teresting aspect of biochemical evolution that green plants, after evolving a mechanism independent of molecular oxygen for generating ATP in light, have also shared with nongreen organisms the emergence of an oxygen-dependent generation of ATP by oxidative phosphorylation.

References and Notes

1. H. A. Krebs and H. L. Kornberg, *Ergeb. Physiol. biol. Chem. u. exptl. Pharmakol.* 49, 212 (1957).
2. D. I. Arnon, *Ann. Rev. Plant Physiol.* 7, 325 (1956).
3. ———, M. B. Allen, F. R. Whatley, *Nature* 174, 394 (1954).
4. A. W. Frenkel, *J. Am. Chem. Soc.* 76, 5568 (1954).
5. D. I. Arnon, *Science* 122, 9 (1955).
6. ———, in *Enzymes: Units of Biological Structure and Function*, O. H. Gaebler, Ed. (Academic Press, New York, 1956).
7. A. L. Lehninger, *J. Biol. Chem.* 190, 345 (1951).
8. W. Vishniac and S. Ochoa, *ibid.* 198, 501 (1952).
9. D. I. Arnon, F. R. Whatley, M. B. Allen, *J. Am. Chem. Soc.* 76, 6324 (1954).
10. F. R. Whatley, M. B. Allen, D. I. Arnon, *Biochim. et Biophys. Acta* 16, 605 (1955).
11. D. I. Arnon, F. R. Whatley, M. B. Allen, *ibid.* 16, 607 (1955).
12. F. R. Whatley *et al.*, *ibid.* 20, 462 (1956).
13. H. K. Schachman, A. B. Pardee, R. Y. Stanier, *Arch. Biochem. Biophys.* 38, 245 (1952); J. B. Thomas, *Koninkl. Ned. Akad. Wetenschap. Proc. Ser. C* 55, 207 (1952).
14. A. W. Frenkel, *J. Biol. Chem.* 222, 823 (1956).
15. A. M. Williams, *Biochim. et Biophys. Acta* 19, 570 (1956).
16. D. M. Geller and J. D. Gregory, *Federation Proc.* 15, 260 (1956).
17. D. M. Geller, doctoral dissertation, Division of Medical Science, Harvard Univ., 1957.
18. J. L. Mattick and E. S. Lindstrom, paper presented before the Midwest Section of the American Society of Plant Physiologists, Ann Arbor, Mich., June 1957.
19. E. C. Anderson and R. C. Fuller, *Plant Physiol. Suppl.* 32, xvi (1957).
20. J. W. Newton, G. A. Newton, M. D. Kamen, paper presented before the Midwest Section of the American Society of Plant Physiologists, Ann Arbor, Mich., June 1957.
21. M. Avron and A. T. Jagendorf, *Nature* 179, 428 (1957).
22. A. T. Jagendorf and M. Avron, *Plant Physiol. Suppl.* 32, iv (1957).
23. J. S. C. Wessels, *Biochim. et Biophys. Acta* 25, 97 (1957).
24. A. R. Krall and M. R. Purvis, *Plant Physiol. Suppl.* 32, iv (1957).
25. C. T. Chow and B. Vennesland, *ibid.* 32, iv (1957).
26. D. I. Arnon *et al.*, *Proc. Intern. Congr. Biochem., 3rd. Congr. Brussels, 1955* (1956), p. 227.
27. H. Gaffron, Ed., *Research in Photosynthesis* (Interscience, New York, 1957), pp. 293, 345.
28. M. B. Allen, F. R. Whatley, D. I. Arnon, *Biochim. et Biophys. Acta* 27, 16 (1958).
29. E. I. Rabinowitch, *Photosynthesis and Related Processes* (Interscience, New York, 1956), vol. 2, pt. 2, p. 1594.
30. A. T. Jagendorf and M. Avron, *J. Biol. Chem.*, in press.
31. K. Esau, *Plant Anatomy* (Wiley, New York, 1953), p. 414.
32. W. O. James and V. S. Das, *New Phytologist* 56, 325 (1957).
33. D. I. Arnon and F. R. Whatley, *Physiol. Plantarum* 7, 602 (1954).
34. O. Kandler, *Z. Naturforsch.* 12b, 271 (1957).
35. A. R. Krall, M. Avron, A. T. Jagendorf, *Biochem. et Biophys. Acta* 26, 431 (1957).
36. D. I. Arnon, M. B. Allen, F. R. Whatley, *ibid.* 20, 449 (1956).
37. C. B. van Niel in *Photosynthesis in Plants*, J. Franck and W. E. Loomis, Eds. (Iowa State College Press, Ames, 1949).
38. M. B. Allen *et al.*, *J. Am. Chem. Soc.* 77, 4149 (1955).
39. D. I. Arnon, F. R. Whatley, M. B. Allen, *Nature* 180, 182 (1957).
40. D. I. Arnon, F. R. Whatley, M. B. Allen, in preparation.
41. A. L. Lehninger, *Harvey Lectures Ser.* 49, 176 (1955); N. O. Kaplan *et al.*, *Proc. Natl. Acad. Sci. U.S.* 42, 481 (1956).
42. E. Marré and O. Servettaz, *Nuova giorn. botan. ital.* 64, 1 (1957).
43. N. O. Kaplan, S. P. Colowick, E. F. Neufeld, *J. Biol. Chem.* 205, 1 (1953).
44. M. Calvin, *J. Chem. Soc.* 1956, 1895 (June 1956).
45. R. H. Hageman and D. I. Arnon, *Arch. Biochem. Biophys.* 57, 421 (1955).
46. D. I. Arnon, in *Phosphorus Metabolism* (Johns Hopkins Univ. Press, Baltimore, Md., 1952).
47. M. Gibbs, *Nature* 170, 164 (1952).
48. D. I. Arnon, *Science* 116, 635 (1952).
49. D. I. Arnon, L. L. Rosenberg, F. R. Whatley, *Nature* 73, 1132 (1954); L. L. Rosenberg and D. I. Arnon, *J. Biol. Chem.* 217, 361 (1955).
50. O. Warburg and G. Krippahl, *Svensk Kem. Tidskr.* 69, 143 (1957).
51. J. A. Barltrop, P. M. Hayes, M. Calvin, *J. Am. Chem. Soc.* 76, 4348 (1954).
52. J. A. Bassham and M. Calvin, in *Currents In Biochemical Research*, D. E. Green, Ed. (Interscience, New York, 1956), p. 48.
53. R. A. Peters, H. M. Sinclair, R. H. S. Thompson, *Biochem. J.* 40, 516 (1946).
54. I. C. Gunsalus, *J. Cellular Comp. Physiol. Suppl. I* 41, 113 (1953).
55. R. Hill, *Symposia Soc. Exptl. Biol.* 5, 223 (1951).
56. O. Warburg, in *Heavy Metal Prosthetic Groups and Enzyme Action* (Clarendon Press, Oxford, 1949).
57. D. Keilin and E. F. Hartree, *Proc. Roy. Soc. (London)* 129B, 277 (1940).
58. D. E. Green, *Symposia Soc. Exptl. Biol.* 10, 30 (1957).
59. M. G. Stålfelt, *Physiol. Plantarum* 8, 572 (1955); O. V. S. Heath and B. Orchard, *Nature* 180, 180 (1957).
60. W. H. Elliott, *Biochem. J.* 49, 106 (1951); *J. Biol. Chem.* 201, 661 (1953).
61. O. Warburg, W. Schroder, H. W. Gattung, *Z. Naturforsch.* 11b, 654 (1956).
62. F. R. Whatley, M. B. Allen, D. I. Arnon, *Plant Physiol. Suppl.* 32, iii (1957).
63. D. I. Arnon, in *Encyclopedia of Plant Physiology*, W. Ruhland, Ed. (Springer, Heidelberg, Germany), in press.
64. F. R. Whatley, M. B. Allen, D. I. Arnon, in preparation.
65. T. P. Singer and E. B. Kearney, *Biochim. et Biophys. Acta* 15, 151 (1954); *Methods of Biochem. Anal.* 4, 307 (1957).
66. M. Mazelis, *Plant Physiol.* 31, 37 (1956).
67. A. San Pietro and H. M. Lang, *J. Biol. Chem.* 227, 483 (1957).
68. M. Avron and A. T. Jagendorf, *Arch. Biochem. Biophys.* 65, 475 (1957).

