The Social Responsibilities of Scientists

A scientist can no longer shirk responsibility for the use society makes of his discoveries.

Bertrand Russell

Science, ever since it first existed, has had important effects in matters that lie outside the purview of pure science. Men of science have differed as to their responsibility for such effects. Some have said that the function of the scientist in society is to supply knowledge, and that he need not concern himself with the use to which this knowledge is put. I do not think that this view is tenable, especially in our age. The scientist is also a citizen; and citizens who have any special skill have a public duty to see, as far as they can, that their skill is utilized in accordance with the public interest. Historically, the functions of the scientist in public life have generally been recognized. The Royal Society was founded by Charles II as an antidote to "fanaticism" which had plunged England into a long period of civil strife. The scientists of that time did not hesitate to speak out on public issues, such as religious toleration and the folly of prosecutions for witchcraft. But although science has, in various ways at various times, favored what may be called a humanitarian outlook, it has from the first had an intimate and sinister connection with war. Archimedes sold his skill to the Tyrant of Syracuse for use against the Romans; Leonardo secured a salary from the Duke of Milan for his skill in the art of fortification; and Galileo got employment under the Grand Duke of Tuscany because he could calculate the trajectories of projectiles. In the French Revolution the scientists who were not guillotined were set to making new explosives, but Lavoisier was not spared, because he was only discovering hydrogen which, in those days, was not a weapon of war. There have been some honorable exceptions to the subservience of scientists to warmongers. During the Crimean War the British Government consulted Faraday as to the feasibility of attack by poisonous gases. Faraday replied that it was entirely feasible, but that it was inhuman and he would have nothing to do with it.

Affecting Public Opinion

Modern democracy and modern methods of publicity have made the problem of affecting public opinion quite different from what it used to be. The knowledge that the public possesses on any important issue is derived from vast and powerful organizations: the press, radio, and, above all, television. The knowledge that governments possess is more limited. They are too busy to search out the facts for themselves, and consequently they know only what their underlings think good for them unless there is such a powerful movement in a different sense that politicians cannot ignore it. Facts which ought to guide the decisions of statesmen—for instance, as to the possible lethal qualities of fallout—do not acquire their due importance if they remain buried in scientific journals. They acquire their due importance only when they become known to so many voters that they affect the course of the elections. In general, there is an opposition to widespread publicity for such facts. This opposition springs from various sources, some sinister, some comparatively respectable. At the bottom of the moral scale there is the financial interest of the various industries connected with armaments. Then there are various effects of a somewhat thoughtless patriotism which believes in secrecy and in what is called "toughness." But perhaps more important than either of these is the unpleasantness of the facts, which makes the general public turn aside to pleasanter topics such as divorces and murders. The consequence is that what ought to be known widely throughout the general public will not be known unless great efforts are made by disinterested persons to see that the information reaches the minds and hearts of vast numbers of people. I do not think this work can be successfully accomplished except by the help of men of science. They, alone, can speak with the authority that is necessary to combat the misleading statements of those scientists who have permitted themselves to become merchants of death. If disinterested scientists do not speak out, the others will succeed in conveying a distorted impression, not only to the public but also to the politicians.

Obstacles to Individual Action

It must be admitted that there are obstacles to individual action in our age which did not exist at earlier times. Galileo could make his own telescope. But once when I was talking with a very famous astronomer he explained that the telescope upon which his work depended owed its existence to the benefactions of enormously rich men, and, if he had not stood well with them, his astronomical discoveries would have been impossible. More frequently, a scientist only acquires access to enormously expensive equipment if he stands well with the government of his country. He knows that if he adopts a rebellious attitude he and his family are likely to perish along with the rest of civilized mankind. It is a tragic dilemma, and I do not think that one should censure a man whatever his decision; but I do think—and I think men of science should realize—that unless something rather drastic is done under the leadership or through the inspiration of some part of the scientific world, the human race, like the Gadarene swine, will rush down a steep place to destruction in blind ignorance of the fate that scientific skill has prepared for it.

