BIOCHEMISTRY

Photosynthesis—Solution?

How green plants convert sunlight into food is a matter of positives and negatives in final steps, Nobelist Calvin reports to conference near Paris.

➤ THE MOST significant energy mystery in the world seems to be only a step away from solution—how the green plant captures and stores the sun's energy.

A quiet colloquium just concluded at the French National Photosynthesis Laboratory at Gif-sur-Yvette near Paris attracted about two dozen world experts, among them Dr. Melvin Calvin, Nobel Prize-winning chemist of the University of California, who won the honor because of photosynthesis research. He reported his latest proposal as to exactly what happens when the green living chlorophyll material converts solar energy from radiation to a usable stable form.

It is a very complex procedure, chemically and biologically.

The primary act of conversion of energy seems to involve the separation of the negative from the positive. The negative consists of electrons, particles of electricity. The positive consists of the charges or "holes" that the electrons leave behind in the molecules from which they come. This handling of atomic entities, so light even in comparison with the atoms themselves, makes it possible to set up energy barriers without too much cost that will keep confined the energy stored by the solar effect.

Dr. Calvin and his colleagues have been performing experiments to determine the way in which the energy conversion occurs. This involves the separation of the oxygen-seeking and the hydrogen-seeking compounds that result from the impact absorption of the sunlight by the green material. Dr. Calvin has concluded from this that the migration of the holes, or positives, and the migration of the electrons, or negatives, both play a role in the final act of photosynthesis.

Spinach and red bacterium, *Rhodospirillum rubrum*, were the experimental material used. When these photosynthetic materials were placed in an instrument called the electron paramagnetic resonance spectrometer and illuminated, it was possible to see signals showing what was happening to the electrons.

Once the details of the photosynthetic process are ferreted out in this laborious method, there may be enough information to attempt the materializatlon of the dream of duplicating outside living material the unique feat of chlorophyll.

One of the wonders of photosynthesis, as explained by Dr. Calvin, is the handling of a "quantum" or package of energy of many thousands of calories in living systems. This causes chemical transformations at room temperatures at a relatively high efficiency. The energy packets involved are of the order of 38,000 calories for green plants and 30,000 for bacteria, and these are small calories and not the large calories a thousand times greater that are used for food measurement. That means the energy packets are about the energy in two teaspoonsful of sugar.

Dr. Calvin observes that the apparatus which accomplishes this is of labile organic construction and that the thermal reactions which can be performed by such a system rarely, if ever, involve energy changes higher than 10,000 or 15,000 calories. It is an impressive accomplishment indeed, he says, to be able to manipulate a package of energy two or three times that size without damage to the apparatus and in a highly directed and specific way.

The ultimate products of this energy transformation have long been known to us in the form primarily of carbohydrate and oxygen, but, of course, including all of the plant substances, Dr. Calvin said in his paper. Some more immediate products of this energy conversion process in terms of more transient specific energy-storing materials can be described. Two such energy-storing intermediates which can be used to produce the final, or more long term, storage materials are believed to be reduced pyridine nucleotide and adenosine triphosphate. It may turn out that other transient energy-bearing chemical intermediates might be still closer to the energy transformation step itself.

The energy is captured and transferred in a sort of bundle of energy scientists call a quantum. The earlier discovery of a chemical, cytochrome f, in green tissues of plants, suggested that this chemical plays a role in which it was first reduced with production of a strong oxidation and then oxidized with production of a strong reducing agent.

Joining with Dr. Calvin in his paper was Dr. G. M. Androes, while discussions with Drs. Kenneth Sauer, I. D. Kuntz Jr. and F. A. Loach were incorporated in the report.

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AGRICULTURE

Glass Fiber Mats Protect Waterways

➤ GLASS FIBER MAT was the most effective of seven materials evaluated in Oklahoma tests for ability to protect newly seeded grass waterways.

The materials were rated by W. O. Ree, U. S. Department of Agriculture, Agricultural Research Service hydraulic engineer, according to the velocity of water they withstood without damage to the waterway or the material. The studies were at the Stillwater Hydraulic Laboratory, with the Oklahoma Agricultural Experiment Station co-operating. Temporary protection of new waterways is needed until the grass is established.

Mr. Ree found that a glass fiber channel lining withstood more than four times as much water discharge as the next best material.

