

**The University of Jordan**  
**Faculty of Medicine**  
**2016-2017**

<b>Course title:</b>	Principles of Genetics and Molecular Biology
<b>Course code:</b>	0501217
<b>Credit hours:</b>	3 credit hours
<b>Calendar description:</b>	16 weeks / Second semester / Year 2
<b>Course coordinator:</b>	Prof. Hatim El-Shanti, Dr. Mamoun Ahram, Dr. Diala Abu Hassan, Dr. Bilal Azab

**Course description:** This is a three-credit hour course mandatory for second-year medical students. The course is designed to introduce medical students to the basics of cell and molecular biology and medical genetics. The basics include the study of cell structure and function, the genetic material, DNA and RNA, with regards to chemical structure, replication, transcription, translation, in addition to the study of basic molecular biology tools and techniques. The course also introduces students to the main principles of medical genetics in relation to various genetic disorders.

**Learning Objectives**

The overall objective is to: 1) study cell organization and function of the different components and abnormalities, 2) learn the basic processes of the central dogma of molecular biology including DNA replication, RNA transcription, and protein translation, 3) become familiar with basic molecular biology techniques involved in recombinant DNA technology, and 4) learn the genetic basis and the principles of disease inheritance.

**Intended Learning Outcomes (ILOs):**

Successful completion of the course should lead to the following outcomes:

**A. Knowledge and Understanding:** Student is expected to

- A1- Recognize the different cell models.
- A2- Learn the molecular components of cells.
- A3- Understand the structure of plasma membranes of eukaryotic cells.
- A4- Know the different types of membrane proteins.
- A5- Recognize the role of membrane proteins in transport.
- A6- Understand the molecular mechanism of cystic fibrosis.
- A7- Understand the structure and role of the endoplasmic reticulum in protein synthesis and sorting.
- A8- Understand the role of the endoplasmic reticulum in lipid synthesis.
- A9- Understand the structure and roles of the Golgi apparatus in the synthesis of cellular molecules.
- A10- Understand the mechanism of vesicular transport.
- A11- Understand the structure and role of lysosomes and endosomes.
- A12- Understand the mechanism of endocytosis.
- A13- Recognize lysosomal storage diseases.
- A14- Understand the structure of the mitochondria.
- A15- Discuss mitochondrial diseases.
- A16- Understand the structure and function of peroxisomes.
- A17- Understand the structure of the nucleus and the nuclear membrane.

- A18- Know the nuclear lamina diseases.
- A19- Understand the structure and organization of the actin cytoskeleton.
- A20- Understand the role of actin and myosin in cell movement and muscle contraction.
- A21- Understand the structure and organization of microtubules and their role in vesicular transport.
- A22- Understand the structure and role of intermediate filaments.
- A23- Know the association of keratin dysfunction in skin diseases.
- A24- Recall the different components of the extracellular matrix.
- A25- Recall the steps involving the synthesis of collagen proteins.
- A26- Recall diseases related to collagen synthesis.
- A27- Understand the mechanisms of cell-matrix and cell-cell interaction.
- A28- Recall the different modes of cell signaling with emphasis on cell surface receptors and their intracellular signaling molecules and their cellular effects.
- A29- Understand the phases and molecular control of the cell cycle.
- A30- Understand the molecular regulation of cell death.
- A31- Understand the types and properties of cancer cells.
- A32- Recognize the basic features of DNA/RNA structures.
- A33- Understand the concept and uses of gel electrophoresis and Southern blotting
- A34- Understand the basics of restriction digestion and its use in restriction fragment length polymorphism (RFLP), recombinant DNA technology, and DNA coning
- A35- Recognize the type of DNA mutations
- A36- Know and differentiate the mechanisms of DNA repair
- A37- Learn the main steps and reactions involved in DNA replication.
- A38- Understand the concept of DNA sequencing and polymerase chain reaction (PCR), and their clinical applications
- A39- Know the composition of the human genome
- A40- Learn the main steps and reactions involved in RNA transcription.
- A41- Understand the mechanisms of regulating gene expression at the transcriptional level in prokaryotes and eukaryotes
- A42- Know the different tools in measuring gene expression at the RNA level starting with single genes (Northern blotting) to high-throughput technologies (DNA microarrays)
- A43- Learn the main steps and reactions involved in protein translation.
- A44- Understand the function and regulation of cancer-related genes including oncogenes, tumor suppressors, and regulators of apoptosis.
- A45- Recognize the main features of chromosome structure.
- A46- Recognize the main types of chromosomal aberrations.
- A47- Understand the principles, mechanisms and classification of congenital anomalies
- A48- Understand the basic principles of chromosomal disorders.
- A49- Know how to draw a family pedigree with comprehensive information.
- A50- Differentiate between the main patterns of single-gene inheritance.
- A51- Understand the basic principles of mitochondrial inheritance
- A52- Understand the basic principles of imprinting and trinucleotide repeat expansions and their clinical implications
- A53- Understand the basic principles of multifactorial inheritance.

