leased by the burning of fossil fuel. If we only wanted to stabilize the greenhouse effect, and not reverse it, we could probably get away with planting enough trees to absorb only 3 billion tons of carbon—since this is actually the amount of carbon that is accumulating in the atmosphere every year. The rest of the carbon released by burning forests and fuel is apparently being absorbed by the oceans and other carbon sinks.

In fact, this more optimistic approach is how Myers does his homework. Myers estimates that the new forests would only have to absorb about 3 billion tons of carbon annually. This assumes that global deforestation is largely halted, a hopeful assumption that Marland does not share in his study. Myers also bases his calculations not on the carbon-fixing ability of the American sycamore, but on a tropical species of eucalyptus or pine, which could absorb about 10 tons of carbon per hectare per year versus the 7.5 tons absorbed by Marland's sycamore.

The bottom line for Myers is that we would still have to plant 3 million square kilometers of trees, an area roughly equal to the landmass of Zaire.

Of course, there is another little problem. Using forests to store carbon is a temporary solution at best. Sooner or later, the carbon stored in the woody mass of trees must be released, says Marland. Even if some of the trees are made into furniture or kept from rapidly rotting, all wood eventually decays, and in the process gives back its carbon. Myers suggests that we might store some of the trees underground or stick them at the bottom of the ocean. Marland thinks the extra trees could be used to generate power, thereby replacing fossil fuels. More study on these options is clearly needed.

Everyone, too, points out that reforestation would only be one of several tools for mitigating the greenhouse effect. And indeed, without stopping or slowing the deforestation that is consuming millions of hectares of tropical forest every year, talking about reforestation seems out of touch with reality. Indeed, in any discussion of reducing greenhouse gases, increasing energy efficiency, and reducing our dependence on fossil fuels usually takes a front seat over reforestation.

Still, in an address before the recent meeting of the American Institute of Biological Sciences in Davis, California, Thomas Lovejoy of the Smithsonian Institution, suggested that reforestation is one way to bring atmospheric carbon under control. But it is not the cure. "What this buys is time—time to develop a better management of energy use and reduction of dependence on carbon-based fuels," says Lovejoy.

■ WILLIAM BOOTH

# American Parallel for Oxford Research

*Biochemistry and pharmacology departments find funds and model for research arrangements in United States*

*Oxford*

OXFORD UNIVERSITY, like most other universities in Britain, has been looking for industrial funding in recent years to help make up for declining support from the government. So far, it has found some of its biggest supporters across the Atlantic.

Last fall, the U.S. pharmaceutical company E. R. Squibb announced that it was making a 7-year, $34-million research grant to Oxford's Department of Pharmacology to support long-term research into various aspects of the influence of chemicals on the activity of the brain.

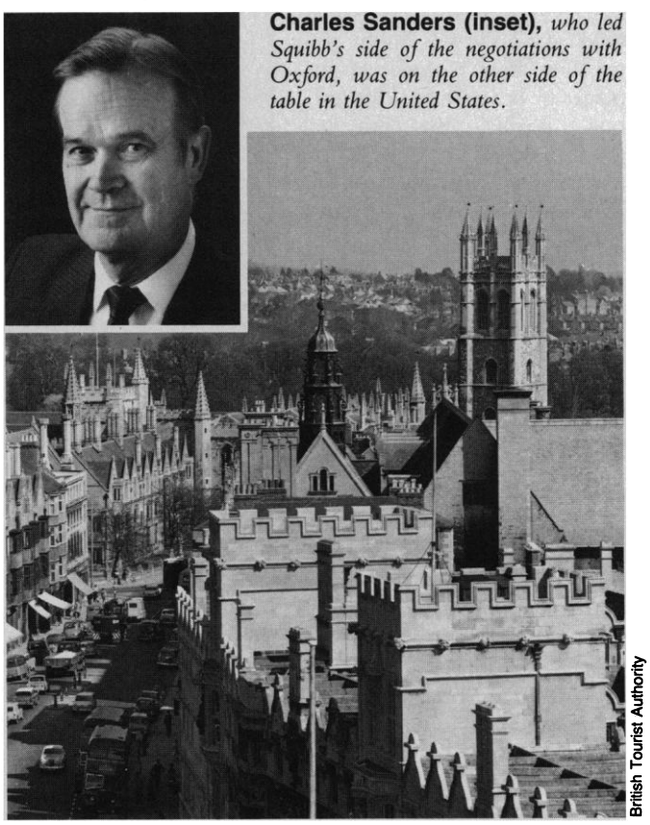
The grant, the largest of its type ever awarded to the university, is similar to a $50-million grant received by Massachusetts General Hospital from the West German company Hoechst under an agreement reached in 1980. The resemblance is not mere coincidence.

