

at all, let alone analyze it in the detail represented by the [reference system] with which this report is so largely concerned?" The answer is simply that circumstances could change, world energy needs escalate. Among other large-scale potential energy sources, coal raises environmental concerns, nuclear breeder reactors pose political and safety issues, fusion awaits real demonstration of its technological feasibility, and earth-based photovoltaic cells may depend on progress in large-scale electrical storage capacity if they are to ease baseload-power needs.

But more than in sheer dollars, the problems facing the sps concept are largely matters of scale, such as launching vehicles with 13 times the cargo-capacity of the space shuttle more than once a day for 30 years. The sheer mass of material required to build the actual satellites has prompted advocates to propose the use of materials from the moon and possibly asteroids—a feat that, says the NRC report, "may be more difficult to achieve than building an sps."

A side-effect of the towering costs, notes the report, is that "the size and complexity of an sps would strain U.S. abilities to finance and manage such an enterprise and, indeed, the governmental machinery for making the decisions necessary to initiate and sustain it." In fact, the document adds, "the worldwide ramifications are so extensive that a multilateral approach with the participation of other countries would probably be the only viable one if an sps were ever to be established." A variety of political, legal, social and military factors thus become part of the equation, potentially delving into such matters as treaties (which already constrain unilateral or commercial use of extraterrestrial materials) or even some sort of world energy authority. (Advocates of the idea have pointed out, however, that even such an inevitably global endeavor is likely to depend for its technological foothold on impetus from a country or bloc with the resources and will to take the initial steps.)

For all its misgivings, the NRC group notes that "the possibility exists that an sps could become an interesting option at some time in the twenty-first century..." Because of the multi-decade lead time such a system would require, the committee recommends that the heads of NASA and the Department of Energy (while refraining from a specific sps research and development program) should periodically review progress in new concepts and technologies that might bear on the idea, and report them to Congress. The practicality and timeliness of any new, large-scale energy system may well depend on developments in many other fields, some of which cannot yet even be envisioned. "It is thus too early," says the report, "to attempt to pick future winners and losers." Funds for sps are unlikely in NASA's FY 1982 budget. □

Those scheming photochemists

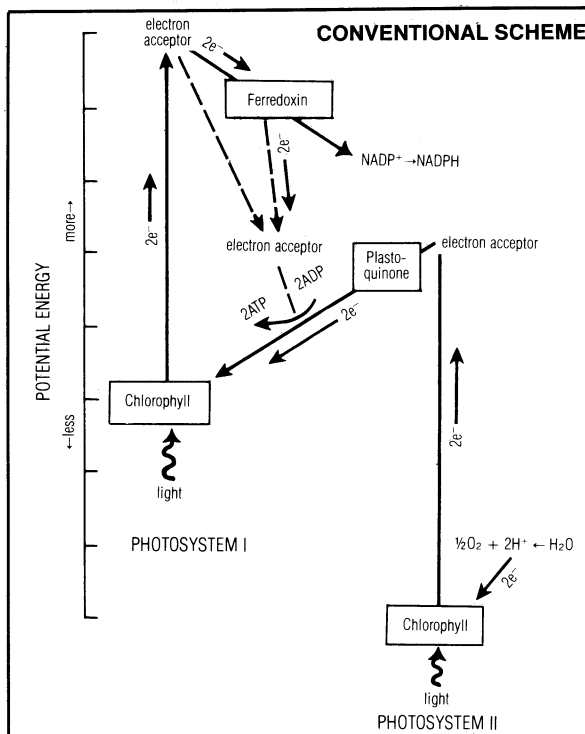
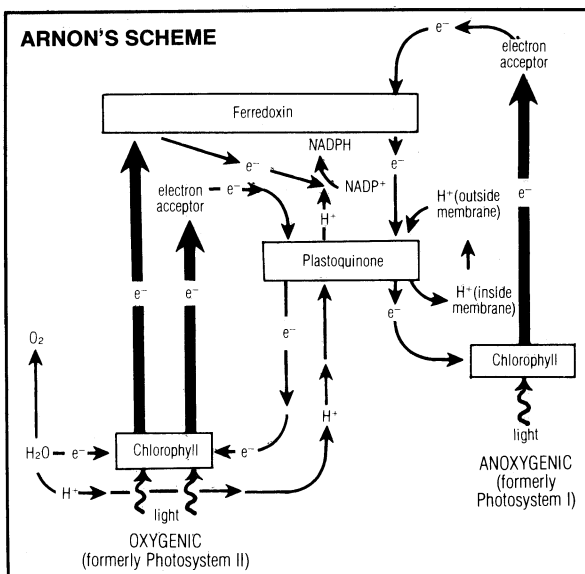
The New Hampshire valley-city Meriden soon will be alive with the sound of photosynthesis. Beginning July 19, researchers will gather at the Kimball Union Academy there for the Gordon Research Conference (informal but thought-provoking meetings designed to advance the frontiers of a given discipline) on the "Biochemical Aspects of Photosynthesis." At this particular conference, the precise mechanism of oxygen evolution in photosynthesis (SN: 1/19/80, p. 38), electron transfer reactions (SN: 8/2/80, p. 68) and the binding of herbicides to specific plant membranes called thylakoids probably will be favorite topics of discussion. And, as always, the work of Daniel I. Arnon and colleagues of the University of California at Berkeley is likely to stir up some debate.

