

# Homework 3

BIOE 498/598 PJ

Spring 2022

**Due Tuesday, 2/26 before 5pm. Submit answers on Gradescope.**

Your task is to optimize a polymerase chain reaction (PCR) process to produce a 1~kb fragment of DNA from a 5~kb plasmid. You will use a virtual PCR simulator (<http://virtual-pcr.ico2s.org/pcr/>) to collect data and train a model for optimization.

The PCR simulator allows you to vary several reaction parameters, including:

1. Number of cycles
2. Time and temperature for denaturation, annealing, and extension
3. dNTP concentration
4. Primer concentration
5. Template (plasmid) concentration
6. Polymerase concentration

For this assignment, you must hold the dNTP, primer, plasmid, and polymerase concentrations constant at the following values:

1. dNTP: 1  $\mu$ L
2. Primer: 1  $\mu$ L
3. Plasmid: 50 ng
4. Polymerase 1.25 U

All of the above reagents cost money to produce, so we're holding them constant to search for the most efficient cycling protocol *per unit of reagent*.

The simulator reports the yield of the reaction, the purity of the product, and the time required to run the reaction. Your goal is to optimize the **production rate** of pure product, defined as

$$\text{production rate} = \frac{\text{yield} \times \text{purity}}{\text{time}}$$

Your total budget is **50 runs** with the virtual simulator. Your team should submit slides detailing your approach (steepest ascent, RSM, or GPR modeling), a plot showing the best objective value over time (as you used your 50~runs), and the optimal conditions and associated yield.