shuttles along metabolic pathways—even as it is incorporated into different biochemical compounds. Naturally enough, then, many of the earliest uses of radiotracers were in explorations of life's intricate biochemistry. During the AEC era, both carbon-14 and tritium (hydrogen-3) were used in notable experiments to trace metabolic pathways in animals and plants, and the utility of these isotopes as research tools continues today. Carbon and hydrogen are ubiquitous constituents of biomolecules, and the radioactive versions of these atoms do not alter the chemistry of life. Among the most celebrated of such metabolic studies was the unraveling of the complex cycles of photosynthesis, the process by which green plants convert atmospheric carbon dioxide and water into sugar. For this AEC-sponsored work, Berkeley chemist Melvin Calvin received the 1961 Nobel Prize for Chemistry.

More recently, studies with metabolic tracers have turned especially to the human heart and brain. But to make such studies possible, better ways were needed to "see" just where the tracers were.

Slices of Life: Medical Imaging

All that has been said about radioisotopes as tools for medical diagnosis and as keys to the mysteries of plant metabolism and

1938 Also in Berkeley, Glenn Seaborg (a future chairman of the AEC) and Emilio Segrè discovered technetium-99m. Berkeley's cyclotrons would also produce the first iodine-131, carbon-14, thallium-201, and gallium-67. Seaborg and Segrè would both win Nobel prizes for later achievements.

1946 Nuclear medicine's modern era began with the announcement in the June 14, 1946, issue of *Science* that radioactive isotopes from the Oak Ridge nuclear reactor, a secret wartime facility, were available to qualified researchers.

1947 Benedict Cassen at UCLA used radioiodine to determine whether a thyroid nodule accumulated iodine, a key to differentiating benign from malignant nodules.

1948 John Gofman and his colleagues at the University of California's Radiation Laboratory began ultracentrifuge studies that would allow them to identify the macromolecules involved in the development of atherosclerosis. This work would be largely responsible for focusing the world's attention on the role of cholesterol and lipoprotein patterns in coronary artery disease.

MEDICAL SERENDIPITY

■ It is a truism of scientific research that some of the greatest discoveries emerge as surprising revelations of research with its sights set elsewhere. Examples abound in the biological research supported by the DOE and its predecessors. Sodium's role in contributing to high blood pressure, for example, was revealed at Brookhaven in the early sixties during studies that were focused on another metabolic issue altogether—the retention of radioactively labeled salt in rats. Also at Brookhaven in the late sixties, the successful application of L-dopa as a medication for the treatment of Parkinson's disease was a tangential product of brain function studies using radioactive manganese. Following early clinical trials, a *New England Journal of Medicine* editorial in 1969 described this discovery by George Cotzias (pictured) as "the most important contribution to medical therapy of a neurological disease in the past fifty years." Today, second-generation drugs based on this research are the treatment of choice for tens of thousands of Parkinson's sufferers in the U.S. alone. ■ Another example of unexpected, though not entirely serendipitous, ramifications is the emergence of organ transplantation as a mainstream medical procedure from early research on irradiated mice. In the fifties, it was known that mice exposed to usually lethal doses of radiation survived if the damaged blood-forming cells of their bone marrow were replaced with healthy marrow. In 1954, however, Oak Ridge researchers showed that rat marrow could be used to save the mice as well. Contrary to conventional wisdom, the alien donor cells were not rejected by the host. This demonstration of immunosuppression, in this case induced by radiation, triggered a renaissance of thinking about tissue and organ transplantation. Further development of immunosuppressive techniques led to successful bone marrow transplantation for the treatment of leukemia and other diseases—and eventually to the practicality of kidney, heart, liver, and other organ transplants in humans. The ground-breaking work at Oak Ridge was one of the starting points for these striking developments, which would culminate in 1990 with the Nobel Prize for Physiology or Medicine, awarded jointly to Joseph Murray and Donnall Thomas. ■