1. (10 points) Erlotinib is a relatively new cancer drug designed to inhibit the epidermal growth factor receptor (EGFR) signaling pathway that is one of the main drivers of cell proliferation in many cancers. Specifically, Erlotinib binds *irreversibly* to EGFR tyrosine kinase, which is on the inside of cancer cells (therefore the drug must get out of the vasculature and through the cell membrane before reaching its target).
   1. Create a compartment model and system of differential equations to model the drug concentration in all “compartments”, assuming:
      1. You plan to deliver the drug, Erlotinib, to a patient in pill form and the rate of release of the drug into the blood stream is proportional to the concentration of drug left in the pill.
      2. That blood mixing occurs much faster than drug release so the concentration of drug in the blood at any given time is homogeneous throughout the blood volume.
      3. The concentration of the drug in the cell cytoplasm will be much less than the concentration EGFR tyrosine kinase (no saturation; hint: first order kinetics).
      4. Spatial diffusion is negligible.
   2. Characterize this system of differential equations and solve it *numerically*. You are free to assume any rate constants you want, just provide a figure that labels the value selected for each rate constant.
   3. How does your system of differential equations change if your drug concentration in the cell cytoplasm is higher than the concentration of EGFR tyrosine kinase (binding site saturation; hint: think second-order kinetics)? How would you solve this new set of differential equations?
2. (10 points) There is a code provided (Lecture24\_PDE\_hyperbolic.m) to *implicitly* solve the reaction of a tympanic membrane an initial pressure, *p*, with membrane tension, *T*, based on the hyperbolic PDE:

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Where is the displacement of the membrane at x and y location and time, t, with all spatial boundary conditions = 0 and initial value, , equal to the result from Lecture21\_PDE\_elliptical.

1. Explain the difference between Implicit and Explicit numerical solutions to initial value PDES.
2. Rework Lecture24\_PDE\_hyperbolic to create an Explicit version of the code (Dunn8.5.3 should help).
3. How did you chose the temporal and spatial resolution (dt and dx,dy) at which to solve the equation? Why? (hint: stability).