rior glucose concentration equilibrates with the concentration exterior to the probe. If the glucose concentration increases, indicator is driven off the substrate to increase the concentration of indicator in solution. Thus fluorescence intensity as seen by the optical fiber follows the glucose concentration. This principle can be applied to any analytical problem for which a specific competitive binding system can be devised.

Conclusion

Fiber-optic sensors are mostly in a developmental stage, having achieved little penetration into the general field of biomedical sensors. There is substantial interest in the development of new sensors for various clinical and research applications. In the case of biochemical fiber-optic sensors, the principal competition involves field-effect devices, which had an early start. There have been difficulties with these devices, but they have great potential. Although fiber-optic technology may lead to improvements in traditional sensors, its most important application could be in the development of entirely new devices.

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Scientists and Congress

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Congress is a body that is expert in one thing—politics. Among the members of Congress are acknowledged experts in one field or another, but on the whole Congress is an aggregation of laymen. We are often asked to judge issues on which we are admittedly not expert, somewhat in the same way that a jury that is not a body of handwriting experts may be asked to judge the conflicting opinions of witnesses who are in fact handwriting experts. Our problem as legislators is like that of jurors in a court of law—we have to resolve claims that are in conflict, and we face an array of more or less persuasive fact and opinion on both sides. It is up to us to make a decision on one side of the issue. To put it another way, our problem is not necessarily a lack of information but resolving the conflicting claims that are put before us. The resolution of conflict, in one arena or another, is the essence of politics and also the essence of legislation.

In the realm of scientific research, Congress plays a role of tremendous importance and makes decisions that are often based on little real knowledge of the facts and less knowledge about the consequences. The federal government spends about $45 billion a year on scientific efforts of one kind or another. It is impossible for any member of Congress to review all of this research, let alone reach any sound conclusions about its entire range. We attempt to find some areas of general focus through our own in-house agencies, the most important being the Office of Technology Assess-

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ment, which can generate papers on any given area of scientific or technological endeavor and give us an idea of the most promising areas in a field. We can also call on the Congressional Research Service, which can give us good studies on almost any subject imaginable. And we can get an accountant's eye view through the General Accounting Office or the Congressional Budget Office.

Summary. Scientists are urged to make their views known to members of Congress. To be effectively heard, they should establish personal contact with their congressmen and senators and their staff. Communication should be frequent, personal, and carefully focused. In the last 2½ years, federal funding of scientific research has been severely cut back, while military research funding has been increased. The selection process for funding research is being politicized. Scientists should concern themselves with what is happening politically because the quality of American scientific research is being threatened.

There are also outside groups like the Congressional Clearinghouse on the Future and lobby organizations of every shape and size. Yet I do not believe that Congress has a good understanding of just how central the federal role is in the realm of scientific research, nor even what profound changes in direction have been taking place since 1981. We have plenty of information at our disposal, but we do not have enough actual contact from scientists in the field.

Contacting Congressmen

The problem facing anyone contacting congressmen is one primarily of gaining attention and getting that attention focused. It is akin to an attorney's problem of working with a jury—you are not certain who will be persuaded by a given argument, and so you must not leave any reasonable avenue of persuasion unexplored. A small organization of scientists is not usually served by a lobby—or an advocate—except in the general sense that medical schools and universities gather information and present relevant viewpoints to Congress. The result is that they have inadequate information on which to plan their operations or to understand how Congress is affecting their work, and Congress in turn has too little understanding of their situation and what affects it. It is not a reasonable goal to expect a small organization to make all members of Congress acutely aware of its daily concerns. Dozens of agencies sponsor research or perform research in-house, involving some $45 billion in every possible field of scientific endeavor, so the competition for attention is enormous. Beyond that, every member of Congress chooses an area of focus—most often, the area of his or her committee assignment.

The basic work of Congress takes place in its committees, just in the way that the basic work of a medical school or university takes place in its departments. Of necessity, every member seeks to know as much as possible about his committee responsibility. Not only that, the most frequent lobby contact is within the area of jurisdiction of a member's committee assignment. As a member of the Committee on Banking, I am much more likely to be contacted by the banking lobby than by, say, the shipbuilding lobby. Consequently, the first suggestion I can offer is that anyone seeking to influence the course of a particular bill should make contact with members of the committee to which that bill is assigned. Those are the members who know the most about it and, more important, the members with the best opportunity to influence the structure of that legislation.

Second, anyone with an interest in a particular bill should make contact not only with the committee members who may be assigned to that bill but with the committee staff as well, because it is the staff who will prepare the draft that the committee has before it and develop the arguments on the items in dispute. Staff members are not all-powerful, but since they have much to do with the way a bill is originally framed, and the way arguments are framed, anyone seeking to make his views and concerns effectively heard should be sure the concerned staff members are informed.

Third, I urge every member of a group to contact at least one congressman and two senators. The men and women who represent a particular district and state, who represent an institution and its particular research effort, need to hear about it—on a personal basis, if possible. If every member of a group of 100 had effective communication with one member of Congress, that would be one quarter of the House. That is enough to make an effective difference on any issue.

Effective Communication

Contact with a congressman or a senator should be made before a crisis. Congressmen are accustomed to emergency communications, but communication is much more effective if we have some prior knowledge of who is asking us to consider a position. A member of Congress should have the opportunity to get to know something of a school, its departments and disciplines, the efforts of its faculty and students, and their concerns about federal policy—just as a matter of background. People who know a scientist and know something about his or her work are going to be much more able to understand what is being discussed when the time comes to explain a particular political concern. In other words, effective communication is what makes an effective difference when it comes down to counting the votes.

