Name:

Question 1

Complete the following three statements in a way that best demonstrates your understanding of statistics.

A p-value is the probability of...

An α-value is the probability of...

An adjusted p-value is the probability of...

What can you conclude if the p-value of a single statistical test is below α?

What can you conclude if the p-value of a single statistical test is above α?

Question 2

A 10 ml sample of river water contains exactly one colony forming unit, or CFU. In this and the following experiments, a CFU is a single bacterium or aggregate of bacterial cells that, when maintained under appropriately controlled conditions, will replicate repeatedly and thus visibly exhibit growth. **If you aliquot 1 ml from this (well-stirred) sample, what is the probability that it will contain that single CFU, and thus exhibit growth?**

A 10 ml sample of river water contains exactly **two** CFUs. **If you aliquot 1 ml from this (also well-stirred) sample, what is the probability that it contains a) zero CFUs, and thus will not exhibit growth? b) exactly one CFU? c) exactly two CFUs?**

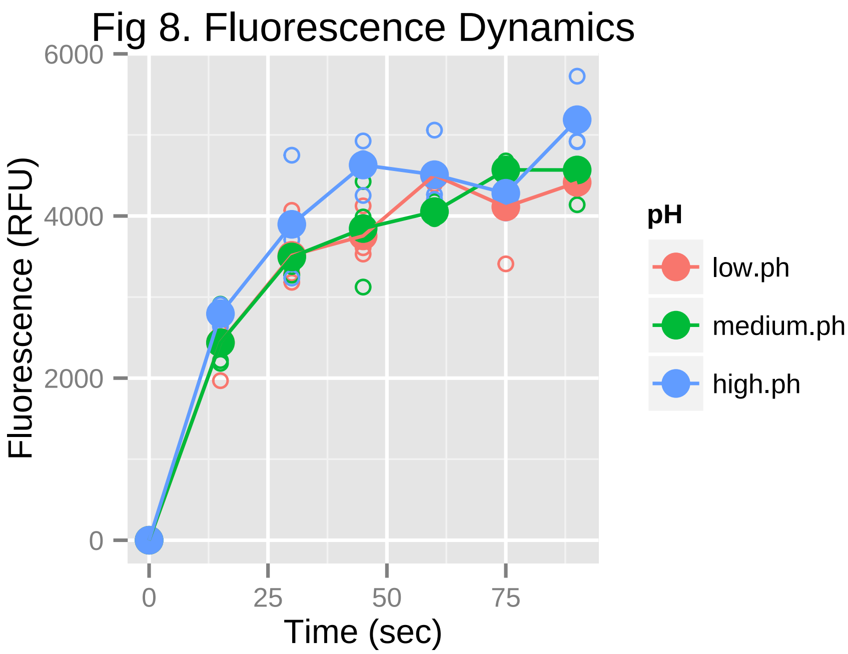
A 100 ml sample of river water contains 10 CFUs. **How would you compute the probability that a 1 ml aliquot contains no CFUs, and thus would not exhibit growth?** *Hint: Don't do this computation; just explain what you'd do, or write what you'd type into R, if you're comfortable with that.*

A 100 ml sample of river water contains 200 CFUs. Your lab mate claims that any 1 ml aliquot would be expected to contain 2 CFUs, and thus would exhibit growth. **Do you agree? How would you compute the probability that a 1 ml aliquot contains no CFUs, and thus would exhibit no growth?**

Question 3

A post-doc in a collaborator's lab recently submitted a paper on the kinetics of ion transport of a newly identified sub-class of transporters. The reviewers have asked for a more rigorous statistical analysis of one section of the paper, which argues that cation transport shows a strong dependence on pH.

The manuscript contains the two figures below, as well as the following table and text.



