Extra Credit Writing 3, Option I (Deadline March 11, 11:59 PM)

This is for you biochemists out there.

This extra credit assignment is worth at most 5 extra credit points.

Background. What are good models for measuring the effectiveness of a drug? Doesn't the effectiveness depend on dosage? How do we quantify that? Can we model the relationship between dosage and response so that patients can safely know what dosage to take of a drug?

Prompt. Do some research on the Hill equation and the dose-response curve. Why is the Hill coefficient, or slope, important to know? *Where* on the dose-response curve are we interested in the slope? If you were worried about overdosing, would you prefer a steep slope? If you were worried about cost of production, and wanted greater increased effect for minimal increased dosage, would you prefer a steeper slope?

Some possible sources. Drug Effectiveness Explained: The Mathematics of Antiviral Agents for HIV. Alan S. Perelson and Steven G. Deeks. Sci Transl Med. 2011 Jul 13; 3(91): 91ps30. doi: 10.1126/scitranslmed.3002656

The Hill equation and the origin of quantitative pharmacology. Rudolf Gesztelyi, Judit Zsuga, Adam Kemeny-Beke, Balazs Varga, Bela Juhasz, Arpad Tosaki. Archive for History of Exact Sciences, July 2012, Volume 66, Issue 4, pp 427–438.

Grading. This is a writing assignment to get your juices flowing. I want to see you engaging with how the *mathematical model* (which lives in the realm of math) interacts with and informs *pharmaceutical practice* (which has real everyday consequences). I also want to see you trying to understand the mathematics, and exploring the things you don't understand about the math.

Miscellaneous guidelines. Usual formatting guidelines. Upload on Canvas in **PDF format** by the above indicated deadline.

Plagiarism. Because this involves research, many of you may run the risk of plagiarizing. If you cannot find your own words to explain something, you have not understood it. Finally, I advise that you not even *think* about copy-pasting something—unless, however, you are quoting other works with proper attribution and citation.

Extra Credit Writing 3, Option II (Deadline March 11, 11:59 PM)

This extra credit assignment is worth at most 5 extra credit points.

Prompt. Try to answer any of the following questions.

(I) Let f be a *continuous* function. If you know the values of $f(x)$ for every rational number x, can you deduce the values of $f(x)$ when x is irrational?

(II) Let f be a *continuous* function that is defined for every real number input. Is it possible for f to hit every real number exactly twice? Put another way, is it possible that the graph of f intersects every horizontal line exactly twice?

(III) Let f be a continuous function, and for any real number x, consider the numbers

$$f(x), \qquad f(f(x)), \qquad f(f(f(x))), \qquad f((f(f(x)))), \ldots.$$

(That is, you iterate f over and over.) Is it possible for f to be a function such that (a) For every real number x, these iterations converge[4], and (b) There are exactly *two* numbers to which these iterates converge[5]?

Miscellaneous guidelines. Usual formatting guidelines. Upload on Canvas in **PDF format** by the above indicated deadline.

[4]That is, the numbers $f(x), f(f(x)), \ldots$ approach some number

[5]That is, there are two numbers R and L such that $f(x), f(f(x)), \ldots$ must approach either R or L, and in fact there is a choice of x for which these numbers approach R, and a choice of x for which these numbers approach L.