69. We were aided in this investigation by grants from the U.S. Public Health Service and the Office of Naval Research.

70. R. C. Fuller and E. C. Anderson, *Plant Physiol. Suppl.* 32, xvi (1957).
71. A. I. Oparin, in *Origin of Life* (Macmillan, New York, 1938); H. C. Urey, in *The Planets* (Yale Univ. Press, New Haven, Conn., 1952).
72. A. V. Trebst and D. I. Arnon, unpublished data.

Arlow B. Stout, Geneticist and Plant Breeder

Arlow Burdette Stout was born at Jackson Centre, Ohio, on 10 March 1876, and died at the age of 81 at his home in Pleasantville, New York, on 12 October 1957.

His youth was spent in a rural community at Albion, Wisconsin, where most of the surrounding land was still uncultivated and offered intimate contact with nature to an eager boy whenever duties on the farm permitted. His education came the hard way, as it did for many of his contemporaries. Beginning in a one-room country school he continued his education at a local academy (Albion Academy), at Melton College, and at the State Normal School at Whitewater, Wisconsin, with frequent interruptions for longer or shorter periods, as required by the need to earn money, usually by teaching. In the autumn of 1908 he entered the University of Wisconsin, from which he received the Bachelor of Arts degree in 1909. He remained at the university as instructor of botany until his appointment as director of laboratories at the New York Botanical Garden in 1911. He was granted the Doctor of Philosophy degree by Columbia University in 1913. He retired from the New York Botanical Garden in 1947.

