BIOLOGY 722
EXERCISE FOR READING WEEK

Imagine a bizarre butterfly wing that comprised 425 square cells arranged into 17 rows and 25 columns (*i*.e., an initially compartmentless, rectangular array). Suppose that morphogens were released only along the longer edges on the perimeter – morphogen A along one edge, morphogen P along the other. Suppose also that morphogens diffused away from sources at right angles and in a manner so that the concentration C diminished with distance x and time t.

Imagine that the morphogen concentration that resided within a cell determined whether gene *Ant* for morphogen A or gene *Pos* for morphogen P were to produce gene product: if C exceeded a critical concentration, then gene product is produced; if C for both morphogens were to exceed a critical concentration (possibly different from the first), then both gene products combine to catalyse morphogenesis (*i.e*., produce pigment, create a vein, or a delineate a boundary). Your task, should you choose to accept it, is to create a *Mathematica* program that models (mathematically) and simulates (graphically) this system and use that program to create a line bisecting the bizarre butterfly wing into anterior and posterior compartments.

The system could be modeled in a variety of ways. For instance, the concentration C at distance x and time t might be modeled continuously, in a manner that is similar to how it Murray (2002) prescribed on the basis of differential equations in the book *Mathematical Biology* book (from which you received chapter 3):

$$C(x, t) = P\, e^{-(Q\, t - (Rx\, x\, /\, t))}$$

wherein P, Q, and R are constants.

The system also could modeled discretely. For instance, values for morphogen concentrations could be stored within an array or matrix that is updated according to an algorithm involving difference equations (*e*.*g*., quantifying how much morphogen decays within a cell during each time increment) and rules (*e*.*g*., whether gene products will be produced given the concentrations for A and P in a cell).

Alternatively, you might find a more creative approach …