

**BIMS 512 Cell Structure and Function****REVISED FALL 2008****Course times:****Tue/Thu 10-11:30 am****Fri 1:30-3:00 pm****Room: 1-17 Jordan Hall****Textbook: Alberts et al, Molecular Biology of the Cell, 5<sup>th</sup> edition.** (available at the Student Bookstore).**Course Website:** <https://collab.itc.virginia.edu/portal>

Assigned reading (either key reviews or selected papers from the primary literature) will be posted as PDF files. Individual lecturers will post Powerpoint files of their lectures and any other corresponding lecture notes.

**EXAMINATIONS:** Four examinations will be given covering each of the four sections of the course (see below). Each exam will be closed book and cover approximately one quarter of the course. The exams are designed to be completed in two hours, but you will be given three hours to complete them. The exam dates are included in the schedule. **Note that the exams will be held in the afternoon on the designated date. This is to allow us to use the large lecture hall Jordan 1-5 for exams. The final exam is scheduled for the afternoon of Thursday, Dec 11th during the final exam period.** The only excused absence from an exam will be for: a schedule conflict with another course, documented illness, family sickness/death, and religious holidays. A make up exam must be scheduled in a timely manner. Having other exams in the same week is not an excuse!

**This course WILL meet on Tuesday, October 14<sup>th</sup>** (scheduled as a Reading Day on the University academic calendar).

**COURSE UNITS**

<b>Unit</b>	<b>Topic</b>	<b>Faculty Coordinator</b>	<b>e-mail</b>
I	Membranes & Intracellular Transport	Judy White	<a href="mailto:jw7g@virginia.edu">jw7g@virginia.edu</a>
II	Signaling	Jim Garrison	<a href="mailto:jcg8w@virginia.edu">jcg8w@virginia.edu</a>
III	Cytoskeleton & Motors; Cell Adhesion & Migration	Rick Horwitz	<a href="mailto:horwitz@virginia.edu">horwitz@virginia.edu</a>
IV	Cell Cycle & Cell Differentiation in Development and Disease	Dan Burke	<a href="mailto:dburke@Virginia.EDU">dburke@Virginia.EDU</a>

## UNIT I: MEMBRANES & INTRACELLULAR TRANSPORT

### AUGUST

Tue 8/26	10 - 11:30	<b>Intro to Membranes and Compartments</b> Hierarchy of Organization; Membranes as boundaries; cell compartments; Membrane structure and dynamics; Cell organelles; Lipid trafficking; Protein targeting	White
Thu 8/28	10 - 11:30	<b>ER Translocation, Protein Synthesis, Quality Control</b> Overview of Major Functions of the ER; Protein Synthesis and the Signal Hypothesis; The Translocon and Protein Topology; Protein Folding and Quality Control; Unfolded Protein Response	Pemberton
Fri 8/29	1:30 - 3	<b>ER Export, Golgi</b> Export from the ER – protein sorting; COPII vesicle formation; COPI vesicles and retrograde traffic; Formation and function of the Golgi; Processing of oligosaccharides; ER/Golgi trafficking and regulation of cholesterol	White

### SEPTEMBER

Tue 9/2	10 - 11:30	<b>Golgi Transport and Membrane Fusion</b> Mechanisms of transport through the Golgi complex; Vesicular carriers -- targeting and fusion; Rabs, SNAREs, supporting proteins; Recycling of fusion machinery	Castle
Thu 9/4	10 - 11:30	<b>Secretory Pathway (include apical/basolateral)</b> Cargo sorting in the Golgi; How to study protein traffic through compartments; Constitutive secretory pathway; Lysosomal proteins - sorting and recognition systems; Regulated secretion	Casanova
Fri 9/5	1:30 - 3	<b>Endocytic Pathway</b> Receptor mediated, phagocytosis, pinocytosis Endocytic machinery, clathrin, caveolae, non-clathrin Endosomal sorting- recycling vs. degradation Subversion of endocytic pathways by pathogens	Casanova
Tue 9/9	10 - 11:30	<b>Nuclear Structure and Function</b> Overview of Nuclear Compartmentalization; Nuclear Envelope and lamina; Laminopathies; Organization of Chromatin; Ribosome Biogenesis	Pemberton
Thu 9/11	10 - 11:30	<b>Nuclear Transport</b> Overview of Nuclear Transport Cycles; The Nuclear Pore Complex and Nucleoporins; Transport Signals and Receptors; The Ran GTPase; Regulation of Nuclear Transport; RNA Export	Pemberton

