UNIVERSITY OF CALCUTTA

NotificationNo.CSR/13/2023

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 exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 11.07.2023 approved the Syllabi of the under mentioned subjects for semester wise Four-year (Honours & Honours with Research) / Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022 . under this University, as laid down in the accompanying pamphlet.

Name of Subject:

1.Anthropology
2.BBA
3.Bengali
4.BFAD
5.Bio Chemistry
6.Botany
7.Chemistry
8.Commerce
9.Economics
10.Education
11.English
12.Geology
13.Hindi
14.History,Islamic History & Culture
15.Home Science
16.Human Rights
17.Journalism & Mass Communication
18.Mathematics
19.Microbiology (Honours)
20.Molecular Biology .
21.Philosophy
22.Physiology
23.Political Science
24.Psychology
25.Social Science
26.Sociology
27.Urdu
28.Women's Studies
29.Zoology

The above shall be effective from the academic session 2023-2024.

12/7/2023

SENATE HOUSE

KOLKATA-700 073

Prof.(Dr.) Debasis Das

Registrar

University of Calcutta

Syllabus for

B. Sc. (Multidisciplinary) Program in

Molecular Biology

Under

CURRICULUM AND CREDIT FRAMEWORK (CCF, 2022)

Submitted

by

The Under-Graduate Board of Studies in Molecular Biology

UGBoS (MLBG)

University of Calcutta

2023

Course outline and scope

Molecular biology is a fascinating area of knowledge that strives to explain in molecular detail how all life on Earth functions and because of its advanced scope, is of enormous scientific importance and practical utility. Unfortunately, because of the details involved, sometimes students lose the big picture and fall upon memorizing the facts.

This course has been designed to provide a simple overview of molecular biology without introducing too many details and with a stress on illustrating how it can solve real-life problems.

Molecular biology is inherently an interdisciplinary subject combining biochemical and molecular biophysics concepts and techniques. The basis of life is biological molecules and their interactions. After completing this course, the student will have a basic but thorough understanding of how proteins and enzymes function on the basis of their amino acid makeup, what is the importance of water for biomolecular and cellular functioning, and what are the functions of carbohydrates, lipids and membranes. The course will also explain the molecular basis of heritability, the concepts of genes and genomes, and how they are constructed from nucleic acids. Where appropriate, the course will also explain how these molecules function together at the cellular and organismic level.

Detailed syllabus

(The first six core courses of the full syllabus will be taught in the minor program)

Semester I

MLBG-MD-CC-1: Cell Biology - Principles and Techniques (3 + 1 = 4 credits)

Learning objectives

After attending this course, the student should be able to

1. identify cells as the basic unit of life
2. explain the composition of essential structures found in prokaryotic and eukaryotic cells and describe their functions
3. explain the construction of a virus particle
4. explain the importance of water for physiological processes and the concept of a buffer
5. tell about the various types of interactions governing physiological processes
6. explain the functioning principles of light and electron microscopes

MLBG-MD-CC-1-Th. Cell Biology - Principles and Techniques (Theory) (3 credits)

Unit 1: Domains of life. Biology of cells (12 hours)

Cells as basic functional unit of life, cellular classification (three domains, i.e. eubacteria, archaebacteria, eukaryotes) (1 hr)

Prokaryotic cell organization: Prokaryotic cell structure, bacterial cell walls (2 hrs)

Eukaryotic cell organization: Brief idea of structure and function of plasma membrane, nucleus, endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosome, peroxisome, cytosol, plant cell wall, plant cell vacuole. (6 hrs)

Viruses, range of sizes, constitution, organization (1 hr)

Brief idea of cell cycle (recapitulation of mitosis and meiosis) (2 hrs)

Unit 2: Molecules, minerals and water (15 hrs)

Importance of the carbon molecule (valency, chiral carbon, types of isomer) (2hrs)

