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RADIATION LABORATORY

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Radiation Laboratory

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**SUMMARY OF THE RESEARCH PROGRESS MEETING OF JULY 24, 1952**

Sergey Shewchuck

August 21, 1952

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Berkeley, California

## SUMMARY OF THE RESEARCH PROGRESS MEETING OF JULY 24, 1952

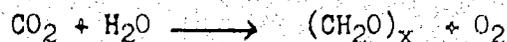
Sergey Shewchuck

Radiation Laboratory, Department of Physics  
University of California, Berkeley, California

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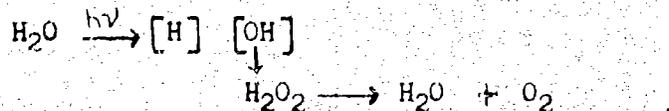
I. Photosynthesis. M. Calvin

Basically photosynthesis is the process by which green plants are capable of converting electromagnetic radiation or energy into chemical energy. In its simplest form the reaction may be expressed as follows:



The forward direction of this reaction is limited to plants; but the reverse, known as respiration, is accomplished in both plants and animals.

The photosynthesis reaction has been subdivided into two distinctly recognized processes. The first is a primary conversion associated with the  $\text{H}_2\text{O}$  molecule itself, it being split by the radiation energy into reducing power and  $\text{O}_2$ . The probable course of the reaction is as follows:



The second is the action of the reducing power, or  $[\text{H}]$ , on  $\text{CO}_2$  to effect in some way the formation of carbohydrates: sugars, fats, etc. It is with this latter aspect of the problem that experimentation is being conducted at the present time. Since it is thought that the process should be one of a build up of more complex molecules by a systematic adding of the carbon atoms, it was logical to employ  $\text{C}^{14}$  in various tracer techniques to determine just how far the carbon atom has progressed.

There is also a need, however, for a determination on a quantitative basis of each of the C atoms in the compounds in the above system. This is being attempted for the first time at present on a purely theoretical basis with the aid of the differential analyzer machine at the Radiation Laboratory. The approach to the problem is first made by sketching a proposed "apple" carbon cycle for the system as shown in Fig. 2 and then setting up differential rate equations for each C atom involved in the cycle, 21 in this case, thus:

$$\left(\frac{dC}{dt}\right)_A = F - FX_A \quad \text{or}$$

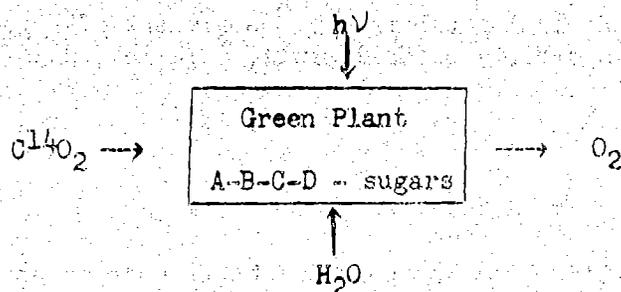
$$\frac{dX_A}{dt} = \frac{F}{A} (1 - X_A)$$

where  $t$  is the time in seconds,  $X$  is the specific activity in terms of that added as  $CO_2$ ,  $F$  is the measured total rate of incorporation of the C atoms in moles/sec and  $A$  is the computed total number of moles in the reservoir of compound A, or B, etc. (for compounds that saturate).

Preliminary results appear to agree very well between the experimental and the theoretical: as for instance, 3 seconds from theory for 87 percent of activity in the carboxyl of glyceric acid as against 4 seconds from experiment, and, 17 seconds for 49 percent of activity in the carboxyl group as against 15 seconds. The next step will be to change the conditions imposed on the cycle and thus see how the distribution of activity is sensitive to the respective cycle condition changes.

A special report, UCRL-1861, on this same subject is in the process of being issued.

The experiment is easy to set up in theory but quite difficult to perform. It appears that even the simplest organisms involve the most complex processes and compounds. The plan schematically is shown as follows:



where A, B, C, and D are the various compounds evolved in the course of photosynthesis. The four ingoing and outgoing quantities are carefully measured. Then at suitable time intervals after radiation exposure the plant is killed and its extracts are analyzed for individual compounds by chromatography. The  $C^{14}$  labelled compounds are located on the filter paper by photographic films, the relative activities are determined by counters and the identity is determined by chemical analysis after cutting out the radioactive spots on the filter paper.

When the plants are killed at the shortest possible time intervals of exposure an analysis of the plant's extracts shows phosphoglyceric acid to be the first acceptor of  $C^{14}$  and hence one of the first compounds to be formed by photosynthesis. At longer time intervals and at various conditions of radiation exposure and of  $CO_2$  concentrations the progressive build up of other compounds is discovered, for which production curves can be drawn in relation to time. One then is able to arrive at a formulation of a more or less complete cycle of compounds showing the acceptance and regeneration of the carbon within a closed system. One such system is shown in Fig. 1 where a qualitative analysis has been determined.

II The Denver Meeting. S. Colgate

S. Colgate attended the 1952 Denver Meeting of the American Physical Society held June 30, July 1-3 at Denver, Colorado. The various topics and points of interest briefly discussed by him will be found in the Physical Review, as abstracts of the papers presented by the speakers.

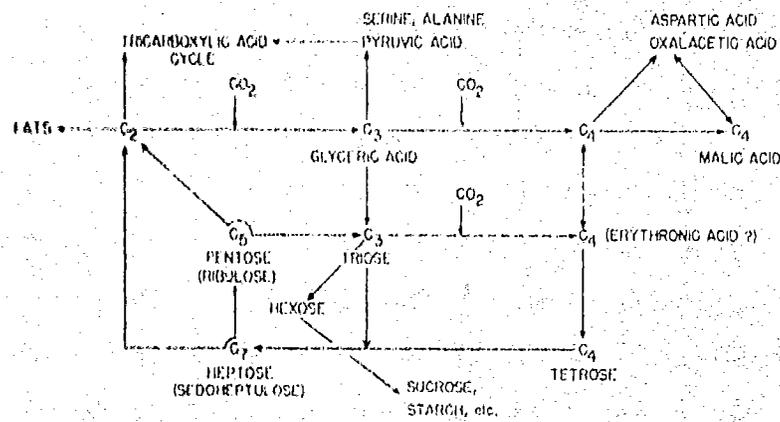


Fig. 1