- A54- Understand and apply the Hardy-Weinberg equation
- A55- Understand the concept of risk assessment
- A56- Understand the concept of genome-wide association studies (GWAS)
- A57- Focus on biochemical genetics and disorders of metabolism.
- A58- Understand the contribution of genetics and genomics to precision medicine
- A59- Know the basics of pharmacogenetics and pharmacogenomics.

### **Teaching/Learning Methods**

Lectures and Discussions:	<b>90%</b>
Homework and Assignments:	<b>10%</b>

### **Main References:**

1. The Cell: A Molecular Approach, Geoffrey M. Cooper and Robert E. Hausmann, 6th edition, Sinauer Associates, 2013.
2. Thompson & Thompson Genetics in Medicine, 8e (Thompson and Thompson Genetics in Medicine) 8th Edition, by Robert L. Nussbaum , Roderick R. McInnes), Huntington F Willard. Elsevier; 8 edition, 2015.

### **Additional resources**

1. The Cell: A Molecular Approach, Geoffrey M. Cooper, 2<sup>nd</sup> edition, Sinauer Associates, 2000.  
<http://www.ncbi.nlm.nih.gov/books/NBK9839/>
2. The Medical Biochemistry page, <http://www.themedicalbiochemistrypage.org/>

## Course Contents

Topic	Week	Instructor	Achieved ILOs	Reference
Introduction into basic cell structure, model systems of cell biology, and eukaryotic cell organelles	1	Abu Hassan	A1-2	Cooper, Ch.1 (pp. 17-38) and Ch.2 (43-57)
Biomembranes and membrane proteins and their role in plasma membrane transport	1	Abu Hassan	A3-6	Cooper, Ch. 2 (pp. 58-64) Ch. 13 (515-543)
Protein sorting and transport, and endoplasmic reticulum	1	Abu Hassan	A7-8	Cooper, Ch. 10 (373-398)
The Golgi apparatus and vesicular transport	2	Abu Hassan	A9-10	Cooper, Ch. 10 (398-412)
Lysosome, endocytosis, endocytosis, and lysosomal storage diseases	2	Abu Hassan	A11-13	Cooper, Ch. 10 (412-416) Ch. 13 (544-553)
Mitochondria and peroxisomes	2	Abu Hassan	A14-16	Cooper, Ch. 10 (421-431, 450-455)
The nucleus	3	Abu Hassan	A17-18	Cooper, Ch. 9 (345-365)
The actin cytoskeleton and cell movement	3	Abu Hassan	A19-20	Cooper, Ch. 12 (459-482)
Microtubules and intermediate filaments	3	Abu Hassan	A21-23	Cooper, Ch. 12 (482-510)
The extracellular matrix	4	Abu Hassan	A24-27	Cooper, Ch. 14 (564-582)
Cell signaling	4	Abu Hassan	A28	Cooper, Ch. 15 (589-634)
The cell cycle	4	Abu Hassan	A29	Cooper, Ch. 16 (641-675)
Cell proliferation, differentiation, and death, and	5	Abu	A30-31	Cooper, Ch. 17 (681-692) Cooper,

cancer		Hassan		Ch. 18 (713-723)
Nucleic acid structure	5	Ahram	A32	Cooper, pp 49-52
Gel electrophoresis and Southern blotting	6	Ahram	A33	Cooper, pp 118-119, 130
Restriction endonucleases, RFLP, recombinant DNA technology, and DNA coning	6	Ahram	A34	Cooper, pp 120-124
DNA replication	6	Ahram	A37	Cooper, pp 191-207
DNA mutations	7	Ahram	A35-36	External source
DNA repair	7			Cooper, pp 207-219
PCR and DNA sequencing	7	Ahram	A38	Cooper, pp 127-129, 124-125
The human genome	8	Ahram	A39	Cooper, Ch. 5, pp.159-162, 166-171
RNA transcription	8	Ahram	A40	Cooper, Ch. 5 (pp. 155-159) and 7
Regulation of transcription in prokaryotes and eukaryotes	8 and 10	Ahram	A41	
Analysis of gene expression	10	Ahram	A42	Cooper, 121-122, 130-135
Translation and its regulation	11	Ahram	A43	Cooper, Ch. 8 (297-319)
Structure & function of chromosomes	11	Azab	A45	
Chromosomal aberrations	11-12	Azab	A46	
Congenital anomalies	12	Azab	A47	
Patterns of single-gene inheritance	12-13	Azab	A48-50	
Non-Mendelian inheritance	13	Azab	A51-52	
Multifactorial inheritance	14	Azab	A53	

Population genetics	14	Azab	A54-55	
Biochemical genetics: disorders of metabolism	15	El-Shanti	A57	Thompson & Thompson, Ch 12 and 13 (partial)
Precision medicine	15	El-Shanti	A58-59	Thompson & Thompson, Ch 18