

Sample Second Midterm Exam, Biol 2021, March 2013

Each question has only one best answer. There are 35 questions and all questions are worth equal weight. Three figures are at the end.

1. What is the role of mannose 6-phosphate in vesicular transport?
 - a. to prevent lysosomal enzymes from leaving the lysosome and returning to the Golgi
 - b. to mark enzymes destined for transport to lysosomes
 - c. to mark receptors for recycling to the Golgi after delivering their cargo to lysosomes
 - d. to mark proteins destined for packaging into secretory vesicles
 - e. all of the above

2. How are phagocytosis and pinocytosis similar?
 - a. They are both constitutive processes that are happening continuously in most cells.
 - b. They both use a mechanism that depends on actin polymerization.
 - c. They are both found in all eukaryotic cells.
 - d. They can both be used to ingest very large particles such as microorganisms.
 - e. all of the above
 - f. none of the above

3. During the development of atherosclerosis, cholesterol becomes deposited on artery walls, clogging blood flow. What could cause this to happen?
 - a. a defect in the binding of LDL receptors to adaptor proteins (adaptors) in the clathrin coat
 - b. too many LDL receptors in the plasma membranes of cells
 - c. a mutation in LDL receptors that prevents them from binding to LDL
 - d. any of the above
 - e. a and c only

4. Which of the following statements about the regulated secretory pathway is (are) FALSE?
 - a. Insulin release from pancreatic beta cells is an example of a regulated secretory pathway.
 - b. The regulated secretory pathway is found only in specialized secretory cells, not in all cells.
 - c. Proteins to be secreted are sorted into secretory vesicles in the trans-Golgi.
 - d. The regulated secretory pathway is a form of endocytosis.
 - e. Secretory vesicles that are docked at the plasma membrane can fuse with the plasma membrane in response to an increase in calcium levels in the cell.
 - f. none of the above; all statements are TRUE.

5. How is chemiosmosis similar in mitochondria and chloroplasts?
 - a. Both produce CO₂ as a byproduct.
 - b. Both create a H⁺ gradient and use it to make ATP.
 - c. Both couple electron transport to H⁺ pumping across a membrane.
 - d. Both use high energy electrons derived from carbohydrates.
 - e. all of the above
 - f. b and c only

6. Which of the following is NOT likely to be found in the stroma of chloroplasts?
- metabolic enzymes
 - DNA and RNA
 - ribosomes
 - pH about 5
 - b and c only
 - none of the above; they are ALL found in the stroma
7. How much energy is required to fix one molecule of CO₂ during photosynthesis?
- 3 ATP + 2 NADPH
 - 9 ATP + 6 NADPH
 - 2 ATP + 3 NADPH
 - 6 ATP + 9 NADPH
 - 6 ATP + 6 NADPH
8. In a classic experiment to investigate the biochemistry of photosynthesis, plant cells were given a rapid pulse of CO₂ labeled with radioactive ¹⁴C. The cells were rapidly frozen after the pulse and the soluble molecules were extracted and separated. In which of the following compounds was the radioactive ¹⁴C first found?
- ATP
 - ribulose 1,5-bisphosphate
 - glucose
 - 3-phosphoglycerate
 - glyceraldehyde 3-phosphate
 - sucrose
9. Which of the following statements about Photosystem II is FALSE?
- The chlorophyll special pair in Photosystem II passes electrons to plastoquinone.
 - The water-splitting enzyme associated with Photosystem II produces O₂.
 - Photosystem II consists of a photochemical reaction center and antenna complex.
 - Light energy is transferred to the photochemical reaction center by resonance energy transfer.
 - none of the above; they are all TRUE.
 - a and b are both false.
10. What is the role of nitric oxide (NO) in blood vessels?
- It binds to a receptor on endothelial cells that send signals to smooth muscle cells to relax.
 - It activates the enzyme guanylyl cyclase in smooth muscle cells.
 - It causes contraction of smooth muscle cells to dilate the blood vessels.
 - It is released at the axon terminals of neurons that form synapses on smooth muscle cells.
 - It is made by the enzyme NO synthase inside smooth muscle cells.
 - none of the above
11. Which of the molecules in Figure A is most likely to be a ligand for a nuclear receptor?
(a, b, c, d or e)

12. Which of the following can be used to regulate a monomeric GTPase when it functions as a molecular switch?

- a. a GAP to activate it and a GEF to inactivate it
- b. a GEF to activate hydrolysis of GTP
- c. a protein kinase to activate it and a protein phosphatase to inhibit it
- d. a GAP to activate GTP binding
- e. a GEF to activate it and a GAP to inactivate it
- f. b and d only

13. Which of the following is NOT a method for assembling signalling complexes?

- a. receptor sequestration in vesicles
- b. scaffold proteins
- c. phosphorylation of activated receptors
- d. phosphorylation of phosphoinositides
- e. None of the above; they are ALL methods of assembling signalling complexes.

