A slice of cell and molecular biology: A cell signaling and cell communication primer

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Lecture Outline:

I. Overview of the Cell

II. Overview of the Cell Signaling Challenge

III. Common themes among many different cell types

IV. Different types of signals: electrical, chemical, mechanical

V. External stimulus $\rightarrow$ membrane interactions $\rightarrow$ intracellular cytoplasmic events $\rightarrow$ gene expression changes

VI. Membrane composition and membrane function

VII. Gene expression events: Transcription (RNA synthesis)  
Translation (protein synthesis)

VIII. Summary
What’s going on inside this cell? How does it respond to its environment?
Cells Respond in Diverse Ways to External Stimuli
Cells Respond in Diverse Ways to External Stimuli

- **A** → Survive
- **B** → Grow + Divide
- **C** → Differentiate
- **D** → Apoptotic cell

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Figure 16-6 Essential Cell Biology (© Garland Science 2010)
Figure 16-7  Essential Cell Biology (© Garland Science 2010)
CELL MEMBRANES

• Semi-permeable to ions and organic molecules (allows selective influx and efflux)
• Protects cell from surroundings; responds to surroundings
• Comprised of phospholipids and embedded proteins
• Protein composition is most variable part between different types of cells
Figure 11-6 Essential Cell Biology (© Garland Science 2010)
Cell Membrane showing orientation of phospholipids in the bilayer
Protein Components of Membranes

Carbohydrate portion of glycoprotein

Channel

Integral proteins

Transmembrane proteins

Nonpolar regions

Polar regions

Peripheral proteins

Phospholipids

Extracellular fluid

Intracellular fluid

Binding of a single ligand type to a receptor can cause different cellular responses depending on the cell type.

(A) Heart muscle cell
- Binding of acetylcholine
- Decreased rate and force of contraction

(B) Salivary gland cell
- Binding of acetylcholine
- Secretion

(C) Skeletal muscle cell
- Binding of acetylcholine
- Contraction

(D) Acetylcholine (a type of neurotransmitter)
Neuronal Communication and Signaling

A Chemical synapse

- Action potential
- Ca²⁺
- Presynaptic terminal
- Synaptic vesicle
- Neurotransmitter
- Ionotropic receptor
- Membrane potential
- Gene expression
- Biochemical cascades

B Electrical synapse

- Action potential
- Gap junction channel
- Coupling potential
Optional video to reinforce signaling themes

http://www.dnalc.org/resources/3d/cellsignals.html
Gene Expression Events

Transcription (RNA Synthesis)
Translation (Protein Synthesis)
Central Dogma of Molecular Biology

DNA → Transcription → RNA → Translation → Proteins

- Reverse transcription

DNA → Transcription

RNA Transport to cytoplasm

Growing Amino Acid chain

5' → mRNA → 3'

www.2classnotes.com

www.tokresource.org
Take Home Summary

Cells communicate with their environment through interactions at the cellular membrane

Membrane proteins are essential features that enable cellular communication by interacting with signals (e.g., chemical, electrical, mechanical)

Signaling at the membrane causes intracellular changes that affect different pathways depending on the type of cell

Cell signaling can stimulate changes in gene expression at the nuclear level, resulting in the production of new proteins