**Questionnaire for SysBio AS#2**

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**NOTE: Answers for questions shown below should be written in English only. Points may be deducted if the sentence structure is incomplete, grammar is seriously wrong, or it is difficult to understand due to incorrect use of words and terminology.**

1. What is the unit of the parameters a, b, c ? For example, the unit of velocity can be m/s or km/h or km/s depending on the units of distance and time.

| The unit of the parameters a,b,c is [mM/s]. |
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The figure shown below is the example results of a mathematical model simulated in this project. Although the mathematical model itself is the same, the dynamic characteristics of this model are very different when the model parameters are different. Please answer the questions below.

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| **Figure 1.** Different parameter sets in the same model generate completely different results | |

1. In the first graph, [Input] decreases to 0.75, but [x] ,[y], [z] decrease to ~0.5, not 0.75. Why ?

| If I set parameters, [a,b,c]=[1,1,1] , it has no other effect on x,y, and z concentration.    As you can see in the picture above, the values(x,y,z) converge to 0.75 as the input decreases to 0.75.  —--------------------------  If I set parameters [a,b,c]=[0.8,0.8,0.8], it has some changes compared to the input.    While the input decreased to 0.75, it can be seen that the values(x,y,z) decreased less than the input when all the parameters were 0.8.  —---------------------------  If I set parameters [a,b,c]=[1.5,1.5,1.5], it is the same as the first graph.    —---------------------------  So the bottom line is, the graph seems to vary depending on whether the parameter is small or high based on 1. In the equations of dX/dt, dY/dt, and dZ/dt, parameters a, b, and c are directly multiplied by X, Y, and Z.  Therefore, if the parameter values are greater than 1, the amount of change in the values(x,y,z) increases, and if they are less than 1, the amount of values(x,y,z) decreases. The parameter of the first graph is 1.5, which is larger than 1, so it seems that the values decreased more than the input. |
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1. In the second graph, x decreases rapidly in the beginning, but 1) why do y and z increase rapidly in the beginning? And 2) why do they decrease again after a certain amount of time? 3) Why does z have a smaller increment than y? Explain the second graph logically using the biochemical meaning of the parameter values that you guessed.

| I set parameters [a,b,c]=[1.4,0.7,0.7] for the second graph.    These three equations are dX/dt, dY/dt,and dZ/dt(and E=1).  I will answer with this principle:  “The sign of the derivative will indicate negative when the function is decreasing  and positive when the function is increasing.”   1. Why do y and z increase rapidly in the beginning?   **Parameter set: a>1, b<1, c<1**  In the dY/dt equation,  x and y all start with 1, and since the coefficient of x is greater than the coefficient of y, the value of dY/dt will be positive even if the input decreases (at the beginning). So the Y(t) graph increases.  In the dZ/dt equation,  Parameters b and c have the same value, but since y increases rapidly first, the dZ/dt value will also be positive. So the Z(t) graph increases at the beginning. However, because the coefficients are the same, Z(t) does not increase as rapidly as Y(t).   1. Why do they decrease again after a certain amount of time?   It is a situation in which x changes to y, and y changes sequentially to z. As the initial input decreases, x concentration decreases rapidly, and y and z gradually decrease. If x falls near 0.5, the derivative of Y(t) will be sufficiently negative because x value is less than the parameter b and c values(0.7).  When y falls sharply, z is still increased, so dZ/dt can be interpreted in the same way of dY/dt. Considering that it is a sequential reaction, z also decreases as y decreases.   1. Why does z have a smaller increment than y?   Since b and c have the same value, the sign of the derivative is determined only by y and z. For example, since b=c=0.7, it can be expressed as dZ/dt=0.7(Y-Z), and the function z(t) increases when Y is greater than Z. However, since the difference in y-z is much smaller than the difference in x-y, Z(t) shows a smaller increment than Y(t).   1. +) Why does z have a smaller decrement than y?   As explained earlier, z does not have a large range of change because the values of b and c are the same. Since the sign of the derivative is determined only by the difference between y and z concentration(y-z) in the dZ/dt equation, it decreases slowly when z is greater than y. |
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1. Adjusting the parameters in a system can yield very different results, as shown in the figure above. What new lessons have you learned from this?

| I think the cooperation of computers and biology would be more needed because I saw the graph change in an instant even if I changed the parameters a little bit. If a person controls and simulates one by one by experiments, there will be many unexpected situations and it will take a lot of time. I think it is great to simulate the results virtually. |
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1. What was the most difficult thing to understand while doing this homework? Did you figure it out after all? (It's okay if you don't understand, let's cover it in the Q&A session).

| It was not easy to understand the concept of estimating x, y, and z concentration without any integration. However, I think I understood the concept while playing the code by myself. I can see what values are multiplied, how the function works when I type the code. |
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1. If you have a friend or a team who helped you understand, please write the name of that friend or the entire team members and what you are grateful for.

| Systematic trio team, and Jonghwan Yoon |
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