Concept of intra- and intermolecular interaction (covalent bond, ionic bond, hydrogen bond, hydrophobic interaction, van der Waals interaction, coulomb interaction). Role of weak forces in biology. (8 hrs)

Structure of water, Henderson-Hasselbalch equation and its significance, concept of pH / pKa, isoelectric pH (pI) and buffers. (5hrs)

Unit 3: Microscopy techniques (18 hours)

Optical microscopy, the nature of light—its particle and wave character. Ray diagrams and image formation.(4 hours)

Simple and compound microscopes, Applications of optical microscopes, Numerical Aperture (NA) Resolution, Contrast, depth of field and depth of focus, Angular magnification, Spherical aberration, Chromatic aberration of optical system (definitions only). Mathematical expression for limit of resolution in terms of Rayleigh criteria. Empty magnification.(6 hours)

Basic principles of oil immersion microscope. Limitations of optical microscopes.(2 hours)

Electron microscopy---basic working principle, advantages of electron microscope over optical microscope, Optical Microscopy vs. TEM, Electrostatic and magnetostatic electron microscopes, Relation between the applied voltage and wavelength of electrons.(6 hours)

MLBG-MD-CC-1-Pr (1 credit/25 marks)

1. Determination of refractive index of a given biological sample by traveling microscope

2. Determination of relative sizes of nucleus and cytoplasm of squamous cells

3. Preparation of phosphate buffer and measurement of pH

4. Negative staining of bacteria using nigrosin

5. Gram staining of bacteria

Suggested Reading

1. De Robertis, EDP and De Robertis EMF. (2006) Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

2. Cooper, GM and Hausman, RE (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman

4. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company

5. Voet D and Voet JG (2004) Biochemistry 3rd edition, John Wiley and Son

6. Sharma VK (1991) Techniques in microscopy and cell biology. Tata McGraw Hill

7. Reimer L and Kohl H (2008) Transmission electron microscopy. Springer.

Semester II

MLBG-MD-CC-2. Biological Macromolecules (3 + 1 = 4 credits)

Learning objectives

After attending this course, the student should be able to

1. describe the structures and the chemical properties of the 20 amino acids.
2. describe the structure and the chemical properties of carbohydrates, lipids and nucleic acids (RNA and DNA).
3. describe the four levels of protein structure and explain how protein structure is influenced by the amino acid sequence.

MLBG-MD-CC-2-Th. Biological Macromolecules (Theory) (3 credits)

Unit 1: Molecular building blocks (16 hours)

Carbohydrate: Structure, function and properties of monosaccharides (hexoses and pentoses), disaccharides (sucrose, lactose, maltose). (4 hrs)

Lipids: Definition and classification of lipids, structure and function of fatty acids, storage lipids, structural lipids. (4 hrs)

Amino acids: structure of twenty amino acids, classification, titration curve of amino acids, concept of zwitterionic structure, physical and chemical properties. (6 hours)

Nucleic acids: Ribonucleic and deoxyribonucleic acids, purines and pyrimidines, nucleosides and nucleotides. (2 hrs)

Unit 2: Proteins and nucleic acids (16 hours)

Proteins: classification of proteins on the basis of composition, conformation and function, different level of structural organization of proteins (primary, secondary, tertiary & quaternary), forces stabilizing protein structure and shape, physical and chemical properties. Domains and motifs (10 hours)

Nucleic acids: Secondary structure of nucleic acids. Watson and Crick model, A and B forms, Supercoiled and relaxed DNA. (6 hrs)

Unit 3: Polysaccharides and membranes (13 hours)

Storage & structural polysaccharides (glycogen, starch and cellulose). (6 hrs)

Roles of lipids in membrane structure. Fluid mosaic model of membrane structure. (7 hrs)

MLBG-MD-CC-2-Pr (1 credits/25 marks)

