essing this crop on a large scale.

Sugarcane-derived alcohol, mixed with gasoline, has been fueling passenger cars in Brazil since 1930. Today, thanks to the PNA, Brazil annually produces 12 billion liters of sugarcane alcohol—enough to run almost 4 million cars. Since 90 percent of Brazilian-made cars are fueled solely by alcohol, the automobile and petroleum industries are essentially separated. Indeed this separation was a major goal of the PNA. In 1980, Brazil spent half of its export income of US$24 billion to import petroleum. Today it exports oil instead, and the sugarcane-industrial complex accounts for about 4 percent of the country's Gross National Product.

A number of factors have contributed to this extensive utilization of sugarcane as an energy crop—long experience in its cultivation coupled with considerable mechanization and fertilizer use, institutional and financial subsidies to well organized cooperatives, a national program for sugarcane improvement (PLANALSUCAR), and importantly, a relatively favorable energy balance for ethanol conversion. Indeed, the current yields of 50 tons/ha/year could be even further improved through the introduction of new varieties and a streamlining of the plantation systems now used.

Yet the PNA is not without its critics. They argue that the government's obligation to protect sugarcane prices is necessarily an impediment to increased productivity, and that with falling oil prices Brazil's balance of liquid fuels is skewed—gasoline surpluses (50 percent of the total production) are exported and diesel oil is in short supply. Moreover, there are concerns about the displacement of food crops, the concentration of land ownership and income, and the environmental impacts of the fertilizers used to grow the sugarcane as well as the by-products of its ethanolic fermentation.

Much of this criticism might be answered if ethanol were produced on a large scale from a subsistence crop like cassava. The current yields of 15 tons/ha/year could be doubled easily by better planting methods, seed selection, disease control and mechanization. At the same time, biotechnological research can help to simplify the alcohol transformation thus accelerating cassava's use as a real alternative energy crop.

—Milton Campanario

Milton Campanario is a professor at the University of São Paulo, and the Institute of Technological Research.

IN MEMORIAM

PROFESSOR EMIL THOMAS KAISER

NEW YORK—The Rockefeller University's Haggerty Professor, Emil Thomas Kaiser, passed away on July 18 of complications due to a recent kidney transplant. His untimely death, at the age of 50, terminated an outstanding research career.

Predicting a protein's structure from its amino acid sequence is difficult: Kaiser approached the issue by analyzing first the constituent parts of an enzyme's structure, then the whole. Although the first rationally designed enzyme is still far from complete, Kaiser made significant progress toward this goal.

IMAGE UNAVAILABLE FOR COPYRIGHT REASONS

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"When I reflect on where the application of chemistry to proteins has taken us, I cannot help but express my feeling that the period ahead of us is a very special one. For a scientist at the present time, the excitement of being able to tame the chemistry of proteins could have its parallel in the exhilaration felt by an artist during the Renaissance."*

As part of the effort to determine enzyme reaction mechanisms, Kaiser also modified existing folded structures to create new catalytic species. For example, by covalently attaching a flavin analog in or peripheral to the binding pocket of known enzyme templates, he created semisynthetic flavoenzymes that perform as redox catalysts—the first was flavopapain.

Designing new proteins requires understanding what effects—if any—the amino acid side chains have on the final structure and activity. Kaiser reasoned that, at least in certain systems, the specific side chains were of limited importance. As long as the global characteristics of a native sequence's folded structure are maintained, nonhomologous peptide analogs should retain their activity. Kaiser tested this premise primarily in model peptide hormones that were predicted to form alpha-helical structures in the amphiphilic environment of their receptors. He designed analogs whose amino acid sequences had minimal homology to the native sequences and a higher helix-forming propensity—but still retained the same global amphiphilic surface and distribution of charged side chains as their prototypes. By modeling systems such as beta-endorphin, calcitonin, and serum apolipoproteins, he was able to create peptides with little homology to their prototypes, but with comparable biological activity. Moreover, these experiments demonstrated that a peptide's correct secondary structure could be induced by the amphiphilic environment of biological interfaces.

To design tertiary structures, Kaiser substituted nonhomologous, but globally similar, peptide sequences for the secondary structures of known folded proteins—reasoning that a similar tertiary structure would result. He prepared these novel proteins by chemically synthesizing peptide segments. He developed a means to attach the first amino acid of a growing segment to a solid support via an oxime linkage, from which the fully protected peptides could be cleaved, purified, and characterized. Incorporating the pure segments into the growing chain results in the rapid synthesis of a protein of enhanced purity. Chemical synthesis is fast and versatile. A 44-residue model of serum lipoprotein A-1 and a 60-residue DNA-binding fragment of a homeo box protein have already been synthesized and evaluated.

It was not only Kaiser's academic excellence that attracted investigators to his laboratory: his personal qualities were at least as important. He treated all his peers and colleagues with grace and deference. As a research director, he was always patient and supportive, often allowing students to pursue independent projects of their own interest and design. Kaiser believed an unfettered atmosphere fostered the creativity that leads to unforeseen scientific advances. All the members of his group held him in high regard, and the outpouring of sympathy from the scientific community worldwide is a measure of their personal and professional esteem for him.

—Edward W. Boyer

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