

150 Points Total Plus 15 bonus points

Answer all questions. Put your name on every page. Read questions carefully and choose the best answer. The exam is double sided with 41 exam questions and 3 bonus questions.

1. **(3 pts)** Substitution with which of the following amino acids would generate an effect that is similar to phosphorylation?
 - a. Glutamic Acid (E).
 - b. Lysine (K).
 - c. Serine (S).
 - d. Alanine (A).

2. **(3 pts)** Which of the following bonds determines the primary structure of proteins?
 - a. Ionic bonds between charged residues.
 - b. Hydrogen bonds.
 - c. Disulfide bonds.
 - d. Peptide bonds.

3. **(3 pts)** Circle the charged phospholipid(s) that is enriched on the cytoplasmic face of the endoplasmic reticulum.
 - a. Phosphatidylcholine (PC).
 - b. Cholesterol.
 - c. Phosphatidylserine (PS).
 - d. Glycine.

4. **(6 pts)** You are making two different drugs that are designed to prevent amyloid fiber formation in humans. What would you design your two drugs to do?

5. **(3 pts)** What makes the selectivity filter of the voltage gated potassium channel **SPECIFIC** for potassium?
- It is lined with negatively charged side chains.
 - It is the perfect size to coordinate potassium that has lost its hydration shell.
 - Sodium is bigger than potassium so it does not fit through the channel.
 - It only opens when potassium concentration is high on the outside of cells.
6. **(3 pts)** How would you describe glucose transport into muscle cells?
- Glucose is transported down its concentration gradient and then phosphorylated in the cytoplasm.
 - Glucose is phosphorylated in the bloodstream and transported down its concentration gradient into the cell.
 - Glucose is transported into the cell against its concentration gradient in an active ATP-dependent process.
 - Glucose is transported into the cell down its concentration gradient in an active ATP-dependent process.
7. **(3 pts)** Order the following events during proteasome-mediated degradation of an unfolded protein X:
- Degradation of protein X within the proteasome chamber.
 - Removal of ubiquitin from protein X.
 - Binding of protein X to the proteasome.
 - Ubiquitination of protein X.
8. **(6 pts)** Compare the roles of Hsp70 and GroEL/ES in protein folding.

9. **(3 pts)** Assume: Free actin concentration is 0.3 micromolar. The critical concentration of the plus end is 0.1 micromolar and the critical concentration of the minus end is 0.3 micromolar. What will happen to actin filaments?
- Both ends will grow.
 - The plus end will grow and the minus end will shorten.
 - The plus end will grow and the minus end will stay the same length.
 - Both ends will shorten.
10. **(3 pts)** Which of the following structures is most dramatically altered by the hydrolysis of its bound nucleotides?
- Microtubules.
 - The centrosome.
 - Actin filaments.
 - Nuclear lamin.
11. **(3 pts)** Which of the following is **NOT** a feature of Kinesin 1:
- It uses the energy from GTP hydrolysis at its motor domain to move.
 - It “walks” away from the microtubule organizing center (MTOC).
 - It takes one step per cycle of nucleotide hydrolysis.
 - The heavy chains interact in a coiled-coil domain.
12. **(6 pts)** The Na/K ATPase pump has a different affinity for the two ions depending on its conformation. Describe how this change in conformation and affinity drives the direction of transport of the two ions.
13. **(3 pts)** Which of the following can release Myosin-V from its cargo?
- Phosphorylation of its tail domain.
 - Myosin binding to profilin.
 - Binding of its light chains to its heavy chains.
 - Binding to a Rab protein.

14. **(3 pts)** Which of the following does **NOT** bind to microtubules?
- a. Katanin.
 - b. MAPs.
 - c. Tau.
 - d. Thymosin B4.
15. **(6 pts)** Describe the mechanism used by XMAP215 to stabilize the plus end of a microtubule.
16. **(3 pts)** In EGF (epidermal growth factor) signaling, which molecule connects the extracellular signal to the cytoplasm?
- a. The EGF hormone
 - b. The EGF receptor
 - c. Grb2
 - d. ERK
17. **(3 pts)** What enzyme below does diacylglycerol (DAG) recruit and activate?
- a. Phospholipase C (PLC)
 - b. Protein Kinase A (PKA)
 - c. Protein Kinase B (PKB)
 - d. Protein Kinase C (PKC)
18. **(3 pts)** Procaspase-9 is a protease that cleaves:
- a. Procaspase-8
 - b. Procaspase-9 itself
 - c. Executioner procaspases
 - d. Executioner procaspases and procaspase-8

19. **(3 pts)** Which ligand does NOT induce the dimerization or trimerization of its receptor?
- Epinephrine
 - EGF
 - Glucocorticoid
 - Tumor necrosis factor (TNF)
20. **(3 pts)** If you delete the PKB gene from insulin-responsive cells, what would you likely observe when the cells are treated with insulin?
- PI3K is not recruited to the plasma membrane.
 - PDK1 is not recruited to the plasma membrane.
 - GLUT4 is retained in intracellular vesicles.
 - Phosphatidylinositol is cleaved by phospholipase C.
21. **(3 pts)** How is Ras activity turned off?
- It is turned off by phosphorylation.
 - It is turned off by hydrolysis of its bound GTP to GDP.
 - It is turned off by hydrolysis of its bound GDP to GTP.
 - It is turned off by hydrolysis of its bound GTP to GMP.
22. **(3 pts)** What kinase phosphorylates insulin receptor substrate-1 (IRS-1) in the insulin signaling pathway?
- Insulin receptor
 - IRS-1 itself
 - PI3 kinase
 - PDK1
 - PKB
23. **(3 pts)** One study suggested that the activity of PI3 Kinase is blocked in some diabetic patients. PI3 Kinase is known to positively regulate the tethering of GLUT4 vesicles to the plasma membrane. Which therapeutic strategy would likely treat these diabetic patients?
- A drug that activates NSF activity.
 - A selective SNARE inhibitor.
 - A chemical that activates Rab.
 - An insulin mimic that activates insulin receptors.

