Freifelder

An Introduction to Practical Biochemistry – D. T. Plummer

Molecular Spectroscopy - C. N. Banwell&McCash Organic Spectroscopy - William Kemp

Skill Enhancement Courses (SEC)

SEMESTER 2

BCMM-H-SEC2-2 Protein purification techniques (Theory)

3 Credits

Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques-

UNIT-I

Protein Isolation- Methods of solubilization of proteins from their cellular and extra-cellular locations- cytosolic, integral and peripheral membrane protein. Brief outline of the use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation, sedimentation coefficient, stabilization of proteins during purification.

Solubility of Proteins based on Protein Purification- Salting in and salting out (Ammonium sulphate fractionation), solvent fractionation, Isoelectric precipitation), lyophilization, Dialysis, Ultrafiltration (Principle and application), Ultracentrifugation

Determination of purity, specific activity, extinction coefficient of enzymes / proteins..

UNIT-II

Chromatographic Separation: partition coefficient, phase systems, liquid and gas chromatography, performance parameters: retention, resolution, basis of peak broadening, peak symmetry, Principle, Application, Advantages and Disadvantages, limitation for different modes of chromatography- Partition Chromatography (Paper Chromatography, hydrophobic interaction/ reverse phase chromatography), Adsorption Chromatography ;Thin Layer Chromatography, Gel filtration chromatography, affinity chromatography, Ion-exchange chromatography, Demonstration of High Performance Liquid Chromatography (HPLC), brief concept of FPLC.

Electrophoresis Techniques: Brief concept of Paper electrophoresis, Principle and application of different types of Gel Electrophoresis (PAGE- horizontal and vertical, SDS-PAGE and molecular weight determination, Isoelectric Focusing (IEF) and 2-D gel electrophoresis, Capillary Electrophoresis (CE).

Mass Spectrometry (Principle and application only)

SEC2P- Protein Purification Techniques (Practical)

1 Credit

List of Practical

1. Assay of enzyme activity and specific activity of Alkanine Phosphatases
2. Determination of Molecular weight of protein from SDS-PAGE (kit based)
3. Column chromatography (size exclusion) by teaching kit (Determination of Void volume)

Reference Book

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M.,

W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1- 4292-3414-8.

Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN: 978-1180-25024.

Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

Enzymes, Malcolm Dixon, Edwin Clifford Webb- provide necessary details

Biochemical Calculations, Segel- provide necessary details

Skill Enhancement Courses (SEC)

SEMESTER- 3

BCMM-H-SEC3-3 Clinical Biochemistry (Theory)

3 Credits

Unit I

Introduction to Clinical Biochemistry

Definition of Clinical Biochemistry and significance of diagnosing a disease with specific biological sample (serum, plasma, CSF, urine and faeces), Collection and preservation of serum, plasma and urine, Use of anticoagulants, Instrumentation (colorimeter, spectrophotometer) – automation (auto analyzer and semi-autoanalyzer), significance of calibration, precision, accuracy, specificity, sensitivity, quality control

Diagnostic biochemical profile

Assessment of glucose metabolism in blood – clinical significance in variation of blood glucose, glucose tolerance test (OGTT, EGTT), Diabetes Mellitus – types, cause, symptoms, treatment, HbA1c, Lactose intolerance.

Lipid profile – composition and function of lipoproteins, clinical significance of elevated lipoproteins (atherosclerosis, hypertension, blood pressure – normal range and factors leading to high blood pressure)

Unit II

Liver function test – function of liver, tests to assess liver function – serum bilirubin (total, conjugated, unconjugated), urine – bile pigments, bile salts, urobilinogen, liver enzyme tests – ALT, AST, ALP, GGT, plasma protein, serum albumin, globulin, A/G ratio, prothrombin time, blood ammonia, tests based on liver's part in carbohydrate metabolism (glucose tolerance test, galactose tolerance test), tests based on detoxicating functions of liver (hippuric acid test), Jaundice and its classification (haemolytic, hepatic, obstructive, neonatal)

Renal function test – function of kidney, classification of renal function test – complete urine analysis, plasma urea, creatinine and electrolytes, GFR and its markers (creatinine clearance test, urea clearance test, inulin clearance test), tubular function test (concentration test, dilution test, urinary acidification), use of urine strip / dip stick method of urine analysis, normal and abnormal constituents of urine

Reference books

- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.

- Medical Biochemistry (2005) 2nd ed., Baynes, J.W. And Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN: 0-7234-3341-0.
- Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN: 81-88237-41-8
- Textbook of Medical Biochemistry, eighth edition., Chatterjee, M.N.; Shinde, R. Textbook of Biochemistry for Medical students, sixth edition, Vasudevan, D.M.; Sreekumari, S.; Vaidyanathan, K.
- Harper's Illustrated Biochemistry.