The major direction of Dr. Stout's research interests was determined by his first formal instruction in botany. In a course at Albion Academy in 1895–96 he used Asa Gray's *How Plants Grow* as a text, and he was especially intrigued with the description of the process of seed formation. However, he was most surprised and perplexed to note, the following summer, that two plants in his family's garden produced perfect flowers but did not fruit. These plants were a cluster of the familiar day lily (*Hem-*

erocallis fulva) and a colony of the tiger lily (*Lilium tigrinum*). His curiosity, aroused by this observation, persisted through the years and led him to undertake extensive studies on sterility and fertility of flowering plants, including the day lily.

Dr. Stout's early major interests included ornithology and archeology, and his decision to pursue botany as a career was not made until he graduated from the University of Wisconsin. This decision was greatly influenced by R. A. Harper, then professor of botany at Wisconsin, and by Zelda Judd Howe, who became Mrs. Stout in 1909.

The 36 years he spent at the New York Botanical Garden were mainly devoted to research on plant breeding, cytology, and genetics, with particular reference to the problems of sterility and fertility of seed plants. He investigated various aspects of the breeding of apples, avocados, cherries, chicory, Chinese cabbage, coleus, day lilies, dates, grapes, lilies, lily-of-the-valley, lobelia, moss pink, narcissus, Norway maple, pears, petunias, poplars, white potatoes, and sweet potatoes.

An investigation of the irregular fruiting of avocado in California and in Florida resulted in the discovery of an extraordinary mechanism of cross-pollination. For seven years, beginning in 1924, he planned, directed, and (with E. J. Shreiner) participated in an extensive program of hybridization of the poplar tree, producing some hybrids with notable hybrid vigor. Studies of the sterilities of the white potato were carried out in cooperation with the U.S. Bureau of Plant Industry; some of the work was done at Presque Isle, Maine. In cooperation with the New York State Agricultural Experiment Station at Geneva, Dr. Stout began an investigation of seedless grapes, in 1919, which included studies of the nature of seedlessness and its heredity and breeding for hardy seedless grapes. These studies were continued until his retirement and resulted in the production of numerous seedlings with seedless or near-seedless berries, some of which evidenced considerable hardiness and promise for commercial use. His investigations of the day lily (*Hemerocallis*), begun in 1911 during his first year at the New York Botanical Garden, were continued throughout his life. They included studies of the taxonomy of the genus, interspecific hybrids, comparative cytology of species and hybrids, self- and cross-incompatibilities, and the selection of seedlings for garden culture. His investigations, besides contributing to knowledge of the phenomena of sterilities and the complexities of their genetics, transformed the day lily from a minor garden plant to one of the most varied and reliable of perennials. The results of his work were published in some three hundred and fifty papers.

After his retirement, he served as a consultant to seed growers, continued his breeding of *Hemerocallis,* published a monograph on *Petunia,* and engaged in a comprehensive study of *Rubus.*

All who knew him were aware of his dedication to science. Hours meant nothing to him. He asked only for the opportunity to devote his energies to those important unsolved problems which had aroused his curiosity. While deeply concerned with the theoretical and basic aspects of cytology and genetics, he appreciated the applied aspects of plant breeding and, like Pasteur, never hesitated to investigate a problem of practical importance, carrying the research as deeply into the fundamentals as time and facilities permitted.

Dr. Stout participated in the activities of the community in which he lived, and his sterling qualities, as a man as well as a scientist, were appreciated by his friends and neighbors, as well as by his colleagues.

He is survived by his wife; a daughter, Elizabeth B. Rausch of Orlando, Florida; a brother, C. D. Stout; and a granddaughter.

WILLIAM J. ROBBINS
New York Botanical Garden,
Bronx Park, New York

News of Science

Geothermal Power in California

Just a few miles north of Santa Rosa, Calif., at Big Geysers, a concern calling itself the Thermal Power Company is engaged in the somewhat exotic business of drilling bores in the rock to tap subterranean steam with a view to harnessing this natural energy for the production of electrical power. This concept of the economic development of geothermal energy is relatively new, for natural steam emanating from the earth in the form of geysers and fumeroles has been regarded traditionally as a scientific curiosity, and regions exhibiting such phenomena have been set aside as parks and tourist attractions. But in the last few years, a number of nations in many parts of the world have been re-evaluating their thermal areas as something more than mere spectacular scenery. For in our modern mechanized society with its great dependence on fossil fuels as energy sources, the doubling and redoubling of power requirements in the postwar years has placed a heavy strain on these patently exhaustible resources. As a result, energy sources which are essentially inexhaustible, such as falling water, nuclear fission, and geothermal steam, are receiving increased attention.

The theory supporting contentions that subterranean steam is a virtually inexhaustible resource is based on the conversion of both meteoric water and magmatic water to steam. Meteoric water, or ground water, contacting hot rocks near the surface is commonly held responsible for geyser phenomena and is certainly accountable for the occurrence of large quantities of steam; but it is magmatic water, reckoned at about 10 percent of the superheated earth's core and released upon cooling and crystallization of magma into igneous rock, that makes up the bulk of the steam reserve. Taking both of these sources into consideration, Italian scientists at Lardarello, Tuscany, where the pioneer project of this type has produced power for many years, have estimated that at the present rate of energy withdrawal from the proven geothermal area, reserves are sufficient for another 11,000 years.

However, despite the success of the Italian development and its expansion following the war, little attention had