# Armin C. Braun, 1911–1986

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Professor Emeritus Armin C. Braun of The Rockefeller University, died on September 2, 1986, three days before his 75th birthday. Dr. Braun was a preeminent plant biologist whose research with crown-gall tumors presaged the discovery of oncogenes in animal cancers and the application of recombinant DNA methods for genetic engineering of plants.

Dr. Braun was born on September 5, 1911, in Milwaukee, Wisconsin. He received a Bachelor of Science degree in microbiology and biochemistry in 1934 and a Ph.D. degree in plant pathology in 1938 from the University of Wisconsin-Madison. He completed his thesis under the direction of Professor James Johnson. During 1936–1937, he spent a study leave in Europe that included a stay in Germany in the laboratory of Dr. C. Stapp, who was a leader in research on bacteria as plant pathogens.

As a post-doctoral fellow in 1938 in the laboratory of Dr. L. O. Kunkel in the Department of Plant Pathology at The Rockefeller Institute in Princeton, he initiated investigations on crown-gall tumors induced by *Agrobacterium tumefaciens*. Dr. Braun was the first to demonstrate that secondary tumors arose both above and below the point of inoculation in stems of sunflower (*Helianthus annuus*). Furthermore, he found that the tumors that developed at points two or more nodes above the location of the primary tumor were free of the crown-gall bacteria. In collaboration with Dr. Philip White, he observed for the first time that rapid and continuous growth of tissue from the sterile secondary tumors of sunflower occurred on a basic culture medium that did not support the continued growth of normal sunflower cells. This simple yet seminal study demonstrated the concept of true autonomy in plant tumor cells.

With the knowledge that the Madagascar periwinkle (*Vinca rosea* L.) was extremely tolerant of high temperatures and also susceptible to the crown-gall disease, he inoculated periwinkle plants with virulent strains of the crown-gall bacterium, permitted the bacteria to act on the host cells for varying periods of time, then killed the bacteria by exposure of the host plants to temperatures of 46 or 47 C. These studies demonstrated that the transformation of normal cells of periwinkle into those of a rapidly growing, fully autonomous crown-gall tumor occurs gradually and progressively over a 3 or 4 day period. Cells transformed during a 34–36-hr period grew very slowly in the host and remained small. Those transformed during a 50–60-hr period were intermediate in their growth, whereas those transformed for a 72–96-hr period grew very rapidly. When these tumors were placed on White's basic culture medium, they grew and retained their characteristic growth properties indefinitely. These studies demonstrated clearly that different degrees of cellular transformation could be achieved experimentally and that once established, transformed cells maintained these characteristics. Furthermore, tumorous growth was shown to result from the activation of biosynthetic systems involved in production of growth hormones and related compounds. Thus, crown-gall tumor cells were shown to possess certain essential characteristics of malignant animal cells and the crown-gall disease could serve as an experimental model for investigating the basic cellular mechanisms that generally underlie neoplastic growth.

Dr. Braun initiated several other important studies concerning the reversibility of the tumorous state, grafting cloned teratoma tumor shoots to the cut stem tips of Turkish tobacco plants. Under optimal conditions the teratoma shoots developed quite normally and some flowered and produced viable seed. The seeds, when planted, gave rise to normal plants.

These simple, elegant experiments demonstrated that the cancerous state is reversible and that the genetic information present in many different types of tumor cells can be reprogrammed to cause them to revert to the normal state. The implication of these observations related not only to the basic nature of cancer but pointed to possible new avenues of approach for the control of cancerous growth.

In pioneering investigations on the nature of a nonhost specific toxin, Braun found that the toxin of *Pseudomonas syringae* pv. *tabaci*, the bacterium that causes the wildfire disease of tobacco, was not essential for pathogenicity of this organism. Furthermore, nontoxin forming mutants could not be distinguished in physiological tests from another bacterium described initially as a different species (the cause of angular leaf of tobacco spot *Pseudomonas angulata* now *P. syringae* pv. *angulata*). As this research progressed, the wildfire toxin was isolated in pure form and characterized in cooperation with Dr. D. W. Woolley. This was the first record of the identification and purification of a specific determinant of a plant disease.

Dr. Braun's research career was interrupted by World War II, in which he served as a pathologist in the Army Medical Corps in Belgium. Subsequent to his return to The Rockefeller Institute, the Princeton Division was sold and the Laboratory of Plant Pathology was moved to New York City, the original site of The Rockefeller Institute for Medical Research. Dr. Braun was named Head of the Laboratory of Plant Biology in 1955 and member and Professor of the Institute in 1959. He received Emeritus status in 1981.

The results of Dr. Braun's life's work and his general observations on the nature of cancer in animals, plants, and humans are documented in three books, The Cancer Problem: A Critical Analysis and Modern Synthesis (1969), The Biology of Cancer, (1974), and The Story of Cancer: On Its Nature, Causes and Control (1977). Dr. Braun was also the author of more than 100 scientific papers.

Dr. Braun was elected to membership in the National Academy of Sciences in 1960 and the American Academy of Arts and Sciences in 1966. He was awarded the Newcomb Cleveland Award of the American Association for the Advancement of Science in 1949. In 1965, he was in the first group of distinguished plant pathologists to receive the Fellow Award by the American Phytopathological Society for outstanding research and service contributions and in 1982 he was a co-recipient with Nobel Laureate Barbara McClintock of the Charles Leopold Mayer Prize, the highest award of the French Academy of Sciences.

Although Dr. Braun was not involved in the presentation of formal courses, he welcomed a number of young investigators to complete research projects in his laboratory. Because Dr. Braun dedicated himself, in an exemplary manner, to resolution of complex problems, he served as a superlative role model for those scientists who were fortunate to have the opportunity to work with him. Dr. Braun's ability to identify the key aspects of a research problem was remarkable, and the experiments designed to solve a problem were elegant in concept and execution. His legacy is delineated in the final paragraph of the last paper that he wrote. "It is most gratifying indeed for one who has spent a lifetime studying plant tumors to see that the concepts developed with the use of those relatively uncomplicated systems find application, and not only contribute to an understanding of cancer as a fundamental biological problem, but provide as well a model for the genetic engineering studies now being so actively and enthusiastically pursued in laboratories around the world."