Pharmacology professor David Smith, who was largely responsible for attracting the U.S. money to the department, says that the terms of the arrangement are based, albeit loosely, on those of the Hoechst/MGH deal (which he says he gleaned originally from an article in *Science*, 11 June 1982, p. 1200). Moreover, Squibb's side of the negotiations were led by the company's executive vice president for science and technology, Charles Sanders. It was Sanders who, in his former position as general director of MGH, was largely responsible for negotiating the U.S. medical school's arrangement with Hoechst.

The Squibb grant follows a path first explored at Oxford by another U.S. company, Monsanto. Five years ago, Monsanto made a long-term grant, currently worth about $2 million a year, to scientists working in the university's department of biochemistry on the structure and functioning of the sugars attached to proteins.

Both grants are relatively unusual for Britain in that—like the Hoechst arrangement with MGH—the companies have not specified in advance particular problems they want solved or drugs that they need help in developing. Instead, they are leaving the choice of research topics up to the scientists they support. In return, the companies will be given the rights to any potentially profitable results to emerge.

The Monsanto-sponsored research has already led to several patented inventions, such as tissue plasminogen activator that includes, for the first time, in a patent a detailed description of the sugars attached to the TPA molecule. It has also spawned a novel arrangement for commercializing the research. The university, Monsanto, and the researchers themselves each have an equity



**Charles Sanders (inset),** *who led Squibb's side of the negotiations with Oxford, was on the other side of the table in the United States.*

British Tourist Authority

interest in a new company, Oxford Glycosystems, that will work on a variety of related activities ranging from the sequencing of sugars on a contract basis to techniques for diagnosing rheumatoid arthritis.

Squibb is supporting research by members of the Department of Pharmacology in an area where the potential markets lie even further into the future, namely drugs that work by influencing specific regions of the brain. "It was one of those fortunate things," says Smith. Squibb had just made a decision to go into neuropharmacology when Smith invited the company, along with 22 others, to send representatives to a seminar at the department in the fall of 1985.

The few British companies represented at the seminar sent relatively low-level research officials, Smith says. In contrast, the American and Japanese companies sent senior executives, usually their vice presidents responsible for research.

Half the Squibb money will be used for a new 50,000-square-foot laboratory building, planned for the same site as one to be constructed by the Medical Research Council (MRC) for its Anatomical Neuropharmacology Unit, which is also directed by Smith. The other half is being used to support basic research in five specified fields: degenerative diseases of the nervous system, such as Parkinson's and Alzheimer's disease, epilepsy, psychoses (in particular schizophrenia), central nervous control of blood pressure, and control of the autonomic nervous system.

Research proposals originating in the department in each of these areas must be submitted to the company. If accepted for funding by Squibb, the research becomes subject to confidentiality and commercial clauses agreed with the department. If rejected, or only partially accepted, the department remains free to seek funding from other sources—though not from Squibb's competitors.

The arrangement contains some standard conditions. All results of research funded by the company must be submitted to it prior to publication in the scientific literature. The company can ask for a delay in publication of up to 6 months. And those receiving the company's research funds must sign a written pledge not to discuss results that might compromise its commercial interests—that is, before they have been patented.

