Name _____
Group #: _____

Question 1:
Starch plays a pivotal role in the energy economy of the plant cell. Produced and stored within the chloroplast during the day as a result of photosynthesis, starch serves as a reserve of carbohydrates. In the night when photosynthesis is inactive, plants depend on this stored starch to provide a steady supply of carbon, supporting various metabolic processes critical for growth and development. Therefore, efficient production and utilization of starch is essential. Any inefficiencies in this process risk causing plant starvation during the night.

1) Construct a simplified diagram to illustrate nocturnal starch degradation and utilization in a plant. Specifically, highlight the enzyme-mediated processes that breakdown starch in the dark. Include the following keywords: Chloroplast, Starch Granule, Starch, β-amylase, Maltose. (hint: use Figure 8.14 or 8.17 in your textbook as a guide)

Question 2:
Enzymes like β-amylase play a pivotal role in optimizing the utilization of starch within plant cells. Specifically, β-amylase facilitates the conversion of amylose within the insoluble starch granules into maltose. As plant physiologists, understanding the efficiency of β-amylase involves utilizing the Michaelis-Menten equation:

$$V = \frac{V_{max} * [S]}{K_m + [S]}$$

Where $[S]$ represents substrate concentration, and V denotes the conversion velocity. The equation allows us to estimate two crucial parameters that describe enzyme kinetics: V_{max} (maximum reaction rate or speed) and K_m (Michaelis constant, reflecting efficiency).

1) Using your diagram and the description above, can you substitute the terms in the mathematical model to better represent the function of β-amylase in a leaf?

Question 3:

We want to investigate whether β-amylase kinetics remain consistent across plant species, or if plants can adapt β-amylase kinetics to optimize maltose breakdown based on their growth environment. For this investigation we will estimate K_m for two distinct plants: the Michigan native, *Acer saccharum*, and the extremophile *Mesembryanthemum crystalinum,* a plant native to the Sanai peninsula. We are given the following data:

Species	S	V
Acer saccharum	0	0
Acer saccharum	0.01	8
Acer saccharum	0.02	21
Acer saccharum	0.05	52
Acer saccharum	0.1	77
Acer saccharum	0.3	93
Acer saccharum	0.5	98
Acer saccharum	1	100
Mesembryanthemum crystalinum	0	0
Mesembryanthemum crystalinum	0.01	4
Mesembryanthemum crystalinum	0.02	16
Mesembryanthemum crystalinum	0.05	40
Mesembryanthemum crystalinum	0.1	70
Mesembryanthemum crystalinum	0.3	74
Mesembryanthemum crystalinum	0.5	79
Mesembryanthemum crystalinum	1	82

1) Using this fitting tool (https://l-gregory.shinyapps.io/MichaelisMenten/), input the substrate concentration and the reaction rate to solve for K_m for each plant?

2) Based on the solved K_m's for *Acer saccharum* and *Mesembryanthemum crystalinum*, which species has a more efficient β-amylase, and discuss any inferences about enzyme kinetics?

Confidence Questions:

1. I have the biological cognition to develop a conceptual diagram(s) 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 in plant physiological models to answer real-word challenges.

Strongly disagree	Disagree	Agree	Strongly Agree
1	2	3	4

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

4. I can and 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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