Class of 8/27/08

Considering a system of equations where,
x = number of species 1, and
y = number of species 2,
and each variable is changing with respect to time, x(t) & y(t), we are asked to find which of the following system of equations will yield a situation being **cooperative** (presence of one benefit's the other), and which is **competitive** (competing for resources).

(A) $dx/dt = -5x + 2xy$, $dy/dt = -4y + 3xy$

(B) $dx/dt = 4x - 2xy$, $dy/dt = 2y - xy$

- Don explains how removing a variable (setting one equal to zero) will affect the rest of the equation. For the first equation in **(A)**, setting y = 0, dx/dt will become negative; Similarly in the second equation, setting x = 0 will give a negative value for dy/dt. Don relates this to being a **cooperative** set of equations, where if one species is removed from the picture, the other species does not benefit. The opposite also holds true, where if the other species (y) is present, species x will benefit.
- A second group agrees, and points out the reverse is happening with system **(B)**, where the removal of one variable causes the other variable to increase, or the introduction of a species slows the rate of the other, thus being labeled **competitive**.
- A third group also agrees, and shares how they achieved their conclusion using a quantitative approach, holding one variable fixed while plugging in a range for the other. Ex: For **(A)**, setting x = 1, and increasing y, showed an increase in dx/dt.
- The notion of using values to show what will happen down the line brings to attention, that using a static point (1,1) for (x,y), respectively, will not give you a visible rate of change.
- Don asks if there is a significance to the signs in each equation, and how the outcome would vary if an equation had two negatives, **dx/dt =(-5x-2xy)**. This is answered by studying the equations while plugging in random values for each variable. It is then visible that this will just expedite the already decreasing function, "extinction." It is also noted that in a real world application, both variables will always be positive.
- Conclusion, **(A): Cooperative** ; **(B): Competitive**.

We are now asked to reversibly generate a system of equations relating predators with their prey, with respect to time. Where, **x = predators (lions)**, and **y = prey (deer)**.

- Team 1 takes the liberty in changing the variables to **x = dinosaurs**, & **y = humans**. They then conclude dinosaurs will have to rely on humans (**cooperative**), but humans will not rely on dinosaurs to survive (**competitive**). So the equations are,
  dx/dt = -3x + 2xy (cooperative) &
  dy/dt = 5y -4xy (competitive)
- It is important to keep in mind that these equations, when being used alone should not be labeled either as cooperative/competitive. These labels are only appropriate for the system of collective points of x and y, thus using these two equations together, gives a system for a predator-prey model, allowing one to study the change of species x/y

together with respect to time.

- To test the theory equations, setting a variable equal to zero will clearly show the consequences. Setting $y = 0$, will result in **$dx/dt = -3x$** (decreasing amount of dinosaurs with no humans), and $x = 0$, **$dy/dt = 5y$** (increasing amount of humans with no Dinosaurs).