The Hazards of Science

THE CODE WORD for criticism of science and scientists these days is "hubris." Once you've said that word, you've said it all; it sums up, in a word, all of today's apprehensions and misgivings in the public mind—not just about what is perceived as the insufferable attitude of the scientists themselves but, enclosed in the same word, what science and technology are perceived to be doing to make this century, this near to its ending, turn out so wrong.

"Hubris" is a powerful word, containing layers of powerful meaning, derived from a very old word, but with a new life of its own, growing way beyond the limits of its original meaning. Today, it is strong enough to carry the full weight of disapproval for the cast of mind that thought up atomic

fusion and fission as ways of first blowing up and later heating cities as well as the attitudes which led to strip-mining, offshore oil wells, Kepone, food additives, SSTs, and the tiny spherical particles of plastic recently discovered clogging the waters of the Sargasso Sea.

The biomedical sciences are now caught up with physical science and technology in the same kind of critical judgment, with the same pejorative word. Hubris is responsible, it is said, for the whole biological revolution. It is hubris that has given us the prospects of behavior control, psychosurgery, fetal research, heart transplants, the cloning of prominent politicians from bits of their own eminent tissue, iatrogenic disease, overpopulation, and recombinant DNA. This last, the new technology that permits the stitching of one creature's genes into the DNA of another, to make hybrids, is currently cited as the ultimate example of hubris. It is hubris for man to manufacture a hybrid on his own.

So now we are back to the first word again, from "hybrid" to "hubris," and the hidden meaning of two beings joined unnaturally together by man is somehow retained. Today's joining is straight out of Greek mythology: it is the combining of man's capacity with the special prerogative of the gods, and it is really in this sense of outrage that the word "hubris" is being used today. This is what the word has grown into, a warning, a code word, a shorthand signal from the language itself: if man starts doing things reserved for the gods, deifying himself, the outcome will be something worse for him, symbolically, than the litters of wild

boars and domestic sows were for the ancient Romans.

To be charged with hubris is therefore an extremely serious matter, and not to be dealt with by murmuring things about antiscience and antiintellectualism, which is what many of us engaged in science tend to do these days. The doubts about our enterprise have their origin in the most profound kind of human anxiety. If we are right and the critics are wrong, then it has to be that the word "hubris" is being mistakenly employed, that this is not what we are up to, that there is, for the time being anyway, a fundamental misunderstanding of science.

I suppose there is one central question to be dealt with, and I am not at all sure how to deal with it, although I am quite certain about my own answer to it. It is this: are there some kinds of information leading to some sorts of knowledge that human beings are really better off not having? Is there a limit to scientific inquiry not set by what is knowable but by what we *ought* to be knowing? Should we stop short of learning about some things, for fear of what we, or someone, will do with the knowledge? My own answer is a flat no, but I must confess that this is an intuitive response and I am neither inclined nor trained to reason my way through it.

There has been some effort, in and out of scientific quarters, to make recombinant DNA into the issue on which to settle this argument. Proponents of this line of research are accused of pure hubris, of assuming the rights of gods, of arrogance and outrage; what is more, they confess themselves to be in the business of making live hybrids with their

own hands. The mayor of Cambridge and the attorney general of New York have both been advised to put a stop to it, forthwith.

It is not quite the same sort of argument, however, as the one about limiting knowledge, although this is surely part of it. The knowledge is already here, and the rage of the argument is about its application in technology. Should DNA for making certain useful or interesting proteins be incorporated into *E. coli* plasmids or not? Is there a risk of inserting the wrong sort of toxins or hazardous viruses, and then having the new hybrid organisms spread beyond the laboratory? Is this a technology for creating new varieties of pathogens, and should it be stopped because of this?

If the argument is held to this level, I can see no reason why it cannot be settled, by reasonable people. We have learned a great deal about the handling of dangerous microbes in the last century, although I must say that the opponents of recombinant-DNA research tend to downgrade this huge body of information. At one time or another, agents as hazardous as those of rabies, psittacosis, plague, and typhus have been dealt with by investigators in secure laboratories, with only rare instances of self-infection of the investigators themselves, and no instances at all of epidemics. It takes some high imagining to postulate the creation of brand-new pathogens so wild and voracious as to spread from equally secure laboratories to endanger human life at large, as some of the arguers are now maintaining.

