ANALYSIS AND MODELING OF CELL MECHANICS

Homework #2 (due 4/13/09)

This homework involves comprehension of key biomechanical concepts of the cytoskeleton, cell-matrix adhesions, and cell-cell adhesions. Please circle your answers.

1. The plasma membrane of eukaryotic cells is supported by
a. actin filaments.
b. microtubules.
c. lamins.
d. intermediate filaments.

2. Actin-binding proteins that generate actin filament bundles
a. are long and flexible.
b. bind only at the ends of actin filaments.
c. can also bundle microtubules.
d. are short and inflexible.

3. All of the following statements about actin assembly are correct except
a. ATP-actin can assemble into filaments.
b. Actin subunits can treadmill through an actin filament.
c. Actin assembly can produce force for movement.
d. Actin (-) ends assemble more rapidly than actin (+) ends.

4. During treadmilling, actin subunits add
a. predominantly to filament (+) ends.
b. predominantly to filament (-) ends.
c. equally to both filament ends.
d. along the length of filaments.

5. Which of the following proteins is involved in formation of actin bundles in microvilli by providing crosslinks between actin filaments?
a. α-actinin
b. cofilin
c. fimbrin
d. profilin

6. Which region of myosin interacts with actin filaments?
a. the head domain
b. the rod domain
c. the light chains
d. the tail domain

7. All myosins move toward the (+) end of actin filaments except
a. myosin I.
b. myosin II.
c. myosin V.
d. myosin VI.

8. In the operational model for movement of myosin along an actin filament, the power stroke occurs during
a. binding of ATP.
b. hydrolysis of ATP.
c. release of phosphate (Pi).
d. release of ADP.

9. Multinucleated cells may result from a defect in
a. myosin V.
b. myosin I.
c. stress fiber formation.
d. myosin II.

10. Membrane extension during cell locomotion is driven by
a. myosin II
b. actin depolymerization
c. contraction
d. actin polymerization

11. Lamellipodia are located
a. at a moving cell's trailing edge
b. at a moving cell's leading edge
c. around the entire periphery of a non motile cell
d. throughout the cytosol of a moving cell

12. Activation of Rho induces
a. filopodia formation.
b. lamellipodia formation.
c. focal adhesion and stress fiber assembly.
d. actin turnover.

13. Growing microtubule ends are normally stabilized by
a. a GDP cap.
b. a GTP cap.
c. phosphorylation of tubulin subunits.
d. γ-tubulin.

14. The drug taxol acts to
a. block microtubule assembly.
b. promote microtubule assembly.
c. promote cell division.
d. sever microtubules.

15. The force for axoneme bending is derived from the
a. sliding movement of central pair microtubules.
b. contraction of central pair microtubules.
c. sliding movement of outer doublet microtubules.
d. contraction of outer doublet microtubules.

16. At MTOCs, microtubule nucleation is facilitated by
a. centrioles.
b. γ-tubulin.
c. GDP-tubulin dimers.
d. basal bodies.

17. Which family of proteins links intermediate filaments with both microtubules and microfilaments?
a. actins
b. keratins
c. laminins
d. plakins

18. The functions of the extracellular matrix include
a. supporting differentiation.
b. inducing morphogenesis.
c. binding growth hormones.
d. all of the above

19. The major families of cell surface adhesion molecules include
a. cadherins and selectins.
b. integrins.
c. the Ig-superfamily.
d. a and b
e. all of the above

20. Which of the following statements best destribes the difference between low-affinity integrins and high-affinity integrins?
a. Many integrins can exist in two conformations a low-affinity (bent) conformation and a high-affinity (straight) conformation.
b. Dissociation of the αβ heterodimer converts many integrins from the low-affinity to the high-affinity state.
c. Association of the αβ heterodimer converts many integrins from the low-affinity to the high-affinity state.
d. Proteolytic cleavage of the C-terminal tails of the two subunits converts many integrins from the low-affinity to the high affinity state.

21. Vertebrate gap junctions are composed of
a. adherins.
b. collagens.
c. connexins.
d. integrins.

22. Which of the following is the term used to describe a thin, sheetlike meshwork of extracellular matrix components that can be found in epithelial cells?
a. basal lamina
b. basement membrane
c. gap junction
d. cell wall

23. Basal lamina include all of the following except
a. type I collagen.
b. type IV collagen.
c. entactin.
d. laminin.
e. perlecan.

24. Proteoglycans are
a. located exclusively at the cell surface.
b. located exclusively in the extracellular matrix.
c. highly positively charged.
d. glycoproteins that contain glycosaminoglycans.

25. Syndecans are cell-surface proteoglycans that
a. bind to collagens.
b. bind to multiadhesive matrix proteins.
c. anchor cells to the extracellular matrix.
d. all of the above

26. Biological roles of proteoglycans and hyaluronan include all of the following except
a. maintenance of porosity for the diffusion of small molecules between cells and tissues.
b. presentation of growth factors to cells.
c. resistance to compression.
d. storage sites for extracellular energy reserves.

27. Which extracellular matrix component is expressed in a cell-specific manner and binds to the tripeptide sequence Arg-Gly-Asp?
a. integrins
b. collagen
c. proteoglycans
d. fibronectins

28. Polymerization of collagen into large collagen fibers occurs (in)
a. the endoplasmic reticulum.
b. the Golgi complex.
c. secretory vesicles.
d. extracellularly.

Short Answer Question

Like *Listeria*, other bacterial pathogens have also evolved to take advantage of actin-based cell motility systems in their hosts. For example, some pathogenic strains of *E. coli* make a cytotoxic factor (CNF1) that converts a specific glutamine residue on RhoGTPases to glutamate. This change blocks both the intrinsic and GAP-stimulated GTP hydrolysis activity of the Rho protein. Predict the effects of CNF1 on human epithelial cells in culture. Please write your answer in the space provided below.