1. Qualitative tests for amino acids and proteins.

2. Qualitative tests for reducing and non-reducing sugars, polysaccharides, lipids.

3. Identification of unknown compounds (from sugars, polysaccharides, lipids, amino acids and proteins).

Suggested Reading

1. Sharma, DK (2013) Biochemistry. Narosa Publishing House

2. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company

3. Voet, D and Voet JG (2004) Biochemistry 3rd edition, John Wiley and Sons.

4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W. H. Freeman

INTERDISCIPLINARY COURSE

MLBG-MD-ID-1-Th. Biostatistics without fear (3 credits)

Learning objectives

After attending this course, the student should be able to

1. properly organize experimental data and describe its salient features.
2. explain what is a normal distribution
3. understand how to estimate population parameters from samples
4. explain and apply the concepts of statistical significance and p-value
5. do correlation and regression analysis.

Unit 1. Simple data analysis (17 hrs)

Making sense of your data: What is statistics? Descriptive and inferential statistics. How to collect a sample?

Describing your sample: Statistical variables. Error, accuracy, and approximations.

Summarizing your Data: Tables and diagrams. Central tendencies. Dispersion.

How does your data look? Distributions. The shape of a distribution. Skewed distributions. The normal distribution.

Unit 2. Estimates and inferences from your data (17 hrs)

How to go from samples to the population? The logic behind sampling. Sample-means and population-mean. Estimation of other parameters.

How to compare samples? From the same or different populations? Tests of significance. Significance of significance.

Unit 3. Relationships in your data (11 hrs)

Paired values. Kinds of correlation. The strength of a correlation. Correlation coefficients. Interpreting correlation coefficients. Predicting based on your data. Regression analysis.

Suggested Reading

1. Pezzullo JC (2013) Biostatistics for dummies. John Wiley & Sons.

2. Rowntree D (2004) Statistics without tears. Pearson.

SKILL ENHANCEMENT COURSE

MLBG-MD-SEC-1. Basics of Molecular Diagnostics (3+1 credits)

Learning objectives

After attending this course, the student should be able to

1. understand the best practices to be followed in a laboratory setting
2. explain the mechanisms of some of the major infectious and non-infectious diseases
3. explain the principles of a number of important and widely-used laboratory diagnostic tests
4. have hands on experience of how to carry out simple laboratory diagnostic tests

MLBG-MD-SEC-1-Th. Basics of Molecular Diagnostics (Theory) (3 credits)

Unit 1. Laboratory practices (6 hrs)

Biosafety practices, laboratory area flow, and practices to minimize contamination.

Unit 2. Mechanisms of infectious and non-infectious diseases (20 hrs)

Idea about the features of pathogenic and non-pathogenic microorganisms. Mechanisms of pathogenicity: entry, colonization, course of infectious disease, duration of symptoms

Ideas about major non-communicable diseases (NCDs) — cardiovascular diseases, diabetes, cancer.

What is diabetes? What are the different types of diabetes? How to test for diabetes?

What are the risk factors for cardiovascular diseases? How to diagnose hypertension?

What is cancer? What are the major risk factors? Screening strategies for cancer.

Unit 3. Diagnostic methods (20 hrs)

Nucleic acid-based methods: Extraction methods, basic extraction steps, and nucleic acid analysis. Principles of PCR based diagnostic methods.

Protein-based methods: General properties and importance of clinically important enzymes like SGOT, SGPT, alkaline phosphatase and creatine kinase, lactate dehydrogenase. Principles involved in their tests.

MLBG-MD-SEC-1-Pr. Basics of Molecular Diagnostics (Practical) (1 credit)

1. Isolation of pure culture by streak plate technique.

2. Antibiotic sensitivity assay by paper disc method.

3. Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain,

4. Count platelets from peripheral blood smears.

Suggested Reading

1. Iles RK and Docherty SM (Ed.s) (2012) Biomedical Sciences. Essential Laboratory Medicine. Wiley-Blackwell

2. Wilson K and Walker J (Ed.s) (2010) Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press