Study question answers 2014 – Topic 4 The cytoskeleton

Multiple choice questions (1 mark per answer)

1. The thick filaments of skeletal muscle cells are composed of the protein...
   a. Keratin
   b. Actin
   c. Kinesin
   d. Myosin
   e. Titin

2. What properties of intermediate filament monomers distinguish them from the monomers that make up microfilaments or microtubules?
   a. There are numerous different types in an individual cell type.
   b. They are primarily fibrous rather than globular proteins.
   c. They do not bind and hydrolyze nucleotides.
   d. Both b and c are true.
   e. All of a, b and c are true.

3. Microtubules are **not** a structural component of...
   a. Cilia
   b. Flagella
   c. Microvilli
   d. Mitotic spindle
   e. Microtubules are a structural component of all of a, b, c and d.

4. Kinesins and dyneins…
   a. Move along both microtubules and microfilaments.
   b. Generally move in opposite directions to each other.
   c. Derive their energy from GTP hydrolysis.
   d. Have globular heads that contain actin-binding sites.
   e. All of a, b, c, and d are true of kinesins and dyneins

5. Which of the following statements is **not** true of the cytoskeletal elements?
   a. Intermediate filaments and microfilaments but not microtubules strengthen cell-to-cell connections.
   b. Microtubules and microfilaments but not intermediate filaments allow for the intracellular transport of molecules within the cytoplasm.
   c. Intermediate filaments and microtubules but not microfilaments function in organizing organelles within the cytoplasm.
   d. Cellular motility can be driven by microtubules and microfilaments but not intermediate filaments.

e. All of a, b, c and d are true of the cytoskeletal elements.

6. The minus end of a microtubule…
   a. Is the end that is bound to γ-tubulin rings in the centrosome.
   b. Is the end to which ATP-αß tubulin monomers are added less rapidly.
   c. Is the end towards which kinesin motor proteins move.
   d. Is the end where polymerization occurs most rapidly for a free microtubule.
   e. None of a, b, c or d is true of the minus end of a microtubule.

7. A scientist observes the motion of a vesicle around the cell. She notices that vesicle movement ceases when the cell is treated with colchicine. Which of the conclusions below can she draw?
   a. Vesicle movement is driven by a motor protein that hydrolyzes ATP.
   b. Vesicle movement relies on the presence of microfilaments.
   c. Vesicle movement occurs by the action of kinesin.
   d. Vesicle movement relies on the presence of microtubules.
   e. None of a, b, c, or d is a valid conclusion given her observations.

8. Skeletal muscle contraction relies on...
   a. The availability of ATP and Ca^{2+} ions.
   b. The rapid polymerization of actin monomers into microfilaments coupled with the action of myosin motor proteins.
   c. The sliding of microtubules over each other, driven by the motor protein dynein.
   d. The activity of the motor protein myosin II within a stabilized array of microfilaments.
   e. Both a and d are true of skeletal muscle contraction.

9. In a dividing animal cell...
   a. A contractile array of microfilaments and myosin II motor proteins drives cytokinesis.
   b. The mitotic spindle is organized between duplicated centrosomes, each containing a pair of centrioles and pericentriolar material.
   c. The kinetochore moves its chromosome towards the spindle pole through the action of motor proteins.
   d. Polar spindle fibres help separate the daughter cells by sliding over each other, a movement driven by motor proteins.
   e. All of a, b, c and d are true of a dividing animal cell.

10. Which one of the following proteins is not involved in vesicle movement within the cell?
   a. Myosin
   b. Tubulin
   c. Keratin
   d. Dynein
   e. All of a, b, c and d are involved in vesicle movement within the cell.

11. Polymerization and depolymerization of actin are essential for…
    a. Production of contractile forces in muscle cells
    b. Movement of cilia and flagella
    c. Formation of lamellipodia and filapodia
    d. Maintaining the shape of an animal cell
    e. All of the above

12. According to the dynamic instability model…
    a. The rate of polymerization at the plus end of the microfilament is exactly matched by the rate of depolymerization at the minus end such that the microfilament turns over but neither grows nor shrinks.
    b. The plus end of the microtubule either grows or shrinks depending on the cellular availability of tubulin dimers.
    c. Microtubule assembly is initiated by the addition of αß-tubulin dimers to a γ-tubulin template.
    d. Contractile assemblies of microfilaments and myosin initiate cytokinesis.
    e. None of a, b, c, or d is true of the dynamic instability model.

Written answer questions (use the marks specified to gauge the content needed for your answer; in all cases, the answer must not exceed the space indicated)

1. Complete the following statements. (1 mark per answer)
    a. The proteins that make up __________intermediate filaments____________________ are specific to a particular tissue. This property can be of use in determining the tissue of origin of metastatic cancer cells.
    b. __________Cilia_________________ are short, numerous, hair-like projections on a cell that use an oar-like power stroke to move the cell or to move fluid over the cell.
    c. A protein that converts the chemical energy of ATP into movement is termed a ______motor protein___________________________.

