Quantitative Reasoning Exercise - Photosynthesis (Light Reactions)

Name _____
Group #: _____

Question 1:
Photosynthesis is the plant physiological process used to transform sunlight, carbon dioxide, and water into carbohydrates, primarily starch and sucrose, which serve as the primary energy source for all other plant processes. The production of starch and sucrose relies on the supply of NADPH and ATP, which are generated in the light reactions. Light energy that is captured by the thylakoid drives the extraction of electrons and protons from water in the lumen. Electrons are transferred across the membrane to NADPH, while the protons generate a gradient in the lumen and power the synthesis of ATP via ATP synthase.

1) Construct a diagram of a thylakoid membrane, and include the following: thylakoid membrane, photon, H_2O, antennae, photosystem II, cytochrome b_6f, photosystem I, ATP synthase, NADPH, ATP.

Question 2:
The rate of electron transported through photosystem II is known as linear election flow (*LEF*). Plant physiologists can measure *LEF* by measuring the light intensity (i), proportion of light absorbed by the antennae (f_{PSII}), and energy productively transported through photosystem II (Φ_{PSII}). We know that the relationship among these variables can be modeled using the following equation:

$$y = A_a * x * B_b$$

1) Using your diagram and the description above, can you substitute the terms in the mathematical model to better represent Linear Electron Flow in a leaf (i.e., substitute with the appropriate light reaction symbols defined above).

Question 3:
You are having a picnic at Baker Woodlot on a blue sky and cloudy day. While you are enjoying your food, you observe a sugar maple (*Acer saccharum*) and you get inspired to calculate it's *LEF*. You also know the following information.

Species	i	Φ_{PSII}	f_{PSII}
Acer saccharum	20	0.8	0.5
Acer saccharum	50	0.8	0.5
Acer saccharum	100	0.8	0.5
Acer saccharum	250	0.77	0.5
Acer saccharum	500	0.60	0.5
Acer saccharum	750	0.46	0.5
Acer saccharum	1000	0.36	0.5
Acer saccharum	1500	0.25	0.5
Acer saccharum	2000	0.19	0.5

1) Use the mathematical model you developed for linear electron flow and solve for the *LEF* of *Acer saccharum* leaf. Plot the relationship between *LEF* and light intensity (i) based on the data (label the axis with the proper units).

2) If a plant was lower in the canopy and received low light, what physiology (if any) could be adjusted to increase *LEF* ?

Confidence Questions:

1. I have the biological cognition to develop a conceptual diagram for plant physiology processes.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

2. I am capable of reasoning with mathematical models and can identify/substitute the relevant variables needed to represent plant physiological processes.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

3. I can deploy mathematical model(s) to answer plant physiological questions.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

4. I can determine trends in data and defend those trends using biological arguments.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

5. Working through quantitative reasoning exercise in small, collaborative groups is preferred over working through the exercise by myself (i.e., independently).

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

6. I understand the value of quantitative reasoning and would like to develop better skills in it.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

Optional: Can you explain why you rank the question like this?

_____
_____

7. Do you have any other comments, concerns, or feedback that you would like to share?

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_____
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_____