and reduce the credibility of the research." But GAO acknowledged that this was no panacea because a researcher might well receive payments from interested parties for services outside the scope of the NSF grant, or he might do work for those parties before or after the period of his NSF grant. The GAO's chief recommendation for ensuring the quality of policy research was that grant proposals be subjected to a broad selection of peer reviewers and that NSF require a formal evaluation of all policy papers after they have been completed.

Senator Kennedy hailed the GAO report as confirmation of his belief that there were "serious deficiencies" in NSF's handling of the grants. He charged that NSF had dispensed $9 million in policy research funds while "the peer review process was routinely short-circuited, and not even the most cursory efforts were made to guard against potentially serious conflicts of interest."

But NSF officials tended to roll with the punch. Atkinson noted that the GAO investigated how a now-defunct office, outside the mainstream of NSF activities, operated a year or two in the past. "I don't think we still do business the way we did then," he said. He found most of the GAO's recommendations "very sensible" and noted that many of them had already been implemented in one form or another. The remaining suggestions will be considered by foundation officials and by the agency's highest policy-making body, the National Science Board, which will review the foundation's handling of policy research on a priority basis.

Meanwhile, Johnson, an untenured research professor, is looking for a new job, a step he says he would have taken anyway, but which must now be performed "under the gun" because of the brouhaha with Kennedy.

—PHILIP M. BOFFEY

Gene-Splicing: At Grass-Roots Level a Hundred Flowers Bloom

For a research technique too new to have produced a single practical application, the recombinant DNA method of gene-splicing has evoked a perhaps unprecedented degree of public interest. Debate about the technique has raged through campuses, spilled over into city councils, and has now reached the attention of state legislatures.

Many of these bodies have made or are making their own reviews of the terms under which the research may proceed. So far all have accepted the guidelines issued by the National Institutes of Health last June, but usually with certain extra restrictions of their own.

With the exception of action being contemplated in New York State, these restrictions are of minor significance, so that in effect the NIH guidelines are being generally endorsed at the local level.

Yet public anxiety about the technique is so definite that even industry, in a change of position, is now, for reasons of self-protection, leaning toward having the government register and keep track of its gene-splicing activities.

Local involvement in the gene-splicing debate has included the following actions.

New York State. Having held public hearings on the gene-splice technique (*Science*, 12 November), the state attorney general's environmental health bureau has prepared a bill to control the research. The bill, which has not yet been introduced, would require everyone engaged in gene-splicing research or production to obtain a certificate from the state health commissioner, who would also specify training and health-monitoring programs. Deborah Feinberg, who drafted the bill, suggests in an accompanying report that all gene-splicing work should be done in P3 (moderate level) containment facilities.

An official of the New York State health department says his feeling is that all new laboratories should be equipped with P3 facilities, but that "we would not require everything to be done in P3 right away." But the department would probably upgrade some lower level experiments to P3 and P4 while endorsing the NIH guidelines in general, the official says.

California. Two committees of the state legislature are at present holding hearings, after which they will decide whether or not to introduce legislation. Marc Lappe, a special assistant in the health department who helped organize the hearings, says that the minimum likely requirement of such legislation would be to make the NIH guidelines applicable to everyone, particularly industry.

New Jersey. State attorney general William F. Hyland, whose interest in biomedical issues was manifested during his handling of the Karen Quinlan case, has been following the gene-splicing issue closely. His assistant on the subject, Dennis Helms, says his own feeling—Hyland has not yet come to a decision—is that state regulation is not a good idea for an issue that can be properly settled only on a national basis. There is no point in driving the research underground by excessive regulation, Helms believes, because "in the end we are going to depend on the responsibility of the individual scientist. But I can assure you the response will be electrifying if there is a bad accident. That will mean banning everything in the ridiculous fashion that always happens when you do things too fast."