Less usual is the fact that the company will hold the intellectual property rights (and not just an exclusive license) to the research that it pays for, with the university receiving a royalty on eventual sales. In return, the university has obtained an obligation from the company to exploit any inventions arising from the research. According to Sanders, the development work on any new drugs or other pharmaceutical products that emerges from the research will be carried out at the company's own institute of medical research in Princeton, New Jersey.

Not everyone in the university is happy about the implications of either the Monsanto or Squibb agreements. "At first, Oxford did not like what we were doing," says Raymond Dwek of the Oxford Glycobiology Unit, referring to the Monsanto agreement. "In particular, there was opposition from those who said that we were selling out to the Americans." Much of the original opposition, however, has since died down.

Smith notes that Squibb is funding "really way out, risky basic research, the sort of thing that universities are good at." He adds that income from the grant will help maintain the department's overall research program, since part of it will go toward overhead costs. British research councils do not pay overhead costs of university research they fund; instead, these indirect costs are supposed to come out of the government's already overstretched direct grant to the university. "If we had not got this Squibb deal, I would soon have had to stop my staff applying for MRC grants," says Smith.

Recent cutbacks in government funding have already forced Oxford University to dip into its reserves to avoid a deficit on its $190-million annual budget. And, as the university prepares to launch a $350-million appeal (using tactics which the organizers freely admit have been borrowed from U.S. counterparts such as Harvard and Princeton), both the Monsanto and Squibb grants are being used to promote the image of Oxford as a modern scientific university geared to the needs of high-tech industry.

"Despite our record in research, we still suffer from a reputation of not being a science university," says development officer Henry Drucker. "It is something that we have to fight against; reputations take a long time to catch up with reality, which is one reason we are pleased to see major companies entering into research contracts with the university."

As elsewhere in Britain, industrial interest has recently blossomed around the university's activities in molecular biology. For example, a newly created company, British Biotechnology Ltd., which has already established a significant market in the United States for reagents under the label "Designer Genes," has recently bought the rights to a technique that could lead to an AIDS vaccine.

The technique was developed by Sue and Alan Kingsman of the university's biochemistry department, and, in a gesture toward strengthening university-industry links, Alan Kingsman has been allowed to combine his university post with a position as the company's associate director of research.

More developments are expected to emerge from two initiatives that have been taken by the university itself. One has been the setting-up of an industrial liaison unit responsible for developing greater industrial support for the university's research efforts.

The second is the creation of a new company, Isis Innovation. Launched at the beginning of September by Kenneth Baker, Britain's Secretary of State for Education and Science, the company has been given the task of finding commercial outlets for scientific ideas developed at the university.

The various initiatives being taken by the university to establish industrial and commercial links are exactly the kind of moves the government has been encouraging universities to take. Their benefits will not be evenly distributed, however. As Smith himself points out, while the pharmacology department has been able to benefit from industrial contracts, others such as anatomy and physiology "do not have the same chances," and are therefore likely to face increasingly serious funding problems. According to Drucker, guaranteeing the long-term support for such activities will be one of the principal aims of the fund-raising appeal when it is launched next month.

■ **DAVID DICKSON**

# Gene Therapy OK'd

The National Institutes of Health advisory committee on human gene therapy this week approved an experiment to insert genes into the cells of terminally ill cancer patients in an attempt to measure the effectiveness of treatment. It is the first time NIH advisers have given their blessing to this kind of study. The test, which is expected to be carried out on no more than ten patients who are likely to die within 3 months, will be conducted by Steven A. Rosenberg of the National Cancer Institute and W. French Anderson of the NIH's heart institute.

Rosenberg has pioneered cancer therapy using tumor infiltrating or TIL cells, a type of white blood cell that shows promise in attacking certain cancers. Using Anderson's gene therapy expertise, the two physicians plan to attach a gene for the antibiotic neomycin to the TIL cells and use it as a marker to trace the course of TIL cells into tumors. Final pre-test approval must still come from the director of NIH and the Food and Drug Administration.

■ **BARBARA J. CULLITON**