Final Exam Info

Date: May 15th, 2019

Location: Normal classroom (HLL-009, Busch Campus)

Time: 4:00-7:00 pm

Notes:

1. Calculators and other electronic devices are **prohibited**. All calculations will be able to be completed by hand.
2. I will hold extra office hours on Tuesday May 14th. I plan to be in my office from 3 pm - 6 pm (Hill 216). Feel free to stop by at any time in that interval (no need to email beforehand) with any questions you have. If this does not work for you, and you'd like to meet at some other time, please feel free to contact me via email, and I'm sure we can set something up.
3. You are allowed to bring **two** sheets of **handwritten** notes as a reference during the exam. I will not allow any typed sheets to be used, including the lecture notes (i.e. the main text).
4. I have designed the exam to take approximately two hours, but you may stay the full three if you'd prefer.

Suggestions:

1. Understand all previous exam questions.
2. Read over covered sections in the textbook, as well as notes from class.
3. Understand all assigned homework questions and quizzes. Solutions to both are available on Sakai.
4. Do the review problems posted on the course site.
5. Solve other (unassigned) homework questions from the same section of the textbook.

Material:
All material covered in the course is fair-game for the exam. Regarding the material from the first two exams, I suggest looking at their respective information sheets to get an extensive list of topics to review. For the new material, see the below list and the Course Calendar. As usual, this list is **not** exhaustive, and anything covered could appear on the exam. See the Course Calendar on the website for the complete set of topics for the course.

<u>Luria-Delbrück Analysis</u>

(a) Basic idea of experiment. What were they trying to understand, and how were they going to use the experiment and mathematical analysis to help answer their question?

(b) Mathematical modeling of both Directed Mutation (DM) and Spontaneous Mutation (SM) hypotheses. Understand the assumptions thoroughly and the difference between the two cases.

(c) Extension of model presented. Be prepared to consider generalizations (for example, unequal growth, stochastic evolution of sensitive/resistant populations, time-dependent mutations, etc), and to set up and analyze these new models. It is very important to understand the model formulation as well as the analysis.

(d) Moment-generating/cumulant-generating functions, and their use in this application. Basic properties.

(e) Main results of experiment and mathematical analysis. Be sure to understand the interpretation and its implications in science.

<u>Chemical-Reaction Networks</u>

(a) Basic interpretation of chemical reactions. Both single reactions and networks of multiple reactions.

(b) Difference between deterministic and sotchastic modeling of chemical reactions. Examples when randomness needs to be considered explicitly.

(c) Mass-action kinetics. What does it mean physically, and the mathematical form it takes for reactions modeled stochastically.

(d) Statistics related to chemical reactions. What quantities are we interested in describing?

(e) Basic mathematical formulation. Stochiometry and propensities. Fundamental description of state space (what I called $p_k(t)$).

(f) Stationary distributions. What is its relation to the distribution of the stochastic process of the reaction network.

(g) Chemical master equation (CME). Fundamental differential equation describing the evolution of the density function of the reaction network. How to compute it, assuming mass-action kinetics, for reaction networks.

(h) Relation between CME and stationary distribution π.