BMT-72106 Cellular Biophysics
Exercise 2, 28.3.2019

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Exercise 1. *Cellular cytoskeleton*
Compare the three components of the cell cytoskeleton. E.g. How are they structured? What are their roles?

Exercise 2. *Cell elasticity*
Describe different methods to measure cell elasticity experimentally.

Exercise 3. *Cytoskeletal dynamics*
Actin and microtubule polymers are extremely dynamic structures. These polymers are always assembling and disassembling. Where does this dynamic nature come from? What is the benefit of having a dynamic cytoskeleton compared to more static one?

Exercise 4. *Actin polymerization*
Actin filaments can push the cell membrane while they are growing by polymerization and thus form extrusions as shown in the Figure 1 below. The force required for this feat can be calculated with equation

$$F = \frac{k_B T}{\Delta Z} ln \frac{[monomer]}{K_c}, \tag{1}$$

where F is the force (N), k_B is Boltzmann's constant, T is absolute temperature (K), ΔZ is the change in actin filament length (m) as shown in Figure 1, $[monomer]$ is the actin monomer concentration (M) and K_c is the critical concentration (M). Actin filaments can grow from both ends (called plus- and

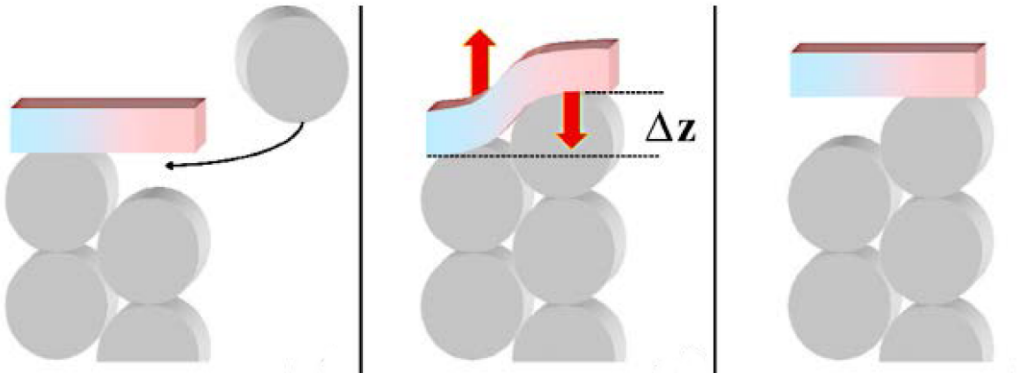

Figure 1: Actin polymerization while pushing the cell membrane.

minus-ends), but with different rates. This is reflected on their critical concentrations: plus-end has $K_c^+ = 0.1$ μM and minus-end $K_c^- = 0.8$ μM.

a) What is happening to the actin filament if the force calculated with Equation 1 is negative?

b) Given the actin monomer concentrations (i) 0.05 μM, (ii) 0.5 μM and (iii) 1 μM, calculate the forces for both the minus and plus ends. You can approximate ΔZ as a half of the globural actin monomer size, which you can find from the literature.

c) If you have a single actin fiber and actin monomer concentration of 0.5 μM, what do you think is happening to the fiber based on equation 1?