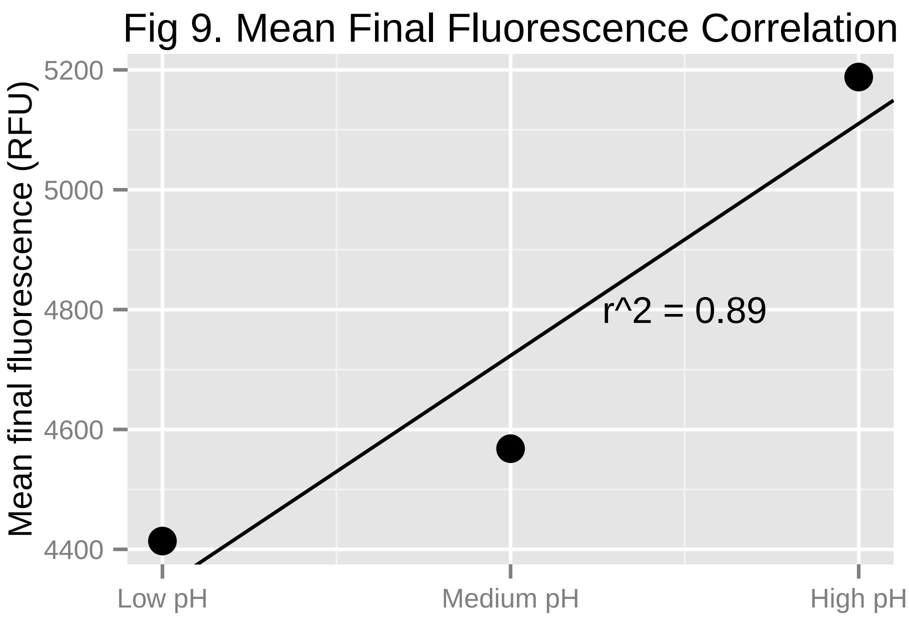


Table 4:
Mean Final Fluorescence

low pH	4414
medium pH	4568
high pH	5188

Cation transport was quantified using fluorescence reporting. For each of three pH conditions, three timecourses were observed, and measurements quantified at t = 15, 30, 45, 60, 75 and 90 sec (open circles in Fig 8). The mean fluorescence for each time point was calculated (filled circles in Fig 8). The final mean fluorescence (FMF) for each pH condition is reported in Table 4. As shown in Figure 9, there is a strong correlation between pH and FMF ($r^2 = 0.89$), confirming that cation transport is indeed profoundly dependent upon pH.

Respond critically to this analysis. Be comprehensive (but concise), and be sure to suggest what you think should be done.

Question 4

You've been reading up on how molecular dynamics simulations work, and have learned that the Lennard-Jones (aka 6-12) potential is often used to model the interaction energy between atoms that are not covalently bonded. The equation for the interatomic energy, V_{LJ}, as a function of distance, r, is:

$$V_{LJ} = \epsilon \left[\left(\frac{r_m}{r} \right)^{12} - 2 \left(\frac{r_m}{r} \right)^{6} \right]$$

The parameters of this model are usually fit to reproduce the results of more accurate (but far slower) quantum mechanical simulations. Based on QM simulations that a former lab member performed, you've fit this potential for the interaction between two hydrogen atoms, and found that the best fit parameters are $\epsilon = 0.091\,\mathrm{kJ/mol}$ and $r_m = 2.01\,\text{Å}$. The residual SSQ for the fit was $0.012\,\mathrm{kJ^2/mol^2}$.

At your weekly lab meeting, a high-school student interning in the lab reported that he'd read that a better represention of the Lennard-Jones potential is given by the equation…

$$V_{LJ} = \frac{A}{r^{12}} - \frac{B}{r^6}$$

…, and that with this equation, he computes A = 93.9 and B = 2.86, with an SSQ of 0.00275 when fitting to the results of the quantum mechanical simulations. He argues that since his SSQ is lower than yours, everyone in the lab should use his formulation and parameters in their work.

Do you agree with this assessment? How would you respond, and what would you suggest be done next?

[extra space if you need it]