Arnon has believed for some time now that there are major mistakes in the scheme most photochemists generally accept as representing the process of photosynthesis in blue-green algae and higher plants. In fact, in the June PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Arnon presents "new evidence" to support his alternative to the conventional scheme.

Now Arnon's alternative is for the most part panned in the photosynthesis community—"He has quite a reputation for putting forth some wild schemes," says one researcher—and even his "new evidence" is "likely to fall apart," says another. Nonetheless, it will be discussed at Meriden. Explains photochemist James R. Bolton of the University of Western Ontario at London, "Arnon stimulates a lot of controversy, and that has its value: It forces other people to think about their [conventional] scheme."

According to the conventional scheme, two light-triggered photosystems (PS I and II) are linked together in a single pathway that uses light energy to split water. The overall photosynthetic equation is $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$, but PS I and II serve only to split the water and generate NADPH and ATP—two energy-packed chemicals that in turn are used in the separate Calvin (named for Melvin

Calvin of UC at Berkeley) cycle that synthesizes the "energy-storer" $\text{C}_6\text{H}_{12}\text{O}_6$, or glucose. The photosynthetic process begins at the chlorophyll center of PS II where absorbed light is used to split water into oxygen, protons (H^+) and excited electrons. The currently accepted scheme holds that these electrons travel through a series of electron acceptors, including plastoquinone. They then are passed to PS I where a second light event gives the electrons enough potential energy to be accepted by ferredoxin, which in turn passes them to NADP in order to form the "energized" NADPH. Hence, the currently prevailing concept of how photosynthetic power is generated involves a linear electron flow from water to plastoquinone to ferredoxin to NADP⁺. The essence of this



scheme is that only PS I can transfer electrons to ferredoxin and that plastoquinone is the obligatory link in electron transport from PS II to PS I.

If this currently accepted scheme is correct, says Arnon, neither ferredoxin nor NADP⁺ should receive electrons when the function of plastoquinone is blocked by chemical inhibitors. However, Arnon says that when he did just that—blocked plastoquinone function with chemicals such as dibromothymoquinone—electrons *did* flow to ferredoxin as long as the protons (H⁺) also liberated during water-splitting were helped across the plant membrane. Arnon therefore proposes a new role for plastoquinone—that of proton shuttling—and an alternative mechanism to PS I and II.

According to Arnon's scheme, an oxygenic photosystem replaces PS II, and an anoxygenic photosystem replaces PS I. The oxygenic photosystem consists of two light events—one that transfers electrons to ferredoxin and the other that helps plastoquinone sweep protons from inside the plant membrane. ATP is formed in the anoxygenic system.

While such a mechanism probably never will replace the currently accepted one, what it will do is "force people to present data that support the conventional scheme," Bolton says. "Any theory of photosynthesis has to be subjected to periodic challenge to make sure it does represent as close to reality as we can make it." □

Tracking a cancer

Epidemiologists, the sleuths of medical science, tracking down the characteristics and causes of mysterious diseases such as legionellosis and toxic shock syndrome, are following a third trail—the outbreak of a rare and often rapidly fatal form of cancer.

