Molecular Cell Biology 5068 In Class Exam 1 **Exam Number: _____**
September 30, 2014

Please print your name: _____

Instructions:

Please write only on these pages, in the spaces allotted and not on the back. Write your number on each page (not your name), so that we can split them up and grade them anonymously. There are a total of 8 pages including this cover page. You may not use any books or notes, and no electronic aids, including calculators.

Answer only in the space provided; short, concise answers are preferred and will be rewarded. Please be as neat as possible.

When you are finished, turn this in to the TA and pick up the take-home portion.

Exam Number:_____

MCB 5068 Exam 1 September 30, 2014

Dr. Mueckler's Lectures (29 Points)

1. List 2 major functions of the plasma membrane in cells. [2 points]

2. Diffusion occurs along a concentration gradient and does not require energy, while active transport occurs against a concentration gradient and requires cellular energy equivalents. Using this information, explain the differences in function of the scramblase and flippase enzymes in terms of energy requirements and the symmetry of the membranes modified by each enzyme. Be sure to state the specific membrane associated with each enzyme in your answer. [3 points]

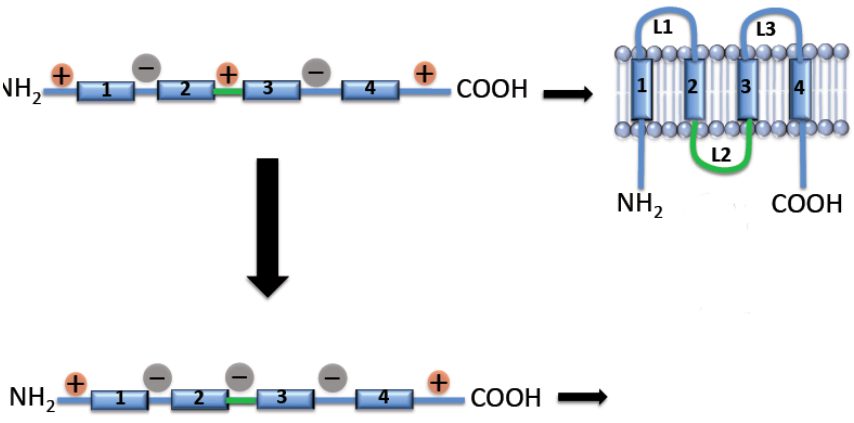
3. List 2 ways in which lipids can be transported between cellular compartments. Briefly explain why such transport mechanisms are necessary. [3 points]

4. Give one reason why disulfide bonds are generally not seen in the cytosol [1 point]. Name the major enzyme responsible for disulfide bridge formation in the rough endoplasmic reticulum. [1 point]

5. Describe the signal sequence mediated process by which proteins are translocated into the rough ER. Be sure to mention all steps and components involved. [5 points]

6. Using an *in vitro* translation system, describe briefly 2 experimental conditions to show that the signal sequence is **necessary** and **sufficient** for protein recognition and translocation into ER rough microsomes. [4 points]

7. Draw the expected topology of the following transmembrane protein based on the charge difference rule. [2 points]



8. Describe one of the three routes a protein may travel in order to be inserted into the inner membrane of the mitochondria. Make sure to mention all the components necessary. (3 points)

9. What is the role of the SAM complex in mitochondrial protein targeting? [2 points]

10. What are the functions of Ran-GAP and Ran-GEF in the establishment of directionality in nuclear transport? Where is each protein localized? [3 points]

Dr. Hanson's Lectures (28 Points)

1. When a newly synthesized glycoprotein in the ER fails its first attempt to fold on the calnexin/calreticulin complex, this "nearly native" form of the protein undergoes an intermediate step to try to be folded correctly again. Name two proteins that are involved in this intermediate step and identify the function of either of the two proteins. (3 points; 2 points for two proteins and 1 point for correctly identifying the function with the protein)

2. What sequence motif promotes exit of a folded membrane protein from the ER? What sequence motif mediates return of lumenal ER proteins from the cis-Golgi to the ER? (2 points)