14. Figure B shows four possible outcomes for the activity of a kinase in a signalling pathway (“E kinase”) that is regulated by feedback. Which one would be the result of positive feedback on E kinase?

(a, b, c, d)

15. The binding of arrestin to phosphorylated rhodopsin is an example of what process?

- a. amplification of a signal
- b. positive feedback
- c. adaptation
- d. formation of a signalling complex
- e. cooperative binding
- f. activation of a molecular switch

16. Which of the following statements is (are) TRUE about G-protein coupled receptors (GPCRs)?

- a. There are only a few GPCRs in the human genome and each one must couple to many different G-proteins.
- b. When the signal molecule binds to the GPCR it causes phosphorylation of the GPCR that allows the G-protein to bind.
- c. GPCRs act as GEFs for specific G-proteins.
- d. When the G-protein binds to the GPCR there is no amplification of the signal because only one G-protein can be activated by one activated GPCR.
- e. Activated GPCRs can only be inactivated by endocytosis and destruction of the receptor in lysosomes.
- f. None of the above; they are all FALSE.

17. Imagine you are working with cultured intestinal epithelial cells in your lab. You have found that adding a certain hormone causes a rapid increase in the rate of efflux of Cl^- ions from the cells followed by a rapid decrease in Cl^- efflux back to normal levels. You suspect that cAMP and PKA are involved in this response. If your hypothesis is correct, which of the following treatments would you predict will cause the continued high rate of efflux of Cl^- after hormone treatment without the usual decrease?

- a. adding an inhibitor of cAMP phosphodiesterase
- b. adding cholera toxin
- c. adding an inhibitor of protein phosphatases
- d. all of the above
- e. a and b only

18. What is the major role of phosphatidyl inositol 4,5-bisphosphate in cellular signalling?

- a. It is the substrate for cleavage by phospholipase C.
- b. It binds to Protein Kinase C to activate it.
- c. It binds to receptors in the endoplasmic reticulum membrane to release calcium.
- d. It is delivered by the sperm when it fertilizes an egg to cause a wave of calcium release in the egg.
- e. It forms a large percentage of the lipids in the plasma membrane.
- f. It is a docking site for the binding of signalling proteins to form complexes.

19. How can animal cells maintain a low level of free calcium (Ca^{2+}) in the cytosol?

- a. by pumping calcium into the endoplasmic reticulum with an ATP-driven Ca^{2+} pump
- b. by binding free Ca^{2+} to calcium-binding proteins in the cytosol
- c. by pumping calcium out of the cell with a Na^+ - Ca^{2+} exchanger
- d. by pumping calcium out of the cell with an ATP-driven Ca^{2+} pump
- e. all of the above
- f. a and d only

20. What do Protein Kinase A (PKA), calcium/calmodulin dependent protein kinases (CaM-kinases), and receptor tyrosine kinases (RTKs) all have in common?

- a. They all require calcium for activation.
- b. They all phosphorylate their target proteins on tyrosines.
- c. They can all directly phosphorylate gene regulatory proteins.
- d. They all become activated when a regulatory protein binds to the catalytic protein.
- e. none of the above

21. During visual transduction in the rod photoreceptors of the vertebrate retina, which of the following events does NOT happen as a direct or indirect result of exposure to light?

- a. Retinal isomerizes from 11-*cis* to all-*trans* retinal.
- b. The trimeric G-protein transducin becomes activated.
- c. Cyclic GMP phosphodiesterase is activated.
- d. cGMP-gated ion channels in the plasma membrane close.
- e. The cell becomes hyperpolarized.
- f. The rate of transmitter release by the rod cell increases.