2. Distinguish between axonemal and cytoplasmic microtubules. (2 marks)

Axonemal microtubules are found in cilia and flagella and exhibit a 9+2 arrangements, i.e. 9 doublets of microtubules organized in a circle surrounding a central pair of microtubules. They are stable microtubules that are involved in cell movement. By contrast, cytoplasmic microtubules are very dynamic and are involved in intracellular transport of vesicles and organelles.

3. Which image below, A, B, or C, depicts intermediate filaments? Explain your reasoning. (3 marks)

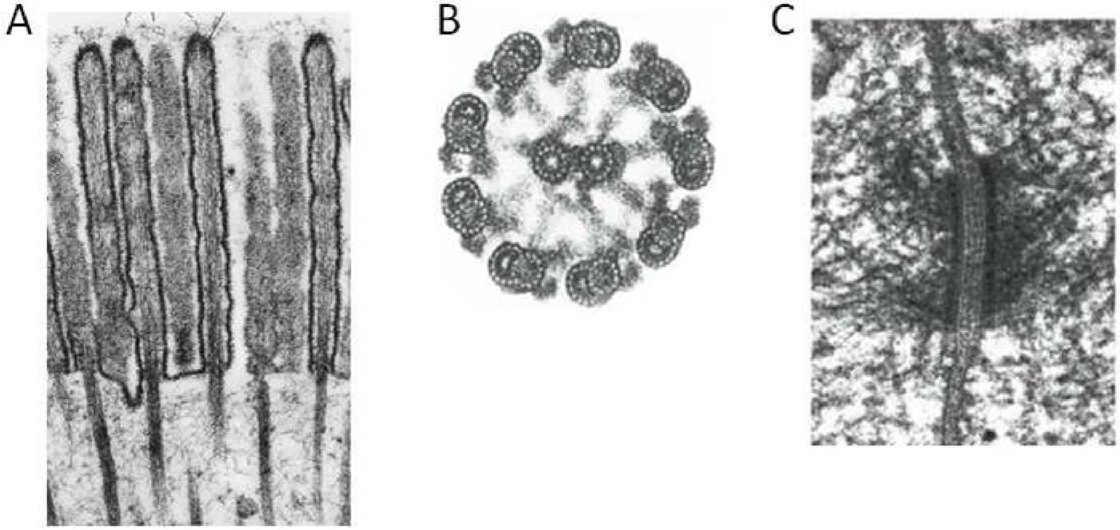

Image C

Image A depicts either microvilli or cilia, structures that are supported by microfilaments or microtubules, respectively. Image B depicts the axoneme of a cilium or flagellum, a microtubule-based structure. Thus, image C must depict intermediate filaments. Image C depicts a desmosome (can be distinguished by the thick plaque of proteins at/under the cell membrane), which is consistent with the involvement of intermediate filaments.

4. You observe a section of cell in which there are no microfilaments, yet chemical analysis of the cell contents reveals a high concentration of G-actin. Explain how this situation could arise. (2 marks)

Although high concentrations of G-actin would normally result in microfilament formation, ATP-G-actin monomers can be sequestered by certain actin-binding proteins, preventing microfilament formation. Under these circumstances, high concentrations of ATP-G-actin could occur in the absence of microfilaments.

5. ATPγS is a synthetic chemical very similar to ATP, except that it cannot be hydrolyzed. How would the ability of a cell in a developing zebrafish embryo to migrate be affected by treating the embryo with ATPγS? Explain your reasoning. (3 marks)

In the presence of ATPγS, cells in a developing zebrafish embryo would not be able to migrate. Two problems would exist. Microfilaments are formed by the polymerization of ATP-G-actin. Once in a microfilament, the actin hydrolyzes ATP to ADP and this increases the likelihood of dissociation, making microfilaments very dynamic. This dynamic activity is essential for cell crawling, the mechanism used by embryonic cells to migrate. Treating the embryo with ATPγS will stabilize microfilaments because ATPγS cannot be hydrolyzed, and therefore inhibit cell crawling. In addition, the motor protein myosin is involved in retraction of the trailing edge and must hydrolyze ATP to work. Treating the embryo with ATPγS would prevent myosin activity.

6. What feature of a microtubule gives it structural polarity? Why is this polarity important in microtubule function? (3 marks)

The tubulin dimers that are the building blocks of microtubules are all oriented in the same fashion, and since they are not symmetrical molecules, the microtubule is a polarized structure. Polarity is important in microtubule function in providing motor proteins with a direction of operation. Polarity is also important in the dynamic activities of microtubules, because rapid growth occurs at only one end of the microtubule (the plus end).

7. Contrast and compare the structure and function of microvilli and cilia. (6 marks)

To address this question, point out the similarities and differences between microvilli and cilia in terms of their structure (for example, they are similar in being cytoplasmic protrusions but different in that the structure results from bundled microfilaments in microvilli and the axonemal microtubules [in a 9+2 arrangement] in cilia) and function (for example, cilia are motile and can be used to move a cell whereas microvilli are not and serve to increase the surface area of the plasma membrane).