24. **(3 pts)** Which of the follow is **NOT** a G protein (GTP-binding protein)?
- a. Ras.
 - b. Sar1.
 - c. Rab.
 - d. NSF.
 - e. Ran.
25. **(6 pts)** A growth factor receptor is a type I transmembrane protein with three domains: an extracellular domain, a transmembrane domain, and a cytoplasmic domain. You observed that this receptor has two N-linked glycans (oligosaccharides). Which domain(s) of the receptor will you likely find the glycans in? Explain.
26. **(3 pts)** Which molecule does **NOT** pass through the Golgi apparatus to reach its final compartment?
- a. EGF.
 - b. Insulin.
 - c. G protein-coupled receptor (GPCR).
 - d. Cytochrome c.
 - e. EGF receptor.
27. **(3 pts)** Which of the following is a guanine nucleotide exchange factor (GEF)?
- a. GPCR.
 - b. Rab.
 - c. Grb2.
 - d. Signal recognition particle (SRP).
 - e. NSF.

28. **(3 pts)** Which of the following will likely induce the ER stress response (unfolded protein response)?
- A chemical that inhibits lysosomal proteases.
 - A drug that interferes with the N-linked glycosylation of proteins.
 - An enzyme that digests O-linked glycans on the cell surface.
 - A mitochondrion-disrupting molecule that releases cytochrome c.
29. **(6 pts)** EGF signaling induces two waves of gene expression: early-response genes and delayed-response genes. What types of proteins are expressed during each wave of gene expression; give specific examples.
30. **(3 pts)** Which organelle has the lowest pH?
- ER.
 - Golgi.
 - Lysosome.
 - Endosome.
 - Extracellular space.
31. **(3 pts)** Which is a direct product of the enzymatic reaction catalyzed by phospholipase C?
- Phosphatidylinositol.
 - DAG.
 - Calcium.
 - Cyclic GMP.
 - Cyclic AMP.
32. **(3 pts)** Proteins are often transported between organelles in the cell. Which of these transport pathways is NOT mediated by membrane-bound vesicles?
- Golgi to lysosome.
 - ER to Golgi.
 - Cytosol to mitochondria.
 - Plasma membrane to endosome.

33. **(3 pts)** If you use RNAi to abolish Cdc25 in rat goblet cells, what would you likely observe?
- Cells enter mitosis prematurely.
 - Cells cannot enter mitosis.
 - Sister chromatids separate prematurely.
 - Cells enter mitosis but fail to exit.
34. **(3 pts)** In a tumor cell line Raf is mutated such that it constitutively binds to Ras even in the absence of EGF signaling. How can you inhibit the growth of this tumor cell line?
- Blocking EGF receptor autophosphorylation.
 - Inhibiting the kinase activity of ERK.
 - Preventing the production of cAMP.
 - Blocking the recruitment of PI3 kinase to the plasma membrane.
35. **(6 pts)** Briefly describe how sister chromatids are separated during anaphase of mitosis.
36. **(6 pts)** The glucocorticoid receptor is a soluble cytoplasmic protein in the absence of its ligand. If you want to relocate the glucocorticoid receptor to the ER lumen and retain it in the ER as a soluble ER luminal protein, what two sorting signals would you add to the protein? Why?

37. **(3 pts)** Which event allows the cell to exit mitosis?
- Degradation of mitotic cyclins.
 - Phosphorylation of condensins.
 - Dephosphorylation of the Y15 residue of Cdk1.
 - Inactivation of Cdc25.
38. **(3 pts)** A mutant cell line harbors loss-of-function mutations in checkpoint kinase-2 (Chk2). What would you likely observe if double stranded DNA damage is induced in the cell line?
- p53 is stabilized.
 - p21 is induced.
 - Cdk1 activity is shut down.
 - ATM is activated.
39. **(3 pts)** In meiosis II, kinetochores of sister chromatids are connected to microtubules from
- The same spindle pole.
 - Opposite spindle poles.
 - The centromere of its neighboring chromosome.
 - Random centromeres of other chromosomes.
40. **(3 pts)** If you use RNAi to abolish the expression of perforin in cytotoxic T lymphocytes, what would you likely observe?
- Granzymes enter the target tumor cell.
 - Apoptosis fails to be induced in the tumor cell.
 - Cytotoxic vesicles fail to tether to the plasma membrane.
 - Cytotoxic vesicles fail to fuse with the plasma membrane.
41. **(6pts)** Describe how PKA is activated by the binding of epinephrine to a cell surface GPCR.

BONUS QUESTIONS

B1. **(5 pts)** Solmonella proliferation in macrophages can be inhibited by

- a. quinines
- b. SSRIs
- c. opiates
- d. benzodiazapines

B2. **(5 pts)** Novel anti-cancer drugs developed in the Su lab target

- a. DNA synthesis
- b. DNA repair
- c. Check point genes
- d. The ribosome

B3. **(5 pts)** Amyloid beta-42 peptide binds to

- a. synaptoporin
- b. synaptophysin
- c. VAMP2
- d. Munc18