But this is precisely the trouble with the recombinant-

[A problem: it has become an emotional issue, with too

many irretrievably lost tempers on both sides. It has lost the sound of a discussion of technological safety, and begins now to sound like something else, almost like a religious controversy, and here it is moving toward the central issue: are there some things in science we should not be learning about?

There is an inevitably long list of hard questions to follow this one, beginning with the one which asks whether the mayor of Cambridge should be the one to decide, first off.

Maybe we'd be wiser, all of us, to back off before the recombinant-DNA issue becomes too large to cope with. If we're going to have a fight about it, let it be confined to the immediate issue of safety and security, of the recombinants now under consideration, and let us by all means have regulations and guidelines to assure the public safety wherever these are indicated or even suggested. But if it is possible let us stay off that question about limiting human knowledge. It is too loaded, and we'll simply not be able to cope with it.

By this time it will have become clear that I have already taken sides in the matter, and my point of view is entirely prejudiced. This is true, but with a qualification. I am not so much in favor of recombinant-DNA research as I am opposed to the opposition to this line of inquiry. As a longtime student of infectious-disease agents I do not take kindly the declarations that we do not know how to keep from catching things in laboratories, much less how to keep them from spreading beyond the laboratory walls. I believe we learned a lot about this sort of thing, long ago. Moreover, I regard it

as a form of hubris-in-reverse to claim that man can make deadly pathogenic microorganisms so easily. In my view, it takes a long time and a great deal of interliving before a microbe can become a successful pathogen. Pathogenicity is, in a sense, a highly skilled trade, and only a tiny minority of all the numberless tons of microbes on the earth has ever been involved itself in it; most bacteria are busy with their own business, browsing and recycling the rest of life. Indeed, pathogenicity often seems to me a sort of biological accident in which signals are misdirected by the microbe or misinterpreted by the host, as in the case of endotoxin, or in which the intimacy between host and microbe is of such long standing that a form of molecular mimicry becomes possible, as in the case of diphtheria toxin. I do not believe that by simply putting together new combinations of genes one can create creatures as highly skilled and adapted for dependence as a pathogen must be, any more than I have ever believed that microbial life from the moon or Mars could possibly make a living on this planet.

But, as I said, I'm not at all sure this is what the argument is really about. Behind it is that other discussion, which I wish we would not have to become enmeshed in.

I cannot speak for the physical sciences, which have moved an immense distance in this century by any standard, but it does seem to me that in the biological and medical sciences we are still far too ignorant to begin making judgments about what sorts of things we should be learning or not learning. To the contrary, we ought to be grateful for whatever snatches we can get hold of, and we ought to be

out there on a much larger scale than today's, looking for more.

We should be very careful with that word "hubris," and make sure it is not used when not warranted. There is a great danger in applying it to the search for knowledge. The application of knowledge is another matter, and there is hubris in plenty in our technology, but I do not believe that looking for new information about nature, at whatever level, can possibly be called unnatural. Indeed, if there is any single attribute of human beings, apart from language, which distinguishes them from all other creatures on earth, it is their insatiable, uncontrollable drive to learn things and then to exchange the information with others of the species. Learning is what we do, when you think about it. I cannot think of a human impulse more difficult to govern.

But I can imagine lots of reasons for trying to govern it. New information about nature is very likely, at the outset, to be upsetting to someone or other. The recombinant-DNA line of research is already upsetting, not because of the dangers now being argued about but because it is disturbing, in a fundamental way, to face the fact that the genetic machinery in control of the planet's life can be fooled around with so easily. We do not like the idea that anything so fixed and stable as a species line can be changed. The notion that genes can be taken out of one genome and inserted in another is unnerving. Classical mythology is peopled with mixed beings—part man, part animal or plant —and most of them are associated with tragic stories. Recombinant DNA is a reminder of bad dreams.