The cancer, called Kaposi's sarcoma, usually affects only two out of every three million Americans annually. But in recent months Alvin E. Friedman-Kien of New York University Medical Center in New York City and some other investigators have diagnosed 41 cases of this cancer among homosexual men. None of the victims apparently knew each other, suggesting that the cancer is not contagious. On the other hand, the victims shared certain characteristics that might help epidemiologists eventually explain the outbreak of the cancer. For instance, most of the patients had frequent sexual encounters with many different partners. Many had been treated for herpesvirus, cytomegalovirus, hepatitis B virus as well as parasitic infections and had used drugs such as LDS and amyl nitrite. A number of the men were also found to have severe defects in their T and B lymphocytes, immune cells essential for fighting cancer and infectious diseases. □

Less drastic surgery for breast cancer

Radical mastectomy has been the usual procedure for treating breast cancers that have spread to the underarm lymph nodes. But now there is an indication that this operation—removal of the entire breast, the lymph nodes and the chest muscles—may be more than is necessary. Breast and lymph node removal, followed by a recently devised combination drug therapy, may be sufficient, according to a report in the July 2 *NEW ENGLAND JOURNAL OF MEDICINE*.

Bernard Fisher of the University of Pittsburgh School of Medicine and colleagues studied 1,863 breast cancer patients who had the less drastic surgery and whose lymph nodes had been determined to be cancerous. Two to four weeks after surgery half of the patients started getting L-phenylalanine mustard and 5-fluorouracil. They continued to receive this treatment between June 1977 and May 1980. The remaining patients were treated with the same two drugs plus an antiestrogen drug—tamoxifen citrate. The two treatment groups were similar in age, location and size of tumor, duration of symptoms and degree of lymph node involve-

ment. Breast tumors removed from 1,414 of the patients were also analyzed for the number of cell receptors for estrogen that they contained.

Fisher and colleagues report that women older than 50 years of age on the three-drug regimen whose cancers were estrogen-dependent and who had one or more underarm lymph nodes initially positive for cancer experienced significantly greater cancer-free survival than did women on the two-drug regimen. These results have important treatment implications for such women because breast cancer patients are at the greatest risk of relapse during the first two years after surgery. However, women under age 50 on the three-drug regimen did not experience any more cancer-free survival than did the women on the two-drug regimen, with the possible exception of women in this age group with four or more underarm lymph nodes initially cancerous and with many estrogen receptors in the breast tumors.

In a related study, whose results appeared in the same journal, Umberto Veronesi and colleagues of the National Cancer Institute in Milan, Italy, reported that with small, recently discovered breast cancers removal of a fourth of the breast and postoperative radiation are as effective in halting spread of the disease as is radical mastectomy. □

Child brain tumor: Comes with the job?

When cancer strikes a child, is parental exposure to chemicals to blame? Recent studies by John M. Peters and colleagues of the University of Southern California School of Medicine in Los Angeles indicate that in cases of brain tumors the parents' occupational exposure to chemicals may be a culprit.

Peters and co-workers—whose study appears in the July 10 *SCIENCE*—matched 92 cases of brain tumors in children less than 10 years old with 92 healthy control children. (Cancer is second only to accidents as a leading cause of death among children. In the cancer category, leukemia claims the most lives of children, brain tumors the second most.) The researchers questioned the parents of these case and control children about their occupations before and during the pregnancy and at the time the case children were diagnosed. Information sought included whether chemical solvents, dust or other fumes were inhaled; whether chemicals contacted skin or clothes; whether radioactive materials were involved; and whether protective equipment or clothing was used on the job. The researchers then analyzed the data, adjusting for potential confounding variables such as parental patterns of food consumption, drug use, alcohol use and smoking habits.

The results of the analysis indicate that parents of affected children reported more exposure to chemicals than did parents of

controls. For example, "Mothers of cases reported skin exposure to chemicals more than three times as frequently as mothers of controls," Peters and colleagues report. Also, fathers of cases reported exposure to paints seven times as frequently as did control fathers. Moreover, while only two fathers of controls had been employed in the aircraft industry, twelve case fathers worked in that industry either during the time of pregnancy or at the time the child's brain tumor was diagnosed. Peters and co-workers cannot yet explain this particular increased risk, although they note that exposure to trichloroethylene (a solvent) was mentioned by two aircraft industry-employed case fathers.

Could such results merely indicate a recall bias? While "it is possible that the mother of a child with a brain tumor might recall more episodes of exposure than a mother of a control," say the Los Angeles researchers, "mothers of cases were twice as likely to have worked during the years before pregnancy, a result that is very unlikely to be due to the bias. Also, the information on where (which industry) the mother and father worked is unlikely to be biased." The researchers conclude, therefore, that an adverse chemical effect could have been transmitted to the case children via the mother during pregnancy or nursing, via parents' soiled worked clothes or via a genetically damaged reproductive system of the father. □