Fri 9/12	1:30 - 3	<b>Membrane potential, action potential and Synaptic Transmission</b> Role of ion channels, pumps and ion gradients in determining the resting membrane potential and mediating the action potential. · Biophysical description of ion channel activity and channel inactivation. · Nernst potential and the Goldman-Hodgkin-Katz potential. · The sequence of events in synaptic transmission (calcium influx, vesicle exocytosis, receptor binding). · Parameters of quantal transmission and their utility in describing synaptic plasticity. · Discussion of mechanisms by which synaptic transmission can be blocked by toxins. · Kiss-and-run exocytosis vs classical full fusion. · Visualizing synaptic exocytosis in TIRF microscopy.	Worden
Tue 9/16	10 - 11:30	<b>REVIEW DAY UNIT I:</b> White, Pemberton, Castle, Casanova, & Worden	
<b>Thu 9/18</b>	<b>1:30 – 4:30</b>	<b>EXAM I</b>	<b>Jordan 1-5</b>
<b>UNIT II: SIGNALING</b>			
Fri 9/19	<b>CANCELLED</b> <b>** LECTURE PPT ONLINE</b>	<b>Intro to Signaling</b> General introduction to the signaling systems discussed in this course. Biological and physiological principles used by signaling systems. Presentation of ligand binding theory and how conformational changes regulate biological systems.	Garrison
Tue 9/23	10 - 11:30	<b>Signaling by Receptor Tyrosine Kinases and TGF-β</b> Signaling by Receptor Tyrosine Kinases and the TGF-beta pathway	Wotton
Thu 9/25	10 - 11:30	<b>Signaling by Cytokines and Regulation of Signaling Pathways</b> Regulation of Signaling, Cross-talk, Other mechanisms of signal transduction	Wotton
Fri 9/26	<b>CANCELLED</b>		
Tue 9/30	10 - 11:30	<b>G Protein Coupled Receptors I (cAMP production)</b> Introduction to certain members of the family of G protein coupled receptors and the family of G proteins. Discussion of the how receptors activate G proteins and effectors like adenylate cyclase. Introduction to kinase cascades and protein phosphorylation via the cyclic AMP dependent protein kinase. Presentation of how protein phosphorylation regulates enzyme activity.	Garrison
<b>TBA</b>	<b>TBA</b>	<b>G Protein Coupled Receptors II (Ca<sup>++</sup> signaling)</b> Introduction to Ca <sup>2+</sup> linked G protein coupled receptors. Activation of phospholipase C and phosphatidylinositols, membrane lipids important in signaling. Ca <sup>2+</sup> and Calmodulin dependent protein kinases and their substrates.	Garrison
<b>OCTOBER</b>			
Thu 10/2	10 - 11:30	<b>Nuclear Hormone Receptors I</b> Structure/function of nuclear receptors; Nuclear functions for hormones/metabolites - orphan receptors; Cytoplasmic functions and crosstalk with signaling molecules	Shupnik

Fri 10/3	1:30 - 3	<b>Nuclear Hormone Receptors II</b>	Shupnik
Tue 10/7		<b>REVIEW DAY UNIT II:</b> Garrison, Wotton, & Shupnik	
<b>Thu 10/9</b>	<b>1:30 – 4:30</b>	<b>EXAM II</b>	<b>Jordan 1-5</b>
<b>UNIT III: CYTOSKELETON &amp; MOTORS; CELL ADHESION &amp; MIGRATION</b>			
Fri 10/10	1:30 - 3	<b>Introduction to Cytoskeleton</b> Principles of filament assembly; Kinetics of filament systems; Intermediate filaments - biochemistry in vitro & functions in vivo	Schafer
Tue 10/14* *Reading Day NOT observed.	10 - 11:30	<b>Actin</b> turnover); Dendritic nucleation and model systems to probe actin dynamics; (Listeria, fish keratocytes, biomimetic systems); Force generation by filament polymerization	Schafer
Thu 10/16	<b>10 - 11:30</b>	<b>Myosin Based Motility</b> The myosin superfamily; The mechano-chemical cycle of myosin; Myosin mechanics	Guilford
Fri 10/17	<b>1:30 - 3</b>	<b>Regulation of Myosin Based Motility</b> Regulation of contraction in striated muscles; Regulation of contraction in smooth muscle; Regulation of non-muscle myosins	Guilford
Tue 10/21	10 - 11:30	<b>Microtubule Assembly, Functions and Regulation</b> general functions of microtubules; how microtubules were discovered; mechanisms of microtubule assembly; modulators of microtubules; <i>Alzheimer's - a microtubule disassembly disease?</i>	Bloom
Thu 10/23	10 - 11:30	<b>Motile processes (Motors)</b> Microtubule-Based Motility Flagella & Membranous Organelle Trafficking Two motor families: Kinesin and Dynein Cargo-binding & Regulation	Pfister
Fri 10/24	<b>1:30 - 3</b>	<b>Cell Adhesion I</b> Cell adhesion structures; Adhesion molecules Functional importance of cell-cell adhesion	Sutherland
Tue 10/28	<b>10 - 11:30</b>	<b>Cell Adhesion II</b> Extracellular matrix; components and function; Cellular receptors for extracellular matrix; Matrix adhesion structures; Functional importance of cell-matrix interactions	Sutherland
Thu 10/30	10 - 11:30	<b>Signaling by Integrins</b> Integrin structure and conformations Inside out and outside in signaling Cytoplasmic domain interactions Downstream signals: tyrosine kinases and Rho GTPases Convergence with growth factor signaling Regulation of cell survival, growth and migration	Vicente

