

two markets, the differences in the proportion of innovations representing an advance lends initial support to the hypothesis that monopoly is a necessary condition for progress. But examination of the development of the broad spectrum market and its operation weakens this conclusion.

TABLE III.—PRODUCT INNOVATION IN THE NARROW AND BROAD SPECTRUM ANTIBIOTIC MARKETS

Year	Narrow spectrum innovations	Broad spectrum innovations
1945.....	1	.....
1946.....	1	.....
1947.....	2	.....
1948.....	1	1
1949.....	1	1
1950.....	3	1
1951.....	1	.....
1952.....	1	.....
1953.....	2	1
1954.....	2	.....
1955.....	3	.....
1956.....	.....	.....
1957.....	3	.....
1958.....	3	.....
1959.....	.....	.....
1960.....	3	.....
1961.....	.....	.....
1962.....	2	.....
1963.....	1	.....
1964.....	2	.....
1965.....	2	.....
Total.....	34	4

The origins of the antibiotics are found in Alexander Fleming's discovery of penicillin in 1928 and in the development research undertaken by a group headed by H. W. Florey in England in the late 1930's. England's involvement in the war and problems of mass producing penicillin caused Florey to seek commercial sources of supply in the United States. The majority of firms contacted by Florey expressed little interest in pursuing the research necessary for large scale production. But he was successful in his contact with the Department of Agriculture's Northern Regional Research Laboratory (NRRL). With the entry of the United States into the war a cooperative program was instituted by the Committee on Medical Research (CMR). The program included a number of drug firms, university and government laboratories, as well as laboratories in England. The commercial laboratories of the drug firms initially concentrated their research on the synthetic production of penicillin,⁵ while the noncommercial laboratories concentrated on the problem of mass production. The development of improved mold strains by the university laboratories and the 'deep fermentation' production process by the NRRL essentially solved the key problems of mass production.⁶

By the mid-1943 the CMR shifted the emphasis in the penicillin program from research to production. To overcome the reluctance of the firms to abandon their synthetic research and adopt the available technology, the program was expanded to include firms not initially under contract with the government

⁵ It has been argued that the drug firms concentrated on the synthetic approach at the expense of the production technology suggested by the NRRL. The reason offered for this approach was that product patents were unavailable on penicillin, and the Department of Agriculture held the key process patents. Richard Harris, *Annals of Legislation, the Real Voice*, The New Yorker, for March 14th, 21st and 28th, 1964. Especially page 69 of the March 14th issue, "... the firms were too busy trying to corner patents on the various processes in the production of penicillin to produce much of it, and the government began to press them to work together." A similar conclusion was reached in Federal Trade Commission, *Economic Report on Antibiotic Manufacture* (Washington, Govt. Printing Office, 1958), pp. 37-38. In defense of the firms involved it should be noted that historically, the synthetic production of drugs had made the 'natural technology' obsolete. For a description of Merck's experience and others see, Tom Mahoney, *The Merchants of Life* (New York, Harpers, 1959), Chaps. 11, 13, 16.

⁶ Until the mid-1940's penicillin was produced by two methods. The less efficient 'surface technique' involved the growth of penicillin on the surface of the culture medium. With the 'deep fermentation technique' the medium was aerated allowing growth throughout the medium.