It is impossible in the modern world

The author is a fellow of Trinity College, Cambridge, and of the Royal Society. This article is the text of an address delivered 24 September 1959 in London at a meeting of British scientists convened by the Campaign for Nuclear Disarmament.

The Campaign for Nuclear Disarmament in Britain recently invited scientists to a meeting to discuss the part they could play in diminishing the danger of nuclear war. Bertrand Russell, J. Rotblat, and John Collins, chairman of the campaign, spoke on what scientists had done and must do in the present dangerous situation. The meeting set up a working party to formulate policy and action. The chairman is N. Kemmer, and the secretary, A. Pirie, The Ford, North Hinksey Village, Oxford, England. The group of scientists hope to cooperate with scientists in other countries and would be glad to hear from such groups.

for a man of science to say with any honesty, "My business is to provide knowledge, and what use is made of the knowledge is not my responsibility." The knowledge that a man of science provides may fall into the hands of men or institutions devoted to utterly unworthy objects. I do not suggest that a man of science, or even a large body of men of science, can altogether prevent this, but they can diminish the magnitude of the evil.

There is another direction in which men of science can attempt to provide leadership. They can suggest and urge in many ways the value of those branches of science of which the important practical uses are beneficial and not harmful. Consider what might be done if the money at present spent on armaments were spent on increasing and distributing the food supply of the world and diminishing the population pressure. In a few decades, poverty and malnutrition, which now afflict more than half the population of the globe, could be ended. But at present almost all the governments of great states consider that it is better to spend money on killing foreigners than on keeping their own subjects alive. Possibilities of a hopeful sort in whatever field can best be worked out and stated authoritatively by men of science; and, since they can do this work better than others, it is part of their duty to do it.

As the world becomes more technically unified, life in an ivory tower becomes increasingly impossible. Not only so; the man who stands out against the powerful organizations which control most of human activity is apt to find himself no longer in the ivory tower, with a wide outlook over a sunny landscape, but in the dark and subterranean dungeon upon which the ivory tower was erected. To risk such a habitation demands courage. It will not be necessary to inhabit the dungeon if there are many who are willing to risk it, for everybody knows that the modern world depends upon scientists, and, if they are insistent, they must be listened to. We have it in our power to make a good world; and, therefore, with whatever labor and risk, we must make it.

Molecular Heterogeneity and Evolution of Enzymes

Coenzyme analogs are useful for studying the evolution, classification, and differentiation of enzymes.

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In recent years the development of new techniques has led to awareness of the heterogeneity of proteins which serve the same function. The classic studies on the hemoglobins, in particular sickle-cell hemoglobin, have clearly illustrated the use of chromatographic and electrophoretic techniques in establishing molecular heterogeneity. The immunological approach to detecting similarities and dissimilarities of enzymes has also attracted much interest. For example, immunological techniques have been used to identify differences between muscle and liver phosphorylases (*1*). Schlamowitz (*2*) has shown differences in alkaline phosphatases by immunological methods. Physical properties have also been used to identify differences between proteins catalyzing the same functions. Crystalline yeast alcohol dehydrogenase can be distinguished from horse-liver alcohol dehydrogenase simply by the fact that its molecular weight is almost twice that of the liver enzyme (*3*).

Another method of detecting the molecular heterogeneity of proteins is the determination of amino acid sequence. Although hormones from different sources may differ somewhat in amino acid sequence, they appear to have the same general physiological properties. Sanger (*4*), in his work on insulin, has shown that the hormone isolated from one species may differ slightly in amino acid sequence from that isolated from another. Similarly, studies with adrenocorticotropic hormone have shown that pig, lamb, and beef hormones have different amino acid sequences (*5*).

Although there has been some investigation of the heterogeneity of enzymes that catalyze the same function, the approach of differentiating the enzymes by their catalytic activities has not been fully exploited. It is the purpose of this article to present evidence that the catalytic technique may be most useful in discriminating differences between enzymes having the same function. Furthermore, data are given showing that this type of approach may prove to be a useful adjunct in studies of the ontogeny of enzymes as well as in studies of the genetic aspects of enzyme formation.

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