Clinical Biochemistry (Practical)

1 Credit

1. Clinical Biochemistry laboratory practices and biosafety
2. Estimation of serum alkaline phosphatase
3. Estimation of lipid profile –
 - i) cholesterol
 - ii) triglyceride
 - iii) HDL cholesterol (demonstration only)
 - iv) LDL cholesterol (calculation using Friedwald equation)
4. Estimation of serum LDH activity (Demonstration)

B.Sc. (Four years)
(Under CCF, NEP 2023)
Question pattern for UG Biochemistry
Theoretical Examinations

| Semester | Course Type (Major/Minor, SEC, IDC) | Paper | Full Marks | Duration | Question pattern and Marks distribution |
|------------|-------------------------------------|------------------------------------|------------|----------------|---|
| III | Major | BCMM-H-CC3-3-Th BCMM-H-CC4-3-Th | 75 | 3 hours | 10 short questions of 2 marks each, 3 questions of 5 marks each and 4 questions of 10 marks each (e.g., 2 x 5; 4+3+3; 3+2+3+2)* |
| | SEC | BCMM-H-SEC3-3 Th | | | |
| | Minor | BCMM-H-CC1-3-Th | | | |
| | IDC | BCMM-H-IDC1-3-Th | 50 | 2 hours | 10 short questions of 2 marks each, 3 questions of 10 marks each (e.g. 2 x 5; 4+3+3; 3+2+3+2)** |

- Questions will cover entire syllabus with weightage according to the number of lecture-hours per module

* 15 short questions of 2 marks each, 6 questions (minimum two from each unit) of 5 marks each and 6 questions of 10 marks each to be set;

- [i. For the papers of three Units- minimum 2 from each unit to be set.
ii. For the papers of two Units- minimum 3 from each unit to be set.]

** 15 short questions of 2 marks each, 6 questions (one from each unit) of 10 marks each to be set.

B.Sc. (Four years)
(Under CCF, NEP 2023)
Question pattern for UG Biochemistry
Practical Examination

| Semester | Course Type (Major/Minor, SEC, IDC) | Paper | Full Marks | Duration | Question pattern and Marks distribution |
|------------|-------------------------------------|----------------------------------|------------|----------------|--|
| III | Major | BCMM-H-CC3-3-P BCMM-H-CC4-3-P | 25 | 3 hours | 25 marks examination(15 marks for Experiment+ 5 marks for Vivavoce +5 marks laboratory note book, Experiments allotted by lottery. |
| | SEC | BCMM-H-SEC3-3 -P | | | |
| | Minor | BCMM-H-CC1-3-P | | | |
| | IDC | BCMM-H-IDC1-3-Tu | | | |

Examination to be conducted by:

- **For Biochemistry Major and SEC papers (both Away centre), both Internal and External examiners follow the instruction from the UGBOS.**
- **For Biochemistry Minor & IDC papers only Internal examiners (2) follow the instruction from the UGBOS**

B.Sc. (Three years)

Multidisciplinary Courses of Studies (Under CCF, NEP

2023) Question pattern for UG Biochemistry

Theoretical Examinations

| Type of Examinations | Paper | Full Marks | Duration | Question pattern and Marks distribution | Examination to be conducted/evaluated by |
|----------------------|---|------------|----------|--|--|
| Theoretical | MBCM-MD-CC3-3-Th MBCM-MD-SEC3-3-Th MBCM-MD-CC4-4-Th MBCM-MD-CC5-4-Th | 75 | 3 hours | 10 short questions of 2 marks each, 3 questions of 5 marks each and 4 questions of 10 marks each (e.g., 2 x 5; 4+3+3; 3+2+3+2)* | ----- |
| | MBCM-MD-IDC-Th | 50 | 2 hours | 10 short questions of 2 marks each, 3 questions of 10 marks each (e.g. 2 x 5; 4+3+3; 3+2+3+2)** | ----- |
| Practical | MBCM-MD-CC3-3-P MBCM-MD-SEC3-3-P MBCM-MD-CC4-4-P MBCM-MD-CC5-4-P | 25 | 3 hours | 20 marks examination(10 marks for Experiment+ 5 marks for Vivavoce +5 marks laboratory note book, Experiments allotted by lottery. | Internal examiners (2) (Home center) following the instruction from the UGBOS. |
| | MBCM-MD-IDC- P | 25 | 3 hours | 20 marks examination(10 marks for Experiment+ 5 marks for Vivavoce +5 marks laboratory note book, Experiments allotted by lottery. | Internal examiners (2) (Home center) following the instruction from the UGBOS. |

- Questions will cover entire syllabus with weightage according to the number of lecture-hours per module

* 15 short questions of 2 marks each, 6 questions (minimum two from each unit) of 5 marks each and 6 questions of 10 marks each to be set;

[i. For the papers of three Units- minimum 2 from each unit to be set.
ii. For the papers of two Units- minimum 3 from each unit to be set.]

** 15 short questions of 2 marks each, 6 questions (one from each unit) of 10 marks each to be set.