

Course Descriptions of Molecular Cell Biology Core curriculum for MBSS Students:

Shalamar Medical and Dental College (SMDC) MBBS students who will opt for 1+5 program will spend the first year, i.e., two semesters at Lahore University of Management Sciences (LUMS) where they will be trained in fundamentals of cell and molecular biology. Students will take a minimum of 24 credit hours, 12 in each semester, which will comprise a list of core and elective courses. However, students can take a maximum of 18 credit hours each semester and may choose additional courses from a wide range of elective courses. The description of different core courses which a student will take during the first year is as follows.

BIO101-Introductory Biology

Introductory biology aims to provide a broad overview of biology as it stands today, exposing students to a variety of topics in modern molecular and cellular biology. The course is divided into five modules:

1. Macromolecules and Cell Biology:

We start with an introduction to the molecules of life and how they are organized into a cell, the basic unit of life in all living organisms. Students learn how cells communicate with each other, how they divide, and how they produce and consume energy.

2. Genes and Development:

The course then focuses on the organization of genetic material and how various molecular, genetic, and biochemical processes underlie the functioning of cells from replicating their genetic material for cell division to specifically producing essential proteins during development.

3. Omics and Systems Biology:

This module provides an overview of how modern biology is reliant on generation and analysis of big data and how this data can be utilised for a better understanding of biological systems.

4. Recombinant DNA Technology:

This module covers gene cloning and protein expression and their applications in Biotechnology

5. Human Diseases and Drug Discovery:

In the end, we discuss how communicable and non-communicable human diseases are caused and how understanding the molecular mechanisms of these diseases allows us to develop more effective drugs. Manipulating genetic materials is at the heart of advances in life sciences that we see today from biomedical to agricultural sciences. This module also provides an overview of how the genetic makeup of organisms can be manipulated in the laboratory.

BIO212-Biochemistry

The Biochemistry Sophomore course is designed to provide undergraduate students an understanding of fundamental concepts in Biochemistry. Students will get a chance to explore the molecular mechanisms underlying fundamental biological processes and understand biochemical concepts and how they relate to biological systems. The central premise of biochemistry entails that complex biopolymers form functional and structural complexes. The highly organized complexes arise from monomeric subunits. The course will address molecular organization starting with the monomeric subunits. Principles of protein organization, structure and how structure relates to function (catalysis and regulation) will be discussed in detail.

BIO216-Molecular Biology

This course provides a comprehensive introduction to molecular biology and is designed for students interested in learning molecular mechanisms which control cellular processes in eukaryotes and prokaryotes. Topics include structure of nucleic acids and proteins, organization of genes, genomes, chromatin and chromosomes, DNA replication, repair, recombination, transcription, mRNA processing, protein synthesis and turnover, control of gene expression, signal transduction pathways, non-coding RNAs, evolution of biopolymers and origin of life.

BIO221-Genetics

It is one of the most fascinating course in biology which covers a great deal ranging from classical genetics to modern molecular genetics, emphasis on how new genes are discovered and how function of genes can be understood makes it really interesting. The intellectual framework of this course will introduce students to basic concepts in genetics and epigenetics. Both genetic and epigenetic inheritance patterns will be introduced with an emphasis on how they can be investigated and they play a role in development. This course is divided in different modules. For example, classical genetics will explain Mendelian laws, chromosomal theory of inheritance and gene interactions which explain deviations from Mendel's laws. Microbial genetics will explain how genetic analysis in microbes can be performed and specific examples of gene regulation will be introduced. Human genetics module will explain how genetics plays a major role by using alleles in humans to understand disease and development. Epigenetics will explain how genes can be switched OFF and ON and how chromatin structure and functional can be inherited with altering basic nucleotide sequence of genes. Last but not the least, understanding quantitative genetics and population genetics will explain how mutagenic traits are investigated and how genes may evolve at a population level. Students will be given research papers in this course which they will read in detail and present in a discussion session in recitation sessions.

BIO300-Methods in Molecular Biology Laboratory

This lab course is designed to introduce fundamentals of molecular and biochemical tools used in a molecular biology lab to understand biological processes. It kicks off with a brief introduction to bioinformatics comprising of exercises and hands on experiments involving homology searches (both DNA and protein searches) and primer design for various applications. Major part of lab comprises of independent modules in molecular biology, biochemistry and genetics which introduce students to molecular cloning, agrobacterium mediated transformations, protein expression and purification through chromatography and enzymatic assays. In addition, classical and molecular genetics module involves experiments using *Drosophila* to understand various concepts of development, chromatin, and gene regulation. A thirty-minute pre-lab lecture is followed by hands on lab experiments which will expose students to cutting edge ideas and questions of molecular and cell biology.

BIO313-Cell Biology

Cells are the most complicated entities known to humans and constitute every living organism in this world from bacteria to humans. Understanding the complex workings of different cells is at the heart of understanding how our bodies work. Cell biology, therefore, is one of the most fundamental subjects of biology. This course is organized into 4 modules that will help students understand how eukaryotic cells are organized and how they function. The first module will provide students with an in depth understanding of the dynamic functions of cell membrane and various components of the cytoplasm like endoplasmic reticulum, mitochondria and chloroplasts. The second module will cover intercellular interactions, cell signaling, and extra cellular environment. The third module will introduce students to

cell division and differentiation. In this module students will learn about cytoskeleton, cell cycle regulation, cell death, cancer and stem cells. The course will conclude after discussing application of above mentioned principles in specialized immune cells that defend their host against invasion of pathogens.

BIO314-Virology and Microbiology

The goal of this course is to provide a strong foundation for advanced microbiology course by familiarizing students with knowledge of bacteriology and virology. Microbiology is an exciting discipline with far-reaching impacts in human health and disease. This course will focus on the study of microbes in particular bacteria and viruses and their interrelationship with human disease. Understanding these relationships is essential in order to develop interventions to prevent infections in a community. The first quarter of the course will cover the basic principals of bacteriology including bacterial structure, growth, metabolism, genetics and general concepts of bacterial disease mechanisms. In the second quarter we will draw on the basic principals learned in the first quarter of the semester to understand bacteriology as it relates to human health and human disease. More precisely, the course will cover the mechanism of disease and drug resistance and State-of-the-art technologies developed to understand pathogenesis. The next half of the course focus will be on viruses, another important pathogen that causes a significant burden of the disease every year. Globally viral infections kill approximately 2 million individuals every year. The higher burden of infections and fatalities caused by viruses is the result of their intrinsic diversity, which makes it difficult to treat and prevent viral infections. This part of the course will follow the same design as the part on bacteriology. However, in the next half, the course will be focused on a basic understanding of viral structures, assembly, replication, types of viruses, viral pathogenesis, and finally vaccines.

Samples course structure for the 1st year at LUMS

Spring Semester	Credit Hours	Fall semester	Credit Hours
BIO101-Introductory Biology	3	BIO221-Genetics or BIO313-Cell Biology	4/3
BIO212-Biochemistry	3	BIO216-Molecular Biology	3
BIO314-Virology and Microbiology	3	BIO300-Methods in Molecular Biology	4
Elective		Elective	
Elective		Elective	