When it comes to getting a message across on a particular matter, scientists should focus carefully, because the people they are talking with are busy and have hundreds of other concerns to attend to at any given time. They want to know the essence of the issue as quickly as possible. One rule I try to follow in obtaining staff memorandums is to have it said in one page. If I need more information I can get it, but most of the time I want the meat of the matter in the most precise way possible. I will need the background if I am called upon to argue a point, but if all I am being asked to do is reach a "yes" or "no" position on a given vote, what I need are the high points.

Shift in Funding

There are other scientific concerns that are not being recognized in Congress, some reasons why I believe scientists have to become more politically involved than perhaps they ever expected. First, there is not much realization in Congress of the fundamental shift that has taken place in the nation's scientific efforts during the last 2½ years. Every civilian agency with research money except the National Science Foundation and the Department of Transportation has undergone budget cuts, in real terms. Meanwhile, military research funding, in real terms, has increased by 53 percent. Research at NASA has been slashed by 61 percent, and at the Environmental Protection Agency it has been cut by almost half. A vast amount of promising research in medical sciences has either been canceled outright or put on hold.

Because of these cutbacks, hundreds, perhaps thousands, of scientists have seen their careers disappear at the stroke of a pen.

The White House defends these cuts, saying that economic recovery is the most vital consideration. But that clearly is not the case because what has taken place is a shift from the expense of basic science. Moreover, the Administration has enthusiastically embraced extremely questionable and costly ventures like the Clinch River breeder reactor. So it is clear that economic considerations are not the only reasons for these cutbacks. The White House also says that, by making the dollars short, the quality of research improves—that too much money has been available for research and consequently too many questionable projects have been approved. The solution, they say, is to make the competition keener. But certain federal agencies are said to have been funding research proposals that have been graded at the bottom of the ladder by the peer review process. It seems clear that some of these odd awards may have been made on the basis of political considerations. The Administration says that the peer review process shuts out smaller institutions and creates favor for big institutions that are able to generate more proposals. But if research cutbacks help make competition keener, then why disregard the competitive review and ranking process? If awards are to be made on an arbitrary political basis, why have competition at all? Scientific researchers have to make it known that there are not only arbitrary and damaging budget cuts being made, but that the selection process for research awards is now being subjected to politicization. This is a threat to the quality of American scientific research.

Politicization of Peer Review

The genius of the approach of the National Institutes of Health and the National Science Foundation to federal research is that awards are based on merit and that proposals are given fair consideration by acknowledged peers in the field. Politically determined research awards may occasionally have some value, but politicians have never, in all of history, been good judges of what constitutes a valid research effort. Copernicus, and any number of others, suffered the evils of political clearance for their studies. Political or theological dogma became more important than the truth, and it cost human progress dearly. Early students of anatomy had to violate the law in order to explore the secrets of human construction and dissect cadavers. We may be tempted to think that academic freedom in this day and age is secure, but human freedom of any description is fragile and always threatened. If funding of scientific research is going to be subjected to arbitrary, political processes, then the validity of federal research is open to question.

I do not think that the peer review process is perfect. Even scientists have their politics. And as we learned in the case of the most recent Nobel Prize for Medicine, a brilliant and original researcher can go for years without recognition, even among colleagues and peers. But when we think about the alternative to peer review, the dangers of politicized research are clear. All we have to do is reflect on the Golden Fleece award, which regularly goes to a hapless researcher whose work may be of enormous importance but which can also be subjected to ridicule by a misinformed layman. Such ignominious treatment could have been accorded to Barbara McClintock, who spent years cross-breeding ears of corn and observing the genetic changes that resulted. Yet her patient and solitary work unlocked priceless information about genetics and led to the Nobel Prize.

The House and Senate have spent days on end battling over amendments to the National Science Foundation authorization—amendments that would stop one kind of research or another, embarrass researchers, and eventually destroy the integrity of the foundation itself. That is the kind of thing that happens when research is subjected to a purely political review of particular efforts. The validity of the effort all too easily becomes secondary to the political angle or the passion of the moment.

Quality of Research

When scientists consider how to get their message across to Congress, I hope they will not fall into the temptation of being concerned simply with money issues. These are important, and they are vital. But so are the underlying issues of quality in research—what it is that cutbacks are doing to quality, what cutbacks are doing to the directions of your work, and what it costs us in the way of lost opportunities to endure no-growth or actual reduction in funding.

The consequences of not making the best effort were once dramatized by the arrival of Sputnik; but in more subtle ways they are clear even today. Worldwide, there is an immense competition for superiority in computer science, yet our officially sponsored research is limited in that area. In medical sciences we are deliberately cutting back areas in which we enjoy a clear lead. In energy we know that our future security can well depend on alternative energy sources, and yet our energy research has been cut by 20 percent. We cannot afford lost opportunities. And opportunities are at stake in the debate about the future scope and course of federally sponsored research. So far, the damage to scientific progress has been limited. But in the next year or so, critical decisions will be made that will influence events for years to come. Scientists cannot afford to sit on the sidelines and hope for the best. Whether they like it or not, the future of American science is at stake, and much depends on their willingness and ability to make their side known and heard.