

# 304 515 Molecular Biology of the Cell

4 credits (4-0-12)

*Modern concepts and knowledge in cell structure and functions that integrate knowledge from various discipline including biochemistry, cell biology, genetics, and molecular biology.*

**Prerequisites:** Graduate biochemistry (109 700) or Molecular biology and recombinant DNA technology (304 512) or permission of the instructors

**Course Instructors:** Montarop Yamabhai

## Course outline

<b>Part I Basic Knowledge</b>	<b>Hrs</b>
1. Overview of the cells and genomes	<b>4</b>
2. Cell chemistry and proteins	
3. Methods in cell biology	
<b>Part II Control of Cellular Function From Nucleus</b>	<b>4</b>
1. Genes and Chromosomes	
2. DNA replication, repair, and recombination	
3. From DNA to proteins	
4. Control of gene expression and development	
<b>Part III Cell Structure and Function</b>	<b>18</b>
1. Transport across cell membranes	
2. Cellular energetics	
3. Intracellular compartments and protein sorting	
4. Cellular trafficking	
5. Cell cytoskeleton	
<b>Part IV Cellular Communication</b>	<b>22</b>
1. Cellular signal transduction	
2. Combining cells into tissues	
3. The cell cycle and programmed cell death	
4. Germ cells and fertilization	
5. Cell interactions in development	
6. Cancer	
7. Infection and immunity	

## Course Description

Interdisciplinary approaches, including researches in biochemistry, cell biology, genetics, and molecular biology that are combined to generate concepts and knowledge in modern molecular cell biology will be taught. Advances in experimental techniques drawn from different disciplines supporting various concepts in molecular cell biology will be presented. The course will focus on the facts and paradigms that are essential for understanding of function of molecules within living cells and of the interactions between cells that allow construction of multicellular organisms.

A new perspective in the study of cell biology after the complete sequencing of the genomes of hundreds of organisms, from bacteria to humans, will be mentioned. New methodologies such as bioinformatics, DNA “chip” microarray, and stem cell research will also be touched upon. In addition relevance issues that are related to biotechnology will be integrated throughout the course.

Students are encouraged to appreciate this course as a dynamic discipline, where advances in experimental researches lead to deeper understanding of sciences. They are expected to be well prepared not only to be engaged in active scientific research and teaching but also to become educated members of the society.

## SYLLABUS

<b>Part I Basic Knowledge</b>	<b>4</b>
1. Overview of the cells and genomes	1
- the universal features of cells	
- the diversity of genomes and evolution	
2. Cell chemistry and proteins	1
- the chemical component of cells	
- catalysis and the use of energy by cells	
- protein structure and function	
3. Methods in cell biology	2
- manipulating cells in culture	
- fractionation of cells	
- analyzing protein structure and function	
- studying gene expression and function	
- visualizing cells	
<b>Part II Control of Cellular Function From Nucleus</b>	<b>4</b>
1. Genes and Chromosomes	1
- molecular definition of gene	
- the structure and function of DNA	
- The global structure of chromosomes	
- organelle DNA	
2. DNA replication, repair, and recombination	1

	- the general features of chromosomal replication	
	- DNA replication mechanisms	
	- the initiation and completion of DNA replication in chromosomes	
	- DNA damage and repair	
	- DNA recombination	
3.	From DNA to proteins	1
	- regulation of transcription initiation	
	- RNA processing, nuclear transport, and post transcriptional control	
	- RNA and the origins of life	1
4.	Control of gene expression and development	
	- gene regulatory protein and genetic switches	
	- regulation of eukaryotic cell cycle	
	- gene control in development	
<b>Part III</b>	<b>Cell Structure and Function</b>	<b>18</b>
1.	Transport across cell membranes	4
	- membrane structure	
	- principles of membrane transport	
	- carrier proteins and active membrane transport	
	- ion channels and membrane electrical potential	
	- transport across epithelia	
2.	Cellular energetics	4
	- mitochondria and electron-transport chains	
	- chloroplast and photosynthesis	
3.	Intracellular compartments and protein sorting	6
	- organelles and the compartmentalization of cells	
	- transport of molecules between nucleus and cytoplasm	
	- protein sorting to mitochondria and chloroplasts	
	- protein sorting to peroxisome	
	- endoplasmic reticulum	
	- protein modification in ER and golgi complex	
	- lysosome and vacuole	
4.	Cellular trafficking	2
	- secretory pathway	
	- endocytosis	
5.	Cell cytoskeleton	2
	- microfilaments	
	- microtubules and intermediate filaments	
	- the cytoskeleton and cell behavior	
<b>Part IV</b>	<b>Cellular Communication</b>	<b>22</b>
1.	Cellular signal transduction	6
	- principle of cellular signaling	

- signaling through G protein-coupled receptors
  - signalling through enzyme-linked cell-surface receptors
  - MAP Kinase pathway
  - second messengers
  - signaling pathways that depend on regulated proteolysis
  - interaction and regulation of signaling pathways
  - from plasma membrane to nucleus
  - signaling in plant
2. Combining cells into tissues 2
- cell junctions
  - cell-cell adhesion
  - cell-matrix adhesion
  - the dynamic of plant cell wall
3. The cell cycle and programmed cell death 4
- overview of cell cycle
  - mitosis
  - cytokinesis
  - components of the cell-cycle control system
  - intracellular control of cell-cycle events
  - programmed cell death (apoptosis)
  - extracellular control of cell development and apoptosis
4. Germ cells and fertilization 6
- meiosis
  - primordial germ cells and sex determination in mammal
  - eggs
  - sperm
  - fertilization
5. Cell interactions in development 2
- universal mechanism of animal development
  - neural development
  - plant development
6. Cancer 1
- tumor cells and the onset of cancer
  - proto-oncogenes and tumor suppressor genes
  - the molecular basis of cancer-cell behavior
  - cell biology of infec
7. Infection and immunity 1
- cell biology of infection
  - innate immunity
  - adaptive immune system

Reading: <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=Books>

**Molecular Biology of the Cell.** 4th ed.

Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Peter  
New York: [Garland Publishing](#); 2002.

**Molecular Cell Biology.** 4th ed.

Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James  
E. New York: [W. H. Freeman & Co.](#); c1999.

**The Cell - A Molecular Approach.** 2nd ed.

Cooper, Geoffrey M. Sunderland (MA): [Sinauer Associates, Inc.](#); c2000.