gram, over how much it will restrict itself to the direct support of basic science, and how much it will venture into providing funds for the development of the "key technologies" required by biological research.

In particular, no clear decision has yet been made on whether the program should support research and development in advanced genome sequencing technology. Early descriptions suggested that it would; and one of the strongest supporters of the program has been Akiyoshi Wada, professor of physics at the University of Tokyo, who has been promoting an international project to develop a "super-sequencer" capable of reading 1 million bases a day, at a cost of 1 cent per base.

Furthermore, Victor McKusick of the Johns Hopkins Medical School says he has been told that human frontiers program funds may be made available to support the creation of an international Human Genome Organization, currently under discussion as a way of coordinating scientific activities in the three continents.

So far, however, companies and research teams developing their own sequencing technologies have been reluctant to enter into cooperation with those they feel could soon become their commercial competitors. The final version of the feasibility study makes no specific reference to genome sequencing, merely saying that research on technology for DNA analysis "might be included."

Nor is there any precise indication of how scientists from nonsummit countries—including where appropriate those from the developing nations—or those who might share an interest in the outcome of the research are likely to be involved.

Given the continuing uncertainties over what will emerge from the program, the six other nations, together with the Commission of the European Economic Community, represented at the economic summit are each holding back before deciding whether to commit any of their own funds directly to the human frontiers program. Almost all have now said that they are prepared to contribute "in kind," however.

Thus the ball now rests firmly in the court of Japan's Ministry of Finance. And the Ministry's reaction is itself said to depend heavily on the energy with which Prime Minister Noboru Takeshita—like his predecessor Nakasone, a keen supporter of the program in public—can be persuaded to follow through on the expressions of interest gathered from the other six leaders at last week's summit meeting.

■ **DAVID DICKSON**

Additional reporting was provided by Don Kirk, a free-lance writer based in Bonn.

U.S.–Japan Science Pact Signed

The United States and Japan have formally agreed to a framework on cooperation in science and technology, pledging to provide "comparable access" to each other's government-sponsored research and to make "equitable contributions" to the relationship. The agreement caps year-long negotiations between the two countries in which the United States has pressed the Japanese to reciprocate American openness in access to research and shoulder a greater share of basic research funding (*Science*, 1 January, p. 13; 31 July 1987, p. 476.).

The pact was signed by President Reagan and Japanese Prime Minister Noboru Takeshita on 20 June during the economic summit in Toronto. It replaces a joint agreement signed in 1980. The new agreement substantially expands cooperation into several broad new areas, including superconductivity, sets up three committees to implement the agreement, and lays down rules for handling intellectual property rights and potentially sensitive military information that might arise from joint research.

But it is most notable for the principles agreed to on the issues of access to government-sponsored research and funding of fundamental research, which, during the past couple of years, have become an increasingly sore point among American science leaders. While American government and university laboratories have been open to Japanese researchers, Americans have felt blocked from Japanese labs.

Solutions to the problem have been complicated by the fact that the structures of American and Japanese basic research are so different. In the United States, about half of all research and development is funded by the government while the Japanese government supports only about 20%. Japanese industry funds 80% of the country's total R&D.

With that in mind, the new agreement is limited in its impact because it applies only to government-sponsored research, not corporate. Nevertheless, said White House science adviser William Graham in an interview with *Science*, "The agreement is trailblazing. It will do a great deal to redress an imbalance of the past. The real accomplishment here is that we did bridge a gap between our structural differences. The agreement is quite different from the previous agreement in that it's a stronger statement of imperatives of cooperation."

Negotiators very carefully chose the word "comparable" to describe the kind of access the two countries are committed to providing. The word is meant to take into account the countries' different research structures and to convey their intention to provide equivalent access in a qualitative sense, rather than numerical. Under this concept, if a Japanese scientist conducts research at the National Institutes of Health, the United States might request access to a laboratory in another field. The word comparable is meant to avoid the idea that there should be a strict one-to-one exchange of visiting Japanese and American scientists.

Under the new agreement, the two countries plan to conduct joint research in the life sciences, including biotechnology, information science, manufacturing, automation, global geosciences and environment, joint database development, and advanced materials.

The inclusion of superconductivity as a topic of joint research is noteworthy, given that Graham barred foreign companies from a national conference on superconductivity held almost a year ago. Graham said, "This agreement deals with research and scientific aspects of superconductivity, not commercialization" as the conference did.

The two governments also settled their differences on language acknowledging the need to protect information related to national security interests. Japan had vigorously objected to an American proposal to refer to military research in the pact because the agreement covers only basic research for peaceful purposes. To the Japanese, it was important to maintain a clear separation between military and civilian research. In a letter issued with the agreement, both countries agreed that if militarily sensitive information "is unexpectedly created" by joint research, it may "be protected from unauthorized disclosure."

Kaname Ikeda, science counselor at the Japanese embassy in Washington, D.C., said in an interview, "This is a well-designed agreement. Now we need to have a good environment so we can implement it successfully and in a productive manner."

■ **MARJORIE SUN**