22. During visual transduction in the rod photoreceptors of the vertebrate retina, one activated rhodopsin protein can activate hundreds of G-proteins (transducins). This is an example of:
- adaptation
 - cooperativity
 - amplification
 - positive feedback
 - cross-talk
23. Which of the following statements about receptor tyrosine kinases (RTKs) is (are) TRUE?
- They are activated by extracellular signal proteins.
 - They have seven membrane spanning protein domains.
 - Their cytosolic domains directly activate trimeric G proteins.
 - The activation of RTKs by ephrins is an example of endocrine signalling.
 - b and c only
24. In yeast, mating factor activates a MAP kinase cascade that results in activation of the mating response. Changes in osmolarity activate a MAP kinase cascade that results in glycerol synthesis. How does the yeast maintain specificity of the responses and avoid cross-talk between these two pathways?
- All of the MAP kinases in the two pathways are completely different.
 - The MAP kinases are bound to different scaffold proteins.
 - The two signals (mating factor and osmolarity) activate different plasma membrane bound receptors.
 - Different yeast cells express only one of the pathways at a time.
 - None of the above; the two pathways do normally share cross-talk.
25. What is a likely function for tyrosine phosphatases?
- deactivating a receptor tyrosine kinase-activated pathway
 - adding phosphates to tyrosines in proteins as part of a complex with a plasma membrane receptor
 - as a receptor in bacterial chemotaxis, activated by the binding of an attractant
 - adding phosphates to lipids to make docking sites for tyrosine-containing signalling proteins
 - removing phosphates from signalling proteins activated by ligands in the transforming growth factor beta (TGF-beta) family
26. Which of the following events is NOT likely to happen in an animal cell in response to insulin-like growth factor (IGF)?
- phosphoinositide-dependent protein kinase 1 (PDK1) is activated
 - Smad proteins move to the nucleus
 - proteins with pleckstrin homology (PH) domains bind to phosphorylated lipids
 - cell growth and survival are stimulated
 - a receptor tyrosine kinase is activated
 - none of the above; they ALL happen in response to IGF
27. In the bacterial chemotaxis pathway, what happens as a result of (downstream of) the activation of a histidine kinase?
- an adaptor protein CheW binds to the receptor
 - the bacterium begins smooth swimming
 - the flagellum begins to rotate in a counterclockwise direction
 - the response regulator protein CheY is phosphorylated
 - all of the above
 - a and d only

28. What is most likely to be responsible for maintaining the elongated shape of the structures in Figure C?

- a. intermediate filaments
- b. myosin thick filaments alternating with actin filaments
- c. actin microfilaments
- d. keratin
- e. microtubules

29. What is the most important rate-limiting step in the assembly of cytoskeletal filaments?

- a. the rate at which the subunits hydrolyze ATP or GTP
- b. the rate at which accessory proteins bind to stabilize the growing filament
- c. the rate at which protofilaments form filaments
- d. the rate at which nucleating proteins initiate polymerization
- e. the rate at which D form monomers leave the filament

30. What would be likely to happen to the cytoskeletal fibers in an actively growing cell if the energy supply was removed so that nucleoside triphosphate concentrations dropped to a low level?

- a. All cytoskeletal fibers would be rigidly frozen in place.
- b. Actin filaments would continuously treadmill.
- c. Microtubules would depolymerize.
- d. Actin filaments would depolymerize.
- e. c and d only

31. Which of the following statements about gamma tubulin ring complexes is (are) TRUE?

- a. They are found in centrosomes of animal cells.
- b. They are associated with the centrioles of fungi and plants.
- c. They nucleate the formation of actin fibers.
- d. They are found at the plus ends of microtubules.
- e. a, b and d only

32. What do actin filaments and microtubules have in common?

- a. They both include bound ATP.
- b. They are both formed from small globular subunits.
- c. They both have polarity with a plus end and a minus end.
- d. They are both very stable structures that rarely break down or re-form.
- e. all of the above
- f. b and c only

33. What do myosins and dyneins have in common?

- a. They both move along actin filaments.
- b. They both use the energy of ATP hydrolysis to move along a cytoskeletal filament.
- c. All members of both families of proteins move towards the minus ends of filaments.
- d. They are each found in only some but not all eukaryotes.
- e. They are both important components of cilia and flagella.

34. Which of the following statements about the mechanochemical cycle of kinesin is FALSE?

- a. The binding of ATP causes a conformational change in the protein.
- b. The two kinesin heads act independently during the cycle and do not cooperate.
- c. ATP hydrolysis causes a change in the affinity of the protein for binding to tubulin.
- d. There is at least one kinesin head bound to the microtubule at all times.
- e. All of the above are TRUE.
- f. All of the above are FALSE.

35. What happens during the force-generating power stroke in the mechanochemical cycle of myosin?

- a. ATP is hydrolyzed by myosin.
- b. There is a large conformational change in the lever arm of myosin.
- c. ATP binds to myosin.
- d. The two heads of myosin must cooperate to produce the force.
- e. The linker region between the two myosin heads causes the rear head to be thrown forward.
- f. b, d and e only