Fri 10/31	1:30 - 3	<b>Cell Migration</b> Coordination of signaling pathways, G proteins Cytoskeleton dynamics Integrins – adhesion/deadhesion	Vicente
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**NOVEMBER**

Tue 11/4	10 - 11:30	<b>REVIEW DAY UNIT III:</b> Schafer, Guilford, Bloom, Pfister, Sutherland, Vicente & Horwitz	
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<b>Thu 11/6</b>	<b>1:30 – 4:30</b>	<b>EXAM III</b>	<b>Jordan 1-5</b>
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**UNIT IV: CELL CYCLE & CELL DIFFERENTIATION IN DEVELOPMENT AND DISEASE**

Fri 11/7	1:30 - 3	<b>Cell Cycle I</b> Organization of the cell cycle Cyclin dependent kinases Cyclins and stage specificity Proteolysis and transitions	Burke
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Tue 11/11	10 - 11:30	<b>Cell Cycle II</b> Cell cycle regulation Cyclin dependent kinase inhibitors G1/S transition - regulation G2/M transition - regulation Check points	Burke
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Thu 11/13	10 - 11:30	<b>Mitosis and Cytokinesis</b> Microtubule dynamics, Spindle assembly Chromosome movements, Motors and Mechanisms Cytokinesis	Stukenberg
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Fri 11/14	1:30 - 3	<b>Cancer</b> General Characteristics; Angiogenesis; Metastasis Transformation; Oncogenes; Tumor Suppressors	Lannigan
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Tue 11/18	10 - 11:30	<b>Growth and Differentiation I</b> Cell differentiation and determination Mechanisms of cell specific gene regulation Local environmental cues, signal pathways, and selective gene expression	Owens
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Thu 11/20	<b>10 - 11:30</b>	<b>Growth and Differentiation II</b> Overview of experimental model systems for studying gene function in vivo; Transgenics, knockouts, targeted knockouts, genetic approaches, congenics	Owens
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Fri 11/21	<b>1:30 - 3</b>	<b>Apoptosis</b> Morphological events in programmed cell death and engulfment Genetics of apoptosis; Caspases; Bcl-2; cytochrome c.	Macara
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Tue 11/25	10 - 11:30	<b>Cell Polarity</b> What do we mean by polarity? Symmetry breaking - budding yeast; Asymmetric cell division and stem cells; Polarity in different contexts. Mechanisms of apical/basal polarity and planar cell polarity. Signaling networks in cell polarization	Macara
<b>Thu 11/27</b>	<b>THANKSGIVING HOLIDAY</b>		
<b>Fri 11/28</b>	<b>THANKSGIVING HOLIDAY</b>		
<b>DECEMBER</b>			
Tue 12/2	10 - 11:30	<b>Adhesion and Morphogenesis I</b>	Gumbiner
Thu 12/4	10 - 11:30	<b>Adhesion and Morphogenesis II</b>	Gumbiner
Fri 12/5	1:30 - 3	<b>REVIEW DAY UNIT IV:</b> Burke, Stukenberg, Lannigan, Owens, Macara, & Gumbiner	
<b>Thu 12/11</b>	<b>1:30 – 4:30</b>	<b>EXAM 4</b>	<b>Jordan 1-5</b>

Courses end: Friday, 12/5  
 ASCB Annual Meeting: 12/13-17