traditional biology which is apt to change this field from a predominantly observational and descriptive discipline into an analytical and causal science.

The concept of mechanistic and thus deterministic biology in the Western World arose perhaps with the posthumous work of Descartes, *De homine*, and a dispute between mechanistic and vitalistic biology still continues. The vitalistic school argues that the totality of life is a quality *sua generis* which cannot be described or reassembled as a summation of its component processes because it is imbued with a formative or directive force (*vis vitalis*, entelechy) which is metaphysical in nature and thus evades scientific comprehension. Traditional biology, whether conscious of it or not, has frequently assumed this vitalistic position of intellectual resignation.

Mechanistic biology (and currently foremost, molecular biology) takes the position that the phenomenon of life represents an unresolved form of chemistry and physics and, therefore, barring subatomic indeterminacy, is rigidly determined at the molecular genetic level. The overwhelming complexity, for example, of ecological situations is considered the result of a large number of uncontrolled variables, but not a valid argument against the principle of determinism.

Thus the disputation between "traditional biology" and "atomistic prejudice," to use Kaellis's terminology, can be regarded as the contemporary form of the dispute between vitalistic and mechanistic biology.

That molecular biology and its related disciplines enjoy rapid growth and a measure of success is, in part, due to the fact that modern biology can draw upon a body of knowledge, experimental methodology, and qualified manpower which are all derived from the high state of development of the physical sciences. In a deeper sense, however, the ascendency of molecular biology is the result of applying an intellectual approach to which traditional biology is not nearly so amenable. What is meant is that the field uses the scientific method of formulation of hypotheses, critical experimentation to directly reject or verify such hypotheses, generalization on the next higher level, and repetition of the process at that level. Traditional biology has not developed great generalized theories striving for the ultimate recognition of the laws of nature with the notable exception of the theory of evolution. Certainly, the various taxonomical systems do not belong in this category of generalizations.

While it may be traumatic to feel that one's proprietory relationship to a traditional field of learning is being invaded, such experiences are not without precedents in the history of science or in the biographies of scientists. The advents of heliocentric astronomy, the oxygen theory of oxidation, the germ theory of disease, the theory of evolution, or the theory of relativity, just to name a few, have not been uncontroversial. There may even have been pleas to establish the Society for Geocentric Astronomy or the Phlogiston Club in order to oppose heliocentric or oxygenistic "prejudices." Science, however, does not advance in this manner but is eminently self-correcting of bias irrespective of where it resides.

FRED E. HAHN
Walter Reed Army Institute of Research, Washington 12

Ethical Code for Scientists?

In recent months a bibliography (*1*) has been assembled entitled "Some ethical problems of science and technology." It covers the period from January 1955 to July 1963 and includes about 300 references in English in a compilation characterized as "not exhaustive."

This bibliography supplies ample evidence of the interest of scientists, engineers, and the public in the ethical aspects of the relationships of scientists and engineers to society and to one another. There emerges, however, one item of substantial difference between the approaches of the engineers and the scientists to their ethical problems, which deserves attention. Engineers have shown a definite interest in organized action (*2*) to improve ethical practice—for example, by emphasis on ethical considerations in the training of engineers, and by the adoption of formal codes of ethics by the various professional societies of engineering. Except among the psychologists, who have adopted a set of "Ethical Standards for Psychologists" (*3*), there is no evidence of similar action by scientists, who seem to have confined their efforts in the area of ethics to discussion.

It is true that it has been proposed at least twice (*4*) that scientists as a group should adopt a code of ethical practice. In their proposal, Pigman and Carmichael, in 1950, discussed the scope of such a code in some detail, but thus far there has been no indication that these, or any similar proposals, are being acted upon.

In taking formal action in the area of ethics, engineers are in accord with traditions long established in other professions (*5*) and with a strong trend in many other occupational groups toward ethical self-regulation. It is tempting, therefore, to speculate on the reasons for the divergence of scientists from what has become substantially the norm of social conduct.

One relevant factor, clearly, is the traditional remoteness of scientists from the temptations of the market place and from stresses generated by competition for professional advantage, for power, and for influence. But even in 1950 Pigman and Carmichael were observing that this remoteness was a thing of the past. Today, such a worldly problem as conflict of interest (*6*) is far from a trivial concern for many scientists, and one can readily argue that, in his role as government adviser, government contractor, government official dispensing large sums of public money, grant recipient, entrepreneur, consultant, supervisor, or employee, the scientist is at least as much enmeshed in ethical problems as the engineer.

Perhaps scientists have merely been somewhat slow to adapt to the great changes which have taken place so rapidly in the scientific professions in recent years. Perhaps the reasons for the difference in approach lie deeper. In any case, the record of need and of precedent suggest that a course of positive action in the area of ethics is something which merits the thoughtful attention of the scientist and the scientist-educator, and of their professional organizations.

LAWRENCE CRANBERG
Los Alamos Scientific Laboratory, Los Alamos, New Mexico

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