Cell Biology II MCDB 3145 – Course and Topic Learning Goals

Students enrolling in this course should be able to demonstrate achievement of the learning goals for either Introductory Biology MCDB 1150 and 1151 or Biofundamentals MCDB 1111, as well as for Genetics MCDB 2150.

Teaching toward the learning goals below is expected to occupy 60%-70% of class time. The remaining course content is at the discretion of the instructors. The relative emphasis placed on the goals below and the order in which they are dealt with may also vary according to the tastes and interests of individual instructors. However, all students who receive a passing grade in the course should be able to demonstrate achievement of the following minimal goals.

<u>After completing this course, students should be able to:</u>

1. Relate structures and functions of cellular lipid-bilayer membranes and their protein components.

a) Explain how membrane lipid and protein components and their structural asymmetries are important for membrane functions in cells.

b) Compare the different ways in which proteins associate with cellular membranes.

d) Predict how variation in the lipid composition of a membrane will affect its fluidity and the mobility of integral membrane proteins.

2. Compare the different ways in which small molecules and ions are transported across cell membranes.

a) Explain how diffusion rates are related to molecular size and hydrophobicity.

b) Compare the mechanisms of facilitated diffusion and active transport for moving ions and molecules across cell membranes through protein transporters.

c) Explain how hyperpolarization and depolarization occur in nerve transmission.

d) Explain how neurotransmitter secretion is related to neuron depolarization.

3. Compare the processes by which newly synthesized proteins are targeted to different cellular locations.

a) Compare the general mechanisms that allow some newly synthesized proteins to be released into the cytoplasm, whereas others are directed into other cellular compartments.

b) Explain how the orientations of transmembrane proteins are determined as they are integrated into a membrane.

c) Describe the mechanism by which chaperones assist in the folding of newly translocated proteins.

d) Explain the function of the unfolded protein response and its value to the cell.

4. Describe the mechanisms by which proteins are trafficked between cellular compartments, secreted from, and imported into cells.

a) Diagram the general mechanism by which proteins are transported between different cellular compartments.

b) Explain how cells regulate the directional flow of secreted components from the endoplasmic reticulum (ER) to the Golgi apparatus to the plasma membrane.

c) Describe the different mechanisms by which secretory vesicles fuse with the plasma membrane.

d) Compare the functions of the various coat proteins involved in vesicle-mediated trafficking.

f) Describe the functions of lysosomes and how vesicles are targeted to them.

d) Compare the mechanisms by which proteins are targeted for degradation by either proteosomes or lysosomes.

f) Distinguish between receptor-mediated endocytosis and phagocytosis.

g) Describe the synthesis of glycoproteins and the functions of their carbohydrate side chains.

5. Describe the structure of the eukaryotic nucleus, its dynamics during the cell cycle, and its mechanisms for exporting and importing specific proteins.

a) Diagram the structure of the nuclear envelope and describe its functions.

b) Describe the arrangement of chromosomal DNA in the nucleus and how it changes during the cell cycle.

c) Diagram the structure of a nuclear pore and describe its permeability properties.

d) Compare the mechanisms for importing specific proteins into the nucleus and into mitochondria.

e) Explain how the controlled nuclear import or export of specific proteins can be used to regulate gene expression.

6. Explain the role of the cytoskeleton in determination of cell shape, positioning of organelles, intracellular trafficking, and cell movement.

a) Compare the characteristics and functions of microfilaments, microtubules, and intermediate filaments.

b) Compare treadmilling of actin filaments with dynamic instability of microtubules.

c) Explain how the growth and branching of actin microfilaments is controlled.

d) Describe the general functions of directional microtubule motor proteins and how they work.

e) Explain how cytoskeletal dynamics can control cellular movement.

7. Describe the role of the cytoskeleton in mitosis and cell division.

a) Explain the mechanisms by which mitotic spindle components position and segregate chromosomes during mitosis.

b) Describe the process of cytokinesis and the roles of cytoskeletal elements in controlling it.

8. Contrast the roles of internal mechanisms and external signals in the regulation of cell division and programmed cell death.

a) Describe how a cell determines whether it is ready to replicate DNA and then enter mitosis.

b) Explain the role of centrosome duplication and cytoskeletal changes during cell division.

d) Discuss how cell cycle, chromosome condensation, and transcription are related.

e) Explain how the cell regulates the timing of events in the mitotic cycle.

f) Describe the mechanism of programmed cell death (apoptosis) and its importance for animal homeostasis.

g) Describe the roles of growth factors in cell growth, division, and prevention of programmed cell death.

h) Explain how defects in control of the cell-cycle or programmed cell death can lead to cancer.

9. Describe how cells respond to stimuli and communicate through trans-membrane signaling pathways.

a) Cite examples of environmental and chemical signals to which cells can respond.

b) Compare the mechanisms by which ion-channel-linked receptors, G-protein-linked receptors, and enzyme-linked receptors transmit signals across the plasma membrane.

c) Identify the steps in signal transduction that account for the specificity of a signaling pathway.

d) Discuss the roles of phosphorylation and dephosphorylation as switch mechanisms in signal transduction.

e) Describe how signaling pathways control gene expression through nuclear effectors.

f) Describe the mechanisms by which signaling pathways control cell shape and behavior.