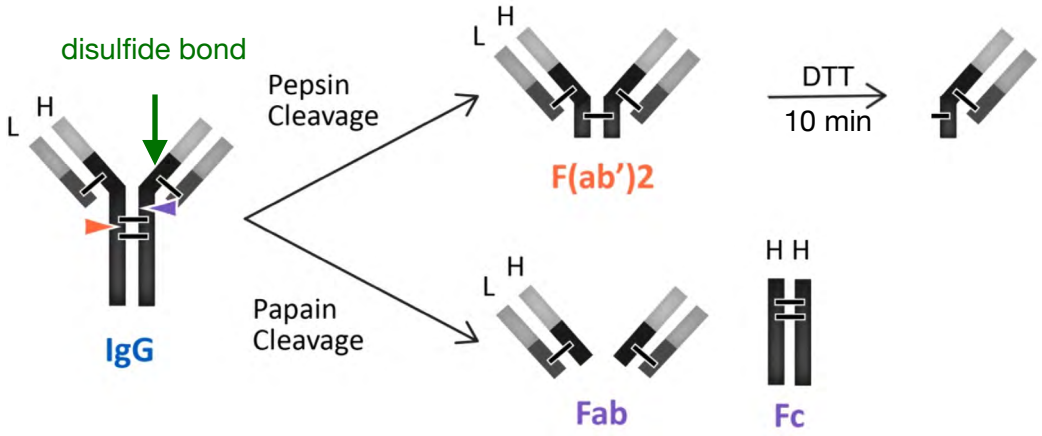
Name and UID: _____

BE 167L: Bioengineering Laboratory
Exam 1
October 29, 2018

Question 1 (10 pt). You are asked as a graduate student to design a fluorescent stain for the PD-1 receptor on T cells. To do so, you are going to use a commercially-available anti-PD-1 IgG antibody, as depicted below. Your advisor explains that two proteases, pepsin and papain, can cleave the protein at the points indicated. She indicates that quantitation is absolutely critical—that is, each stain needs to have the same fluorescent signal.

This information may be helpful for designing your strategy:



(a) Design a protocol outline for conjugating the antibody with a fluorophore. Indicate the reagents you would use, and the steps you would perform them in. You do not need to indicate timing or a specific fluorophore.
(b) DTT is a reducing agent that cleaves disulfide bonds. The student you are working with accidentally adds 1000X too much DTT, panics, and leaves the reaction overnight. What should you be concerned about occurring?
(c) Sketch a spectra for a fluorophore, labeling the relevant properties of interest. Be sure to label the property that allows us to observe them.
(d) You turn on the microscope and the light to shine on your fluorophore then observe bright, uniform light through the eyepiece. What could be wrong?

Question 2 (10 pt)

(a) What is the central goal of a lab notebook?
(b) What are three kinds of data?
(c) What are four ways to present information in a plot? Indicate which are useful for each form of data above.
(d) Sketch the elements of a plot.

Question 3 (20 pt). You are working as a scientist in a company making a PDMS device to capture and analyze cancer cells circulating in the blood of patients. The company has identified an antibody that binds tightly to cancer cells but not to other cells. You are first going to test this with cancer cells you have cultured mixed with primary blood cells from non-cancer patients.

(a) You obtain your first batch of cells and look under the microscope. In one region of your sample where there are no cells, you notice small specks that seem to vibrate with motion. What are these? What should you do?
(b) You are normally able to culture the primary cells for five passages, but one sample only lasts through two passages. Your colleague notes that the patient was a 98 year old woman. What might have caused this difference? How could you prevent this from happening?
(c) To create the device, you are told to micro-contact print the antibody, then "block" the device's surfaces by incubating with human serum. What is happening here? What physical interactions are involved? What does "blocking" accomplish?
(d) After printing the antibody, you no longer are able to measure its binding to cells. What might have happened?
(e) Your supervisor suggests changing the surface of the device to prevent the need for blocking. What are two things you could do? Given the description above, what else might need to be changed?
(f) You want to culture the cancer cells in the device after capture. What are four elements of the environment you must control to accomplish this?

Question 4 (10 pt)

(a) Which of the following expressions can represent a distribution that has a range of $0 < x < 1$ (i.e. $p(x) = 0$ otherwise)? Explain. If possible, solve for the unknown a.
   i. $p(x) = a x^3$
   ii. $p(x) = -10^a x$
   iii. $p(x) = 100x^2$
(b) If possible, solve for $p(x < 1/2)$ in each of the above cases.
(c) Solve for the mean of each distribution where possible.
(d) What are three things you can say (total) about the sampling distributions of the mean for $N = 1$ and $N = 5$?
(e) As you make more measurements (increase N), how does your confidence in the true value change? How is this related to the sampling distribution?