The easiest decision for society to make in matters of this

kind is to appoint an agency, or a commission, or a subcommittee within an agency to look into the problem and provide advice. And the easiest course for a committee to take, when confronted by any process that appears to be disturbing people or making them uncomfortable, is to recommend that it be stopped, at least for the time being.

I can easily imagine such a committee, composed of unimpeachable public figures, arriving at the decision that the time is not quite ripe for further exploration of the transplantation of genes, that we should put this off for a while, maybe until next century, and get on with other affairs that make us less discomfited. Why not do science on something more popular, say, how to get solar energy more cheaply? Or mental health?

The trouble is, it would be very hard to stop once this line was begun. There are, after all, all sorts of scientific inquiry that are not much liked by one constituency or another, and we might soon find ourselves with crowded rosters, panels, standing committees, set up in Washington for the appraisal, and then the regulation, of research. Not on grounds of the possible value and usefulness of the new knowledge, mind you, but for guarding society against scientific hubris, against the kinds of knowledge we're better off without.

It would be absolutely irresistible as a way of spending time, and people would form long queues for membership. Almost anything would be fair game, certainly anything to do with genetics, anything relating to population control, or, on the other side, research on aging. Very few fields would get by, except perhaps for some, like mental health,

in which nobody really expects anything much to happen, surely nothing new or disturbing.

The research areas in the greatest trouble would be those already containing a sense of bewilderment and surprise, with discernible prospects of upheaving present dogmas.

It is hard to predict how science is going to turn out, and if it is really good science it is impossible to predict. This is in the nature of the enterprise. If the things to be found are actually new, they are by definition unknown in advance, and there is no way of telling in advance where a really new line of inquiry will lead. You cannot make choices in this matter, selecting things you think you're going to like and shutting off the lines that make for discomfort. You either have science or you don't, and if you have it you are obliged to accept the surprising and disturbing pieces of information, even the overwhelming and upheaving ones, along with the neat and promptly useful bits. It is like that.

The only solid piece of scientific truth about which I feel totally confident is that we are profoundly ignorant about nature. Indeed, I regard this as the major discovery of the past hundred years of biology. It is, in its way, an illuminating piece of news. It would have amazed the brightest minds of the eighteenth-century Enlightenment to be told by any of us how little we know, and how bewildering seems the way ahead. It is this sudden confrontation with the depth and scope of ignorance that represents the most significant contribution of twentieth-century science to the human intellect. We are, at last, facing up to it. In earlier times, we either pretended to understand how things

worked or ignored the problem, or simply made up stories to fill the gaps. Now that we have begun exploring in earnest, doing serious science, we are getting glimpses of how huge the questions are, and how far from being answered. Because of this, these are hard times for the human intellect, and it is no wonder that we are depressed. It is not so bad being ignorant if you are totally ignorant; the hard thing is knowing in some detail the reality of ignorance, the worst spots and here and there the not-so-bad spots, but no true light at the end of any tunnel nor even any tunnels that can yet be trusted. Hard times, indeed.

But we are making a beginning, and there ought to be some satisfaction, even exhilaration, in that. The method works. There are probably no questions we can think up that can't be answered, sooner or later, including even the matter of consciousness. To be sure, there may well be questions we can't think up, ever, and therefore limits to the reach of human intellect which we will never know about, but that is another matter. Within our limits, we should be able to work our way through to all our answers, if we keep at it long enough, and pay attention.

I am putting it this way, with all the presumption and confidence that I can summon, in order to raise another, last question. Is this hubris? Is there something fundamentally unnatural, or intrinsically wrong, or hazardous for the species in the ambition that drives us all to reach a comprehensive understanding of nature, including ourselves? I cannot believe it. It would seem to me a more unnatural thing, and more of an offense against nature, for us to come on the same scene endowed as we are with curiosity, filled to over-

brimming as we are with questions, and naturally talented as we are for the asking of clear questions, and then for us to do nothing about it or, worse, to try to suppress the questions. This is the greater danger for our species, to try to pretend that we are another kind of animal, that we do not need to satisfy our curiosity, that we can get along somehow without inquiry and exploration and experimentation, and that the human mind can rise above its ignorance by simply asserting that there are things it has no need to know. This, to my way of thinking, is the real hubris, and it carries danger for us all.