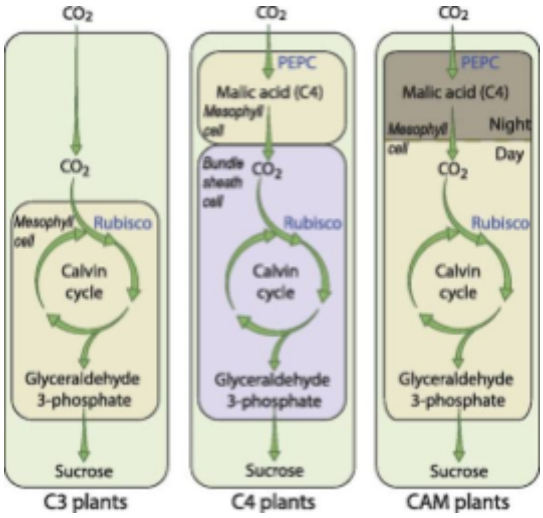
Lauren Cho, Charlotte Langlois, Maria Gabbasova

BC368 - Biochemistry of the Cell II
Case Study #8 - Baker to Botanist

Background:

In her free time, Professor Martha is an avid baker who loves plants. She was very excited to have received her very own tomato (*Solanum lycopersicum*) and vanilla plants (*Vanilla planifolia)* from two of her students at a teacher appreciation luncheon. After some quick Googling, Martha returned home and diligently set up the appropriate tropical temperature and watering regiment for the plants, which she set on her kitchen window to ensure proper sunlight. The plants were thriving until Martha decided to go on a week-long vacation during spring break. When she returned, the tomato plant was severely wilted beyond repair, but the vanilla plant was green and still thriving.

Biochemistry: C3, C4, and CAM plants perform photosynthesis to convert CO_2 into carbohydrates. C3 plants rely on this direct fixation pathway. C4 plants have adapted to compartmentalize carbon fixation and the Calvin Cycle, increasing CO_2 concentrations within the plant. CAM plants have adapted to adverse conditions by separating light-dependent reactions and the use of CO_2 in the Calvin cycle by time. At night, CAM plants open their pores to take in CO_2, and close them during the day.

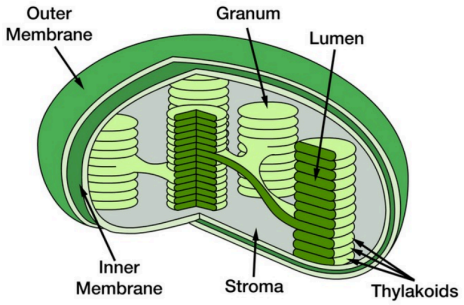


Q1: What physiological factors could explain why the tomato plant wilted, while the vanilla plant remained healthy? What does this suggest about the plant type of the tomato and vanilla (C_4, C_3, CAM)?

Background 2: Now that her tomato plant was gone, Martha was extra protective of the vanilla plant, she moved it to her windowless bedroom in order to remind herself to water it properly. To remedy the lack of light, Martha set up the plant under an old, full spectra LED lamp that she found in her basement. When she plugged it in, she noticed that the bulb would flicker off for prolonged episodes. She figured that the plant got enough light regardless, and turned off the lamp at night. Over the next few months, she began to notice wilting, yellowing leaves, and no vanilla bean production. Luckily, she has many friends in the chemistry department, and sent her plant in for testing.

Lab Findings:

Test	Status
Lumen pH	HIGH
pmf	LOW
ATP Synthase activity	LOW



Q2: Based on the data collected, what seems to be making Martha's plant wilt?

Biochemistry 2: CAM plants are on a strict circadian schedule that coordinates stomatal closure during the day and opening during the night. Disrupting this rhythm causes futile cycling between day and night processes.

Q3: How could this explain your answer to question two on a biochemical level?

Bonus Question: What treatment do you recommend for Martha's plant?

References:

1) Wang, H.; Wang, X.-Q.; Zeng, Z.-L.; Yu, H.; Huang, W. Photosynthesis under Fluctuating Light in the CAM Plant Vanilla Planifolia. *Plant Science* **2022**, *317*, 111207. https://doi.org/10.1016/j.plantsci.2022.111207.
2) Winter, K.; Smith, J. A. C. CAM Photosynthesis: The Acid Test. *New Phytologist* **2021**, *233*. https://doi.org/10.1111/nph.17790.
3) Armarego-Marriott, T. Stop the Clock: Optimized Carbon Fixation and Circadian Rhythm in a CAM Plant. The Plant Cell 2017, 29 (10), 2314–2315. https://doi.org/10.1105/tpc.17.00783.