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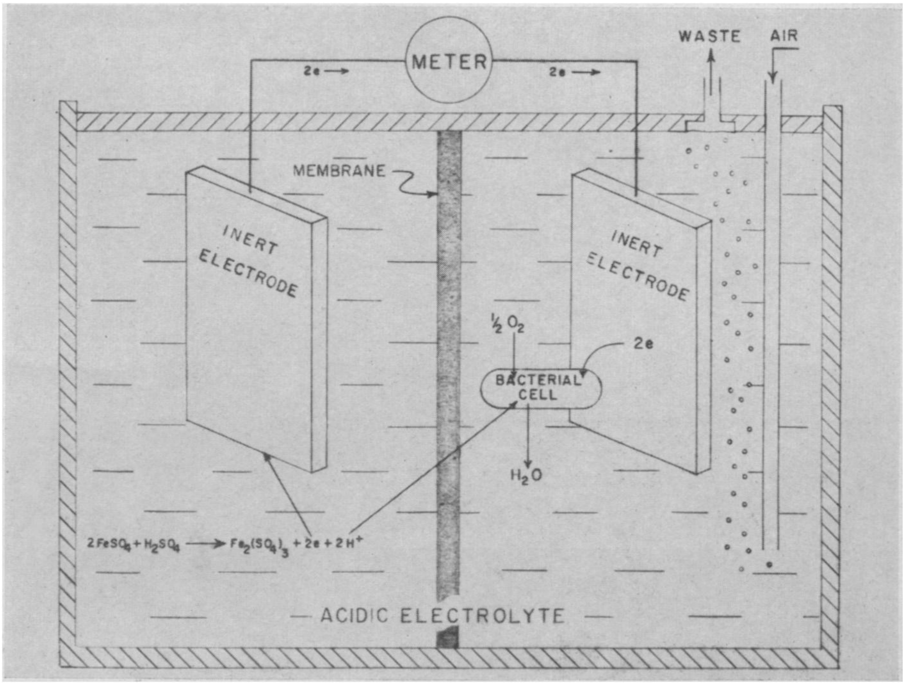

BIO-ELECTRIC CELL—This new type cell proves that bacteria use electrons instead of eating solid food. Ferrous sulfate reacts with sulfuric acid giving up two electrons in the left compartment. Bacteria in the right compartment "call" the electrons which pass into the inert electrode, through a wire (top), are registered on a meter and taken off the right inert electrode. ➔

BIOPHYSICS

Bacteria "Eat" Electrons

A new bioelectric cell which could supply power for vehicles in space and light for cities on earth proves bacteria do not eat solid foods.

➤ A RADICAL new fuel cell harnesses electricity produced when bacteria "eat" electrons. It shows for the first time that these tiny microbes actually use electrical charges instead of solid foods.

Developed for powering space vehicles and lighting cities, fuel cells have used certain bacteria fed with organic wastes to produce chemicals which make electrical energy. But Drs. Joseph A. Sutton and John D. Corrick of the U.S. Bureau of Mines in Washington have discovered that bacteria, drawing electrons from living or lifeless matter, can be used for power. And bacteria can do it while separated from the food source.

The unique "bioelectric cell" now under study is divided into two compartments, each containing a non-reacting electrode or terminal and filled with a weak acid solution. Inorganic materials, such as fool's gold (pyrite), in one side reacts with the acid, freeing electrons and hydrogen.

The electrons are "called" through a wire by bacteria in the second compartment. These consume the electrons and produce water as a waste product. Usable electric current is generated by the electrons passing through the wire.

"So far our cell has not produced the amount of electricity that other cells have," Dr. Corrick told SCIENCE SERVICE. "We haven't wanted to," Dr. Sutton explained. The scientists are primarily interested in the principle, not the application.

The cell was designed for exploratory-type experiments separate from their regular duties. The Bureau of Mines is applying for a patent on the method but so far no money or time has been spared for large-scale studies.

Two reasons why the bioelectric cell may prove better than the popular biochemical fuel cell are that it should not generate heat during the process (a drawback to present fuel cells in space work) and that the electrodes do not break down or corrode, thus giving the cell an extremely long life.

Prior to their fuel cell, electricity could not be produced by microbes from inorganic materials alone and there was no direct method for determining how many electrons were transferred from inorganic substances to biological organisms, Dr. Sutton explained. The measurement of these transfers may aid medicine in the study of electrical activity of living cells.

Until now it has only been believed that bacteria used the electric particles instead of the organic or inorganic materials for energy.

As proof that bacteria actually use electrons, the two biochemists showed that the membrane and salt bridges were used to separate the organisms from the ferrous sulfate which supplies the electrons through chemical reaction with sulfuric acid. Electricity can only be produced if the iron and bacteria are separated by a membrane or salt bridge, they said.

