Demo 1 Your Initial Physiology Model

Build a small working model that answers a physiological question. Use AI-assisted coding to implement the equations, explore parameter changes, and check the results. This is the first version of your final project: Demo 2 will extend it, and Demo 3 will integrate and validate the extended model.

1 Choose a question and model

Choose one of the following starting points, or discuss another course-related model with the instructor. Keep the scope small enough that you can explain every equation and parameter.

- Medicine entering and leaving the body: How does a constant input rate affect the amount remaining over time? Use $dA/dt = I - kA$, where A is amount, I is input rate, and k is the elimination constant. Compare continuous input with no input.
- Reversible receptor binding: How does free ligand concentration affect receptor occupancy? Use $\theta = L/(Kd + L)$ for equilibrium binding, where L is free ligand concentration and Kd is the dissociation constant. Assume one type of binding site and no competing ligand.
- Enzyme saturation: How does substrate concentration affect reaction rate? Use $v = Vmax\ s/(Km + s)$. Explore how changing Vmax or Km changes the curve.

An equilibrium curve or a time-dependent simulation can satisfy this assignment. Use clearly labeled illustrative parameters; you do not need clinical data or a complex model.

2 Build and understand the implementation

- State your physiological question, equations, variables, parameter values, units, and assumptions. For a time-dependent model, specify the initial condition and time range.
- Use an AI tool to help generate or revise the code. Read the code and identify where the equations, parameters, calculation method, and plots are implemented.
- Create a runnable script or simple browser demo. Include at least one labeled plot with units and a legend when comparing curves. Sliders and elaborate interfaces are optional.
- Make at least one purposeful code change yourself, such as changing a parameter, adding a comparison curve, or improving a check. Explain what you changed and why.

3 Predict and explore

Choose one parameter and compare at least three values while holding the other settings fixed. Before running these cases, write a prediction. Then describe whether the results match your prediction and explain the physiological meaning. Include the comparison plot in your submission.

4 Check that the model works

Complete at least two distinct checks: one against a known mathematical result and one additional check of units, bounds, limiting behavior, or numerical accuracy. Show evidence, not only a statement that the code works.

- Medicine model: compare the numerical trajectory with $A(t) = I/k + (A_o - I/k) \exp(-kt)$, for constant I and $k > 0$. Also check the no-input case or the long-term amount I/k. If you plot the analytic expression directly, verify it by substitution or an independent hand calculation.
- Binding model: verify $\theta = 1/2$ at $L = Kd$. Also check $\theta = 0$ at $L = 0$, the bounds $0 \leq \theta \leq 1$, or approach to saturation at large L.
- Enzyme model: verify $v = Vmax/2$ at $s = Km$. Also check $v = 0$ at $s = 0$ or approach to Vmax at large s.

For numerical time integration, also check whether using a smaller time step or tighter solver tolerance changes your conclusion. Explain any discrepancy and how you addressed it.

What to submit on Canvas

- Working code: your script or demo files, with brief instructions, required packages, and any data needed to run them. Do not submit API keys or passwords.
- A short report of about 1-2 pages, including plots: your question; equations and assumptions; parameter values and units; prediction and comparison; validation evidence; findings and limitations.
- A brief AI-use note in the report: name the tool, summarize what it helped with, and describe one code change, correction, or verification you performed. A full chat transcript is not required.
- A next-step paragraph in the report: propose one relevant mechanism or interaction to add in Demo 2, and explain how it would help answer your project question.

Submit Demo 1 separately from Written HW1. They share the same deadline. No API access or paid subscription is required for this assignment.

How Demo 1 will be assessed

- Physiological question and model understanding — 25 points: clear purpose, correct equation interpretation, units, and assumptions.
- Working and reproducible implementation — 25 points: code runs, instructions are sufficient, and plots are clearly labeled.
- Parameter exploration and interpretation — 20 points: a prediction, three parameter values, and an explanation of the results.
- Validation and limitations — 20 points: meaningful checks with evidence and recognition of what the model cannot explain.
- AI-use reflection and project next step — 10 points: clear ownership of the work and a feasible extension.

Total: 100 points. A simple model that you understand and validate can earn full credit. Visual polish and extra features do not substitute for correct science and clear reasoning.