Cambridge. The city council is in the throes of creating an ordinance on gene-splicing research. Though Mayor Vellucci would still like to ban all P3 and P4 research, the proposal of the citizens' review board—to endorse the NIH guidelines with added restrictions—will probably prevail in some form.

San Diego. Seeking to avoid a Cambridge-style confrontation, the University of California at San Diego informed city mayor Pete Wilson last year of its intention to build two P3 facilities. The mayor asked his quality of life board to set up a DNA study committee chaired by Albert Johnson, dean of sciences at UCSD. After hearing witnesses from both sides, the committee completed a report last week for submission to the mayor and council. The report endorses the NIH guidelines but in addition recommends that the council consider the desirability of confining all gene-splicing research to P3 facilities; that the university refrain from experiments requiring P4 facilities; that it notify the city of any P3 experiment requiring the highest degree of biological containment (EK3); and that an ordinance be passed to bring industry and others within the ambit of

the guidelines. "Ideally, if this work is to continue, it should go forward with the full knowledge, understanding and approval of the people of San Diego as to its potential benefits and hazards," says the DNA study committee.

Madison. A resolution asking for a citizens committee and public debate on the issue will come before the city council in a few weeks. The University of Wisconsin set up a committee at the same time as the resolution was introduced. "There is now a little bit of jostling going on between the city and the university about whether there should be a public debate," says Philip Ball, an aide to the mayor.

Bloomington. The mayor's office, after following the events in Cambridge, heard rumors of gene-splicing research at the University of Indiana, and was later informed by the university of plans to build a P3 facility, where only P1 or P2 experiments would be conducted for the time being. The mayor's environmental commission has held one set of hearings and will hold another later this year, but has found no serious fault with the university's procedures. "People so far are pretty calm. For the most part the community is satisfied that the university is being responsible. We don't anticipate taking any action at the present time," says Deborah Mantell, an aide to the mayor.

Ann Arbor. City mayor Albert Wheeler, who happens to be a microbiologist, is taking no action. One reason may be that the University of Michigan has gone through a more intense debate about the technique than any other institution, Harvard and MIT included. Vigorous opposition to the research was mounted by Susan Wright, a historian of science. One of her supporters has said, and the proponents of the research agree, that the university will never be the same again.

Deciding that gene-splicing research was the wave of the future, the university planned to construct three P3 facilities. It set up a committee A to get the job done, a committee B to look at the ethical and social aspects of the research, and a committee C to assess biohazards. The nonbiologists on committee B concluded last March that the research should go ahead. The one dissenter, historian Shaw Livermore, opined that things were not so bad that we had to change the order of life. While the technique would help alleviate human distress, said Livermore, "I believe that the limitations of our social capacities for directing such a capability to fulfilling human purposes will bring with it a train of awesome and possibly disastrous consequences."

The university's board of regents held five meetings on the issue, deciding last May by a 6-to-1 vote that the research should be allowed to proceed. Robert Helling, head of one of the two groups using the technique, says the debate took up an enormous amount of time—he has done almost no research for a year—but has been well mannered. "There have been intense feelings at times but there has never been anything personal, we have tried to keep things civilized."

Industry. The industry attitude toward the control of gene-splicing research is about to undergo an important change. Apart from General Electric, all major firms known to be actively interested in the technique are drug companies, whose positions are coordinated by the Pharmaceutical Manufacturers Association in Washington. Until recently, the PMA has advocated voluntary compliance with the NIH guidelines, asking only that they be modified by lifting the restriction on large volumes of liquid and by protecting intellectual property rights.

Position Not Pragmatic

"We now realize that position was not pragmatic," says PMA scientific direction John G. Adams. "We are in a fishbowl on this. There are charges that we are doing something clandestine." Hence, for its own protection, the PMA is leaning toward having some agency of government keep a registry of industrial research; provided they were not subject to disclosure under the Freedom of Information Act, the industry could submit research plans and even results to the registry, Adams suggests.

