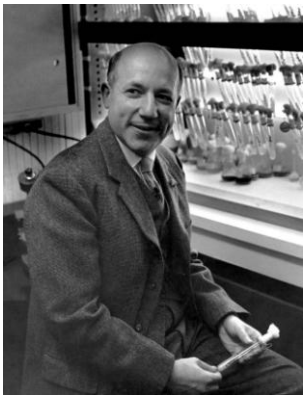

Are you what you eat?

Page 2: Calvin's Contributions

Case Study Problem

C-643 Intermediary Metabolism

As Rose discovered later, her simplistic understanding of photosynthesis was about half a century out of date. In the 1940's, knowledge of metabolic pathways exploded with the availability of radioisotopes. Carbon dioxide, being one of the simplest compounds of carbon, became one of the first ^{14}C-labeled compounds to be produced and used to study metabolism. Melvin Calvin, a physical organic chemist with broad interests and experience with radioisotopes from the Manhattan Project, exploited CO_2 in a series of elegant experiments to trace the flow of carbon in photosynthesis - work for which he received the 1961 Nobel Prize in Chemistry. His major discoveries included the identification the five-carbon molecule that reacts with CO_2 and the reactions dependent on thiamin pyrophosphate that rearrange sugar phosphate skeletons in the conversion of three-carbon intermediates into five-carbon intermediates.

Among the more informative experiments were those done by one of Calvin's associates, James Bassham. He followed the incorporation of two different radioisotopes into photosynthetic intermediates as a function of time after a light-to-dark transition and back. (See Figure 1 below.) The presence of several experimental variables made the results confusing to Rose. However, she felt sure that making sense of the data would be a good test of her understanding of photosynthesis.

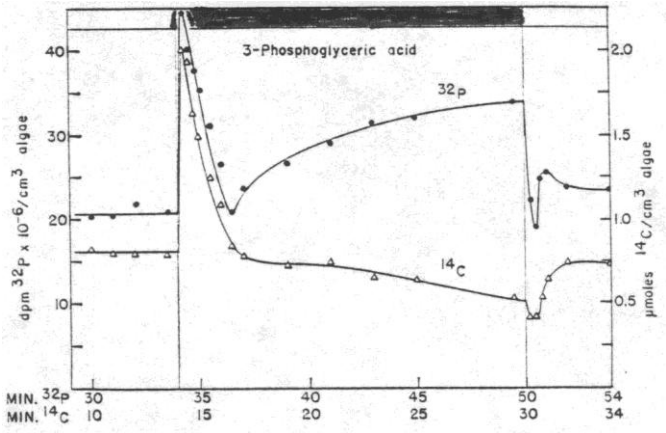

Figure 1. The effects of light and dark on the amounts of ^{14}C and ^{32}P labeling of 3-phosphoglycerate in *Chlorella pyreniodosa*. After 30 minutes of photosynthesis under steady-state conditions with unlabeled CO_2, ^{32}P-labeled phosphate was added to the algae, and 20 minutes later, $^{14}CO_2$ was added. This was sufficient to achieve isotopic equilibration in the Calvin Cycle intermediates but not long enough to significantly label the pool of stored carbohydrate (starch). At the times indicated, and during the light, dark, and again in the light, samples were taken and cells were killed in ethanol. The radiolabeled metabolites were analyzed by two-dimensional chromatography and radioautography.

1. **Examine Figure 1 and as a group make a list of things you observe in the data - one clear statement for each observation.**
2. **Explain as many of the observations as you can.**
3. **Define precisely the aspects of the observations that you cannot explain and use that list of learning issues to guide your preparation for next class.**

Written by Harold B. White, Department of Chemistry and Biochemistry, University of Delaware