3. Briefly describe how the UPR in yeast works. Be sure to discuss Ire1, BiP, Hac1, and UPRE in your answer. (4 points)

4. There are 3 roles of Sec23/24 heterodimer complex in COPII vesicle. Name <u>one</u> role. (1 point)

5. Endoglycosidase D can be used to determine if a protein is within the ER or cis-Golgi due to what modifications of secreted proteins as they pass through the Golgi apparatus? (2 points)

6. Describe how clostridial toxins were used to elucidate the mechanism underlying vesicle fusion. (3 points)

7. What is the approximate pH inside each of the following organelles: (a) endoplasmic reticulum and (b) lysosome? (2 points)

8. Patients who have I-cell disease suffer from severe skeletal and neurological problems and have low survival rate as most of them die within 5 years of birth. What enzyme are these patients lacking, and how does this deficiency affect lysosomal enzymes in regards to their modifications? (2 points)

9. Explain two models of transport through the Golgi. (4 points)

10. Explain how LDL, transferrin, and EGF differ regarding what happens to the receptor and cargo. (5 points)

Dr. Morley's Lecture (18 Points)

1. There are 3 different steps in how F-actin is generated from G-actin. Explain these three steps. (3 points)

2. In videos shown during Dr. Morley's lectures, various actin filaments were seen to be "moving" from one direction to another. This phenomenon is really due to _____, where a difference in critical concentration causes barbed end to polymerize while pointed end to depolymerize. (1 point)

3. (True or False) At low concentrations, cofilin severs F-actin to promote depolymerization of the pointed end by hydrolyzing GTP to GDP. (1 point)

4. (True or False) Gelsolin binds to the barbed end and works with Arp2/3 complex to regulate the branching network in migrating cells. (1 point)

5. What is the function of formin? (1 point)

6. Explain how WASP (Wiskott-Aldrich Syndrome Protein) is involved in nucleation. Be sure to discuss changes in conformation, activating signal, and downstream signal. (4 points)

7. Expression of active forms of small G-proteins in cells can induce different subcellular structures that are based on assemblies of actin filaments. Fill in the blank with the name of a small G-protein. (3 points)

_____ can cause the formation of stress fibers.

_____ can cause the formation of lamellipodia.

_____ can cause the formation of filipodia.

8. Briefly describe how Ras-related proteins can be activated or inactivated. Be sure to mention the role of the two proteins involved in this process. (4 points)

Dr. Mahjoub's Lecture (14 Points)

1. Microtubules play diverse roles in cells. List 4 ways in which the heterogeneity of microtubule function is established? [4 points]

2. Describe the structural differences between sensory and motile cilia. [2 points]

3. The rabies virus typically infects peripheral tips of axons and travels by retrograde axonal transport to the cell bodies of neurons. The latency from infection to symptom onset is due to the time it takes for the virus to reach the soma. The P protein of the virus interacts with a microtubule motor protein to mediate transport. Which motor protein likely interacts with this protein? [1 point]

4. Name the three major types of microtubules that emanate from the MTOC during mitosis and play critical roles during chromosome segregation in anaphase. [3 points]

5. Sas6 plays a critical role in the initiation of templated duplication of centrioles and establishment of the 9-fold rotational symmetry of centriolar microtubules. What are the 2 **specific forms of regulation** that prevent Sas6 from aberrantly forming a bunch of microtubule rings non-specifically in the cytoplasm? [4 points]

Dr. Cooper's Lecture (11 Points)

1. Describe how a point mutation in keratin's terminal domain can lead to human epidermal disease, even when the mutant keratin is expressed at much lower levels than wild-type keratin. [2 points]

2. For three classes of intermediate filaments, give the name and their biological function. [3 points]

Intermediate filament	**Function**
1.	
2.	
3.	

3. Why does entropy increase during protein self-assembly, even though the subunits are going from a highly disordered state to one of increased order? [2 points]

4. What does the term "critical concentration" mean in terms of steady-state between polymer and monomer? Construct a graph depicting the relation of monomer and polymer concentrations (y-axis) as more subunits are added to a system (x-axis) at steady state. On the graph, label the critical concentration. What does a high critical concentration mean in terms of the affinity (Kd) of the subunit for the end of the filament? (4 points)