All the major drug companies are interested in the technique but only six are actively engaged in it—Hoffmann-La Roche, Upjohn, Eli Lilly, Smith Kline and French, Merck, and Miles Laboratories. A smaller company whose activities have attracted a lot of attention is Cetus Corporation of Berkeley, California. Cetus has as consultants Stanley Cohen, who pioneered an important aspect of the technique, and Joshua Lederburg, also of Stanford. The company's present specialty is improving the genetics of industrial microorganisms, but gene-splicing "will be a very major aspect of our future output," says corporation president Ronald E. Cape. Cape believes that those suspicious of industry's involvement with the technique underestimate how conservative industry tends to be. Cetus is fully complying with the NIH guidelines but, Cape notes, "there is only so much curtailment that the United States, by regulation or moral suasion, can enforce on the rest of the world." At a recent meeting it was clear that the European scientists "were obviously able to move ahead in certain directions which were shut off, at least for the time being, to American scientists," Cape notes.

Another small company active in the field is Genentech, which is funding Herbert Boyer of the University of California, San Francisco, in a project to synthesize human insulin with the gene-splice technique. The human gene for the insulin precursor molecule has not been isolated, so the plan is to synthesize the gene chemically on the basis of the protein's known structure.

On the basis of work by Boyer and Cohen, Stanford and the University of California have applied for a patent on commercial uses of the gene-splice technique. The patent, which does not apply to academic or industrial research, would require commercial users to abide by the NIH guidelines. The Patent and Trademark Office announced last month that it would give accelerated processing to patent applications involving gene-splicing, "in view of the exceptional importance of recombinant DNA and the desirability of prompt disclosure of developments in the field."

The Patent Office action, stimulated by Betsy Ancker-Johnson, Commerce Department assistant secretary for science and technology, has been criticized by Senator Dale Bumpers (D–Ark.) for having weakened the NIH guidelines. The announcement allows firms to avoid disclosure of proprietary information if it would prejudice their foreign patent rights. Bumpers aide George L. Jacobson says that this in effect exempts industry from the disclosure provisions of the NIH guidelines, an action which preempts the discussions now going on elsewhere in government as to whether and in what form the guidelines should be made to apply to industry. Ancker-Johnson says that the announcement extends the guidelines to industry by requiring that they be followed if quick patents are to be granted.

Environmentalists. Several environmental groups have taken stances on the issue. The Environmental Defense Fund and the Natural Resources Defense Council have filed a petition with the Department of Health, Education, and Welfare asking for a public hearing to determine whether any gene-splicing research should be allowed and if so, under what conditions. Such a hearing, the petitioners state, would serve as "a broad-

based public review of the existing NIH guidelines and would permit open debate on issues given little attention by the NIH Drafting Committee or the office of the director," such as whether the human gut bacterium *Escherichia coli* is a suitable host for gene-splicing work.

Friends of the Earth believes that a moratorium should precede the review: there should be a public debate "so that an official moratorium on recombinant DNA research can be imposed pending further public investigation." As for the Sierra Club, its board of directors decided on 9 January that, pending further information and discussion, "the Sierra Club opposes the creation of recombinant DNA for any purpose, save in a small number of maximum containment labs operated or controlled directly by the federal government."

What all these activities represent, at state and city council level, by industry and environmentalists, is an extended exercise in public education about the gene-splice technique and its implications. The calls to prohibit or slow down the research seem threatening and irrational to those scientists who first pointed to the risks and who believe, with some measure of justice, that there should be a presumption in favor of their estimate of how to deal with them. Yet the bottom line reached by most public bodies so far is to endorse the NIH guidelines with minor changes. Whatever further restrictions emerge from the present round of debate, the research will at least be proceeding on the basis of informed public consent, a desirable and probably inescapable condition for a technique of such consequence.—NICHOLAS WADE

Carter Appointments: Fresh Moves on Sea Law, Arms Control

In its inaugural week, the embryonic Carter Administration took several bold steps toward fulfilling the President's campaign pledges to work vigorously toward a sea law treaty, an accord on strategic arms, and a comprehensive nuclear test ban. Two strong appointments were announced: that of Elliot L. Richardson to head the U.S. law of the sea delegation and that of Paul C. Warnke to be chief negotiator for the strategic arms limitations talks (SALT) and director of the Arms Control and Disarmament Agency.

