

MOLECULAR AND CELLULAR PHYSIOLOGY

16:340:592

Course Directors:

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Course Description: This course is designed to explore the molecular mechanisms of cell biology as it pertains to mammalian physiology. Specific emphasis is placed on the molecular mechanisms of gene expression and genome function including the role of chromatin and non-coding RNA, translation, cell cycle and division, protein trafficking, cellular metabolism and cell signaling. Other topics include the specific function of cellular organelles, DNA replication and repair, mRNA processing and translation, the nuclear pore complex and shuttling between the cytoplasm and nucleus, cytoskeleton, protein trafficking between organelles and through the secretory pathway, electron transport, cell homeostasis and apoptosis, extracellular matrix, stem cell development and hematopoiesis, and cellular clocks.

Learning Objectives: The overall goal of this course is to provide a solid understanding of the molecular basis of how eukaryotic cells function in the context of whole organisms.

1. Students are expected to learn cell organelles, gene/protein nomenclature and the function of specialized cells.
2. Students are expected to gain a fundamental understanding of the molecular mechanisms that guide cell specialization as it pertains to mammalian physiology. Specifically, students will learn the mechanistic control of DNA replication and repair, transcription, translation, cell cycle, the secretory pathway, central metabolism, cell signaling and aspects of development.
3. Students will learn critical reasoning skills, hypothesis development, experimentation, and some rudimentary molecular biology data analysis. The goal is to get you to integrate molecular and cellular mechanisms with physiological processes at the animal level.

LECTURE SCHEDULE

Topic
Introduction to Cells, Cell Specialization in Mammals
Chemistry of Cellular Components and Organelles: Nucleic acids, amino acids, polypeptides, and lipids
Proteins
The Nucleus, Genome Structure and Chromatin
Chromatin Regulation
DNA Replication
DNA, Recombination and Repair
Transcription and Splicing
Translation and the Ribosome
Control of Gene Expression
Post Transcriptional Control (miRNA and RNAi)
Cell Signaling and Homeostasis
Actin and Tubulin Cytoskeleton
Motor Proteins
Cell Cycle, Cell Division, Mitosis and Meiosis
Membrane Structure and The Secretory Apparatus
Membrane Proteins and Translocation into the ER and Nucleus
Vesicle Transport
Endosomes, lysosome and phagocytosis
Ion Channels
Extracellular Matrix
Mitochondria Transport and Electron Transfer
Cellular Stress, Apoptosis and Senescence
The Cellular Clock
Cellular Differentiation, Stem Cells and Hematopoiesis