Since all bacteria use electrons, the two scientists said, almost any type of bacteria could be put in the cell and "fed" the correct number of electrons from any substance. The process should work with any "food" or electron source.

The long-range goals of this research are many, Dr. Sutton said. Lighting mines, operating mining equipment and selectively separating metals from solution are only three goals which might prompt the Bureau to act on the project. But safer and longer-lasting space power cells and the promise that any type of waste material could power factories and cities using only harmless organisms may be even more important.

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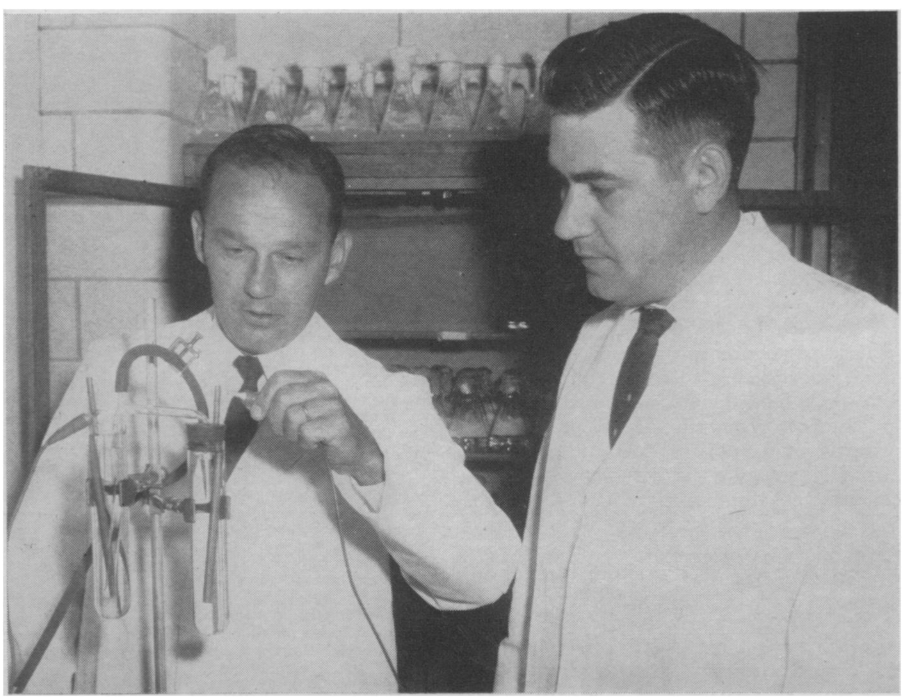

BACTERIA FOR POWER—Drs. Joseph A. Sutton (at left) and John D. Corrick, developers of the new bio-electric cell, in a laboratory at the U.S. Bureau of Mines, College Park, Md.

NECROLOGY

Marjorie Van de Water Dies After Long Career

➤ MISS MARJORIE VAN DE WATER, 61, staff writer of SCIENCE SERVICE died at her home, 3015 Blueford Rd., Kensington, Md., August 2. Death was caused by cerebral embolism.

The exciting and increasingly important field of psychology has been covered for the American people by Marjorie Van de Water since 1929 when she joined the SCIENCE SERVICE staff after having been a laboratory aid at the National Bureau of Standards, a research assistant at the National Research Council, and a research assistant at the U. S. Civil Service Commission.

She was a life time member of the National Association of Science Writers and in 1959 was awarded the science writer's prize of the American Psychological Foundation for her career of distinguished popular interpretation of psychological science. Marjorie Van de Water had covered almost every meeting of the American Psychological Association since the Toronto meeting in 1931, as well as many of the regional meetings of this science.

During World War II she, together with Prof. E. G. Boring, made an unusual contribution to the war effort in a new type of book on "Psychology for the Fighting Man," a wartime best seller with a half-million circulation. A second book was similarly prepared for the returning serviceman.

She is survived by her sister, Mrs. Jean H. O'Neill, of Stuart, Fla., who was with her at the time of death; a brother, Donald G. Van de Water, Stuart, Fla.; nephews, Dr. Malcolm Van de Water, Jupiter, Fla., and Hugh O'Neill, Stuart, Fla.; nieces, Mrs. W. L. Pearson of Miami, Miss Patricia O'Neill of University of Florida, Gainesville, Mrs. Isaac Elkins, Stuart, Fla., and Patricia Shumway of Los Angeles. Also surviving are grandnephews and grandnieces.

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