BIOCHEMISTRY

Lightless Photosynthesis

Scientists have succeeded for the first time in eliminating the need for light in photosynthesis, an important breakthrough in man's understanding of this complicated process.

➤ AN IMPORTANT breakthrough in man's understanding of the photosynthetic process by which green plants convert sunlight into food energy has been made.

For the first time, scientists have succeeded in eliminating the need for light in a key energy-transforming reaction of the photosynthetic process.

They did it by replacing light energy with a chemical source of energy, and by identifying an important chemical component in the plant's photosynthetic apparatus—an iron-rich protein called ferredoxin.

With the aid of the newly-discovered ferredoxin, they were also able to play another "trick" on the photosynthetic process of green plants:

They forced the tiny green photosynthetic units known as chloroplasts into a completely new productive sequence.

Instead of giving off oxygen that is normally "exhaled" by plants, the chloroplasts isolated from spinach leaves were stimulated to give off hydrogen gas—a feat that would have been considered impossible under the theories of photosynthesis that prevailed until recent years.

This discovery was made by Dr. Kunio Tagawa, research biochemist, and Dr. Daniel Arnon, professor of cell physiology, University of California, Berkeley, and biochemist in the University's Agricultural Experiment Station, Davis, Calif.

The new knowledge provides clear evidence supporting the Berkeley scientists' "electron flow" theory, which views the initial steps in photosynthesis as proceeding from light energy into chemical energy by way of the flow of electrons among several compounds.

In addition, the findings show an important basic unity between the photosynthetic processes in the chloroplasts of green plants and the corresponding chemical reactions found in certain bacteria that grow without light and oxygen in the soil.

Or as Dr. Arnon has termed it, the results demonstrate "the beautiful biochemical unity of nature."

Of special interest to Dr. Arnon and his associates has been the "primary photochemical act;" that is, the first steps in the utilization of light that precede the conversion of carbon dioxide into plant substance.

A few years ago, Dr. Arnon's group found that two key compounds in photosynthesis—adenosine triphosphate (or ATP) and reduced pyridine nucleotide — are formed in chloroplasts at the expense of light energy by a process called "photosynthetic phosphorylation."

These two compounds supply the chemical energy needed to "drive" the entire cycle by which carbon dioxide is utilized by the plant.

The role of light, according to Dr. Arnon's theory, is to provide an initial energy "kick" to start the chain of reactions.

Electrons ejected from chlorophyll by light are boosted to higher levels of energy in the initial "uphill" step of the process.

The electrons then pass through energy conversion steps yielding ATP and reduced pyridine nucleotide.

From here the ensuing chain of chemical reactions, involving the building of plant substances, is "downhill' in terms of energy expenditure.

Still a puzzling question remained: what is the nature of the chemical electron carrier that transports the electrons after the initial energy "kick"?

A clue to the answer came early this year, when a group of scientists at the Du Pont Laboratories in Wilmington, Del., isolated an iron-rich compound they called "ferredoxin" from some soil bacteria.

Learning of this discovery, Drs. Tagawa and Arnon at Berkeley searched for the same compound in spinach chloroplasts, found it, and tested its properties.

They found that it was "the most electronegative electron carrier in cellular oxidation-reduction reactions"—in other words, it has the greatest electron-carrying capacity of any chemical yet located in the photosynthetic mechanisms of plants and photosynthetic bacteria.

Using ferredoxin, the researchers conducted their experiments on the production of hydrogen gas by chloroplasts and found that the new chemical can stimulate the process in striking fashion.

Advancing another step, they sought to duplicate a portion of the primary photochemical act without light.

In place of light, they supplied the initial energy "kick" with hydrogen gas, known to be a powerful electron supplier.

The result was the production of reduced pyridine nucleotide by chloroplasts (that is, the build-up of a key store of chemical energy) entirely in the dark.

The report by Drs. Tagawa and Arnon is being published in *Nature*.

• Science News Letter, 82:125 August 25, 1962

MEDICINE

Thalidomide Uproar May Have One Good Result

➤ ONE GOOD RESULT may come from the current uproar over thalidomide, the sleeping drug which produced deformed limbs in thousands of European babies.

Further studies may provide clues to the mechanism by which such births occur in the general population, says Dr. Milo B. Brooks, medical director of the Child Amputee Prosthetics Project at the University of California, Los Angeles.

He believes that the drug's effects "may be an opening door into the mystery of the causes of limb deficiencies."

He suggests that research with animals, possibly pigs or monkeys, may produce deformities in offspring similar to those found in humans, thus providing a way of studying the damaging effects.

Dr. Brooks visited Germany this spring and saw dozens of infant victims of the deforming drug. One mother told him that she had taken only one tablet of the drug during the first month of pregnancy.

There is as yet no explanation of thalidomide's effect on offspring, but noting that the drug has occasionally resulted in neuritis after long continued use, Dr. Brooks points out that if the drug can paralyze a nerve, it may be able to damage the budding limb of an embryo and prevent it from developing.

He also reports that research elsewhere has indicated that thalidomide has the power to increase greatly the effect of other drugs taken with it, including such common drugs as aspirin and alcohol, at least in animals.

Dr. Brooks strongly recommends that babies with limb deficiencies should be brought to the attention of child prosthetics clinics as early as possible, "preferably within hours of birth." The shock to the family can be cushioned by the knowledge that most limb-deficient babies can be helped to live a normal life through artificial devices.

There are now 16 child prosthetics centers in the United States. The UCLA project, second oldest in the nation, has fitted 257 children with artificial limbs in the last eight years.

• Science News Letter, 82:125 August 25, 1962

PHYSICS

Ruby Laser Pierces A Sapphire Crystal

See Front Cover

➤ A PULSED ruby laser piercing a sapphire crystal is shown on this week's front cover. The laser at the Radio Corporation of America Laboratories in Princeton, N. J., generates energy so intense that it can bore a sixteenth of an inch hole in the sapphire in a thousandth of a second.

The heat produced at the surface of the crystal is at least 2,800 degrees centigrade.

Lasers are devices that amplify light waves and emit them "in step" to form a highly directional and powerful beam of coherent light, in contrast to the incoherent, or random nature of light waves emitted from conventional sources.

Their name is derived from the term, "light amplification through the stimulated emission of radiation."

Able to amplify light waves just as radio waves are amplified, lasers already foreshadow an era in which light beams may be used in guiding space vehicles and communicating between planets.

• Science News Letter, 82:125 August 25, 1962