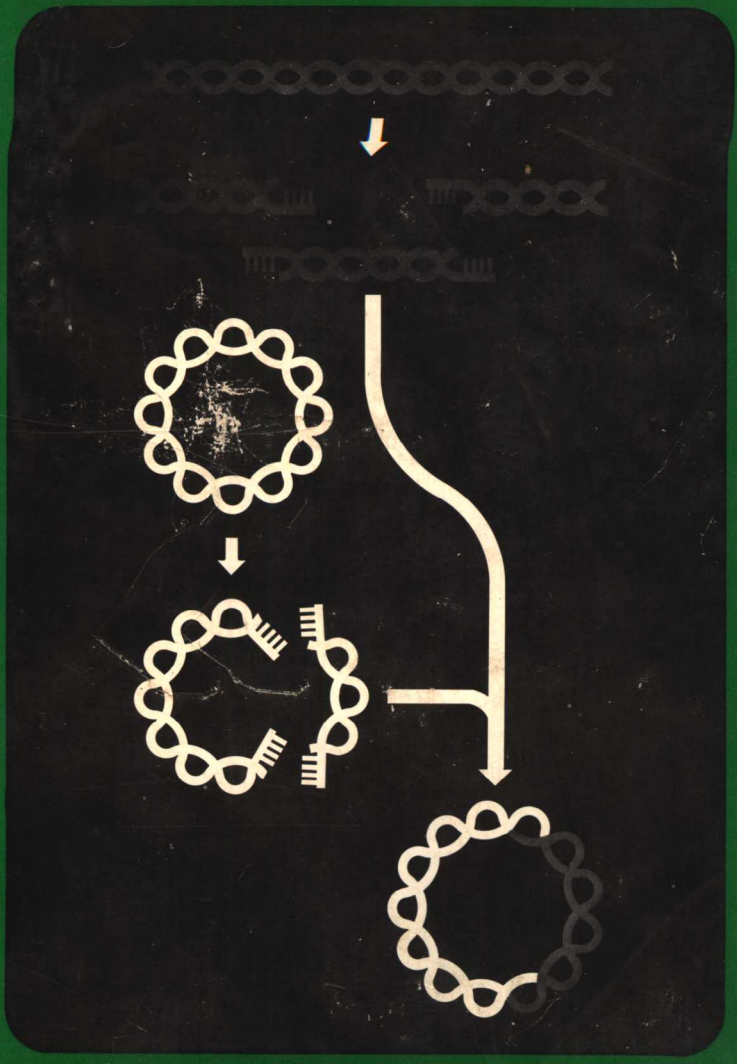

# Recombinant Molecules: Impact on Science and Society

Tenth Miles International Symposium

Edited by
Roland F. Beers, Jr.
Edward G. Bassett

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# Recombinant Molecules:
## Impact on Science and Society

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# Preface

One of the major events in the history of biological research occurred when it was found that excised segments of genetic material (DNA) from two different species could be annealed *in vitro* to form a hybrid DNA molecule which, on reintroduction into the cell, could impose entirely new genetic controls on that cell. The technology that enables the molecular basis of gene expression and heredity to be established, while providing a foundation for the creation of new organisms with desired genetic characteristics, has evoked a serious concern among scientists and laymen. This concern emanates from the theoretic creation of unique forms of agents of infection (or those adversely affecting the environment) whose biological properties cannot be completely predicted.

To provide a vehicle for a discussion of the scientific and societal ramifications of this technology, Miles Laboratories, Inc. sponsored the Tenth Miles International Symposium held at the Massachusetts Institute of Technology. Actively participating and sharing views during this conference were involved scientists from all over the world. These proceedings are the papers delivered at this 3-day conference.

The editors extend grateful thanks to Frank E. Young, M.D., Ph.D., Chairman of the Program Committee, and to members of that Committee who also chaired individual sessions. Acknowledgment is also given to Walter A. Compton, M.D., Chairman and Chief Executive Officer of Miles Laboratories, Inc., whose interest and encouragement have made these symposia a traditional annual event.

We are grateful to the authors for assisting in the prompt publication of this volume. Within the time allowed for editing, it was not possible for each discussant to review his remarks; if error or misinterpretation of the discussions has resulted, the editors take full responsibility.

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# Contents

**Section F: Societal Impact—Issues and Policies**

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# 1. Introduction

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One of the original purposes for establishing the annual Miles symposium series was to follow and record the evolution of the science of molecular biology into a technology of molecular biology. The intellectual tour de force of twentieth century biology had taken place: the discovery of the structural basis for genetic transfer from one generation to the next and the beginning of an understanding of possible mechanisms for translating genetic information to somatic structure and function. The double helix of DNA and the genetic code for amino acids formed the basis for the central dogma of molecular biology in 1967, the year of the first Miles symposium on the subject of messenger RNA. Today's symposium is a clear recognition of the fact that molecular biology is on the threshold of becoming a technology.

Nevertheless, even though the current status of molecular biology has been the expectation of both the scientist and the public supporting him, there is today a growing feeling of uneasiness and outright fear of this new technology, a concern that received its first major public recognition at the now famous Asilomar conference in February, 1975. The immediate issue, like that of the first nuclear chain reaction, is the uncertainty of the potential for what is popularly referred to as genetic engineering. Four technologies from molecular recombinant research with decreasing probability of success and increasing lag time until success is achieved appear to me to be:

1. genetic modification of microbial organisms for the purpose of increasing the quality and quantity of a desired microbial product