Homework #6 (HW6) Assigned 4/13/22
BIOEN 5250/6250, Spring 2022 Due online 4/26/22, 9 am MST

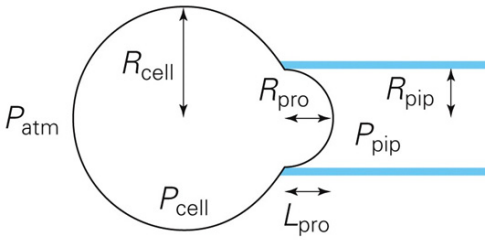
You must follow the homework guidelines on Canvas (Files/Homework/5250_instructions_for_preparing_homework.pdf). Submit completed homework on Canvas before the beginning of class on the due date.

1. (Parameter optimization to determine material coefficients – 50 points) You will make use of the FEBio model from Homework 5 named Biphasic_Confined_Compression.fsm to perform a material parameter optimization. In the Canvas subdirectory, you will find target experimental data for the indenter force as a function of time for the biphasic confined compression analysis named z-force.txt. Using the optimization wizard in FEBio Studio, set up an optimization file to determine the modulus E in the Holme-Mow constitutive model for the solid phase and the permeability k that provide the best fit to the supplied data. Run the optimization and ensure that your optimized results do not end up on the rails of the limits you assigned for the material coefficients.

    a. Report your results for the optimized values of E and k.

    b. Plot the experimental data for force-time that was provided, the force-time data for the initial guesses for E and k used during the first iteration of the optimization, and the force-time data using the optimized material coefficients all together on a single graph. Rerun-the model twice with the two sets of material coefficients to get these latter two sets of data. The z-force for the rigid indenter can be obtained in the graph panel by selecting "indenter" from the pull-down menu for "source" and then selecting Z-force for the y-axis variable.

(Cell Mechanics – 50 points) A micropipette aspiration experiment is conducted to learn more about the mechanical response of a cancer cell.



    a. Derive a relationship for cell membrane stress T in terms of the measureable parameters P_{pip}, P_{atm}, R_{cell}, and R_{pip}. At the time of interest, the length of the protrusion of the cell into the pipette is equal to the radius of the pipette. Assume that there is no friction between the cell membrane and the micropipette and that stress is uniform throughout the cell membrane. Also assume that the membrane has a thickness h (Hint: you will need to enforce equilibrium twice, "cutting" the cell along vertical planes at two separate locations: (1) the center of the spherical section and (2) the tip of the pipette).

    b. The investigators are also interested in determining the pressure inside the cell, P_{cell}, during the experiment. While they can't measure this, use your work in part (a) to develop a relationship for this pressure in terms of the measurable parameters.