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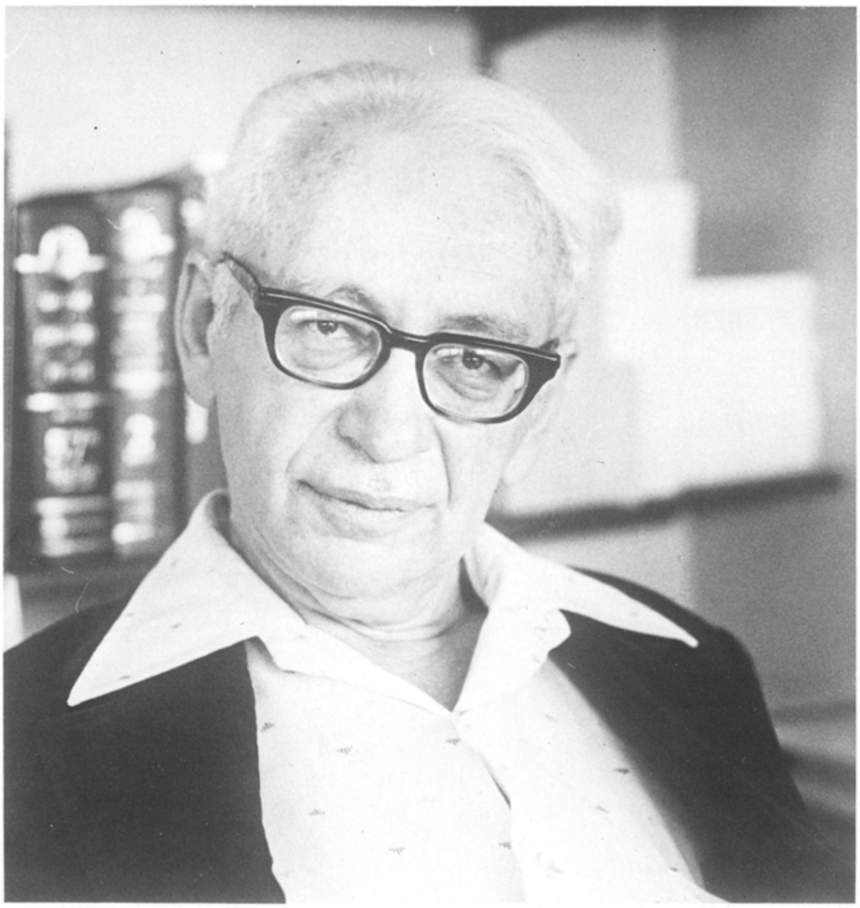
In Memory of Efraim Racker



Efraim Racker

1913–1991

After a long Saturday in the lab, Efraim Racker suffered a stroke and died two days later, September 9, 1991, at the age of 78. This is the sort of death Ef would have chosen for himself. Born in Poland and educated in Vienna, he received his M.D. degree in 1938 and soon thereafter fled the German occupation to Cardiff, Wales. He emigrated to this country in 1940 and over the next 14 years worked in Minneapolis, New York City, and New Haven. In 1954, he moved to the Public Health Research Institute of New York, where he stayed until 1966, finally joining the Cornell faculty as Albert Einstein Professor. He was an associate editor of this journal since its founding.

His work had multiple flowerings. In the early 1950's, a time when biochemistry was virtually synonymous with energy metabolism, Ef (a youngster challenging Otto Warburg) proposed and nailed down the first mechanism by which an enzyme captures the free energy of an oxidative reaction and uses this for ATP synthesis. He remained proud of having unraveled "substrate-level oxidative phosphorylation" mediated by glyceraldehyde-3-phosphate dehydrogenase. As it turned out, the simplicity and elegance of this mechanism seduced an entire field into imagining that *mitochondrial* oxidative phosphorylation works in analogous ways, an idea that led bioenergetics into a doomed search for the "high-energy intermediate" between NADH oxidation and ATP formation. Over the next 20 years, this field became increasingly frustrated, and hence increasingly vituperative in its ever-contracting controversies. The ox-phos deadlock was broken when Peter Mitchell provided the idea of chemiosmotic coupling, and Ef showed experimentally that mitochondria actually work this way, that the high-energy intermediate is, in fact, a transmembrane electrochemical gradient for protons.

To do this, Ef had to step out of the paradigm of energy coupling he had created for glycolysis and simultaneously to create a new approach: membrane reconstitution. Taking seriously the idea that an intact membrane is necessary for mitochondrial energy conservation, Ef forged a magnificent series of experiments in which the key oxidative enzymes of mitochondria were picked one by one out of their native membrane and placed, along with the mitochondrial ATPase complex, into well-sealed liposomes. These reconstituted membranes were at last competent to catalyze oxidative phosphorylation. Old ideas die hard, and these experiments met with the usual objections (enzymes not 100% pure, possibility of side reactions, etc.). So Ef, along with Walther Stoeckenius, cut the Gordian knot by demonstrating light-dependent ATP synthesis by liposomes reconstituted with only ATPase and bacteriorhodopsin. Chemiosmotic coupling became the new paradigm, and membrane transport was placed at the very core of metabolic biochemistry.

Through the 1970's, Ef happily exploited the many spinoffs of membrane reconstitution, carrying out work on other membrane transporters. His lab was home to the first functional reconstructions of purified ATP-driven pumps (Ca^{2+}-ATPase) and ion channels (nicotinic acetylcholine receptor). Always aware that reconstitution is only a means to a mechanistic end, Ef used these minimal systems to attack basic questions, such as modulation of transport function by lipids or phosphorylation. Indeed, long convinced that phosphorylation was somehow involved in cell growth, he became interested in oncogenes and in 1986 enrolled as a student in a summer course in recombinant DNA methods. In the last few years, he had been working on the role of chaperonins in protein folding and membrane targetting.

Beyond a body of classic work, Ef leaves us with many examples of the best spirit of scientific research. He loved argument for its ability to plow up and ventilate the scientific earth; a gifted painter and an incompetent cellist himself, he showed how artful science is, illustrating the impalpable mix of right-brain intuition with left-brain analysis that is so essential for fundamental understanding. He set the standard for correct behavior when, in 1981, he was victimized by fraudulent data-handling in his own lab; he even went so far as to ask the Editor of this journal to take his name off the roster of the Editorial Board, until the situation was cleared.

Friends, students, colleagues, and adversaries alike will miss him; he leaves behind a lasting, enriching stamp on the practice of biochemistry, including a bagful of pointed aphorisms, the most-quoted of which is ''Don't waste clean thoughts on dirty enzymes.''

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