In addition, Washington seemed smitten by a fever of gossip about who is under consideration for which high-level jobs, and in science circles this naturally centered on who would be appointed presidential science adviser.

As of this writing, Wolfgang Panofsky, of the Stanford Linear Accelerator Center, was still rumored a likely choice for the refurbished job of presidential science adviser, if only because neither of the other two most frequently mentioned scientists are likely to end up with the job. Lewis S. Branscomb, of the IBM Corporation, who figured during the campaign and transition period, seemed a less likely choice for the President, who has encountered criticism for having already appointed three cabinet members who were on the board of directors of IBM. Jerome B. Wiesner of MIT seemed unlikely to accept the job were it offered. Other names which have been mentioned are John S. Baldeschwieler of the California Institute of Technology and Robert Charpie of the Cabot Corporation.

There was, in the first week, an encouraging development for ocean science in the appointment of Richardson, President Nixon's and President Ford's cabinet officer for all seasons, as U.S. Ambassador to the Law of the Sea Conference. The appointment was barely announced when Richardson, who only days before had been the outgoing Secretary of Commerce, held a 2½-hour meeting with the State Department's sea law staff. The reaction of one staffer indicated the contrast to the sleepy months that had preceded. "Obviously, Richardson is a plum for the law of the sea. We're delighted. He obviously knows his way around. Now we have lots of work to do." The next session of the 140-nation conference will be held in New York, in May.

On substantive questions, Richardson seemed qualified to iron out a number of long-standing differences—more properly termed wars—which have grown up among federal agencies over what should be the U.S. position at the talks. "He's had four cabinet posts. When he deals with the cabinet, we won't have to go to them hat in hand," explains another sea law expert. The U.S. team has been particularly at odds on the ocean mining issue, which has complicated U.S. attempts to exert leadership at the conference and has become the central knot around which the negotiation is entangled. Several sea law experts last week expressed hope that Richardson, who has a well-known facility for mastering extremely complicated issues, may be able to work out a successful solution to the conference's ocean mining snarl, where, last April, Henry Kissinger's 11th-hour proposals failed. Richardson has already asked for a review of the issue.

The U.S. delegation also seems more likely to produce a new position on the question because of the dismissal of sea law bureaucrat Leigh Ratiner, Ocean Resources Administrator of the Department of the Interior, who, for years, has largely controlled the U.S. position on deep-sea mining and whose views were often at odds with others on the U.S. delegation. Ratiner left the government for private law practice as a result of a routine house cleaning of 41 mid-level officials by incoming Interior Secretary Cecil D. Andrus.

Help for Ocean Science?

As for ocean science, John Norton Moore, former deputy chief of the U.S. team commented that Richardson may also be able to exercise the "leadership" that Moore feels is needed to rescue oceanography from its current, dismal future (*Science*, 4 June 1976). Because of a last-minute wobble in U.S. negotiating strategy at the last session, countries with coastlines that oceanographers are interested in studying were gaining power over the freedom of scientific ships to operate in their waters—power which some American scientists fear will drown their activities in a sea of red tape.

There are some final, political dimensions to the Richardson appointment that were noted last week by a number of observers. Carter, by naming a prominent Republican who has also served in a key position as U.S. Ambassador to England, is sending other nations a bipartisan signal designed to make them sit up and take greater note of any new U.S. proposals. Thus he is strengthening the U.S. hand at the bargaining table. Underlying this strength is a simple, political truth that other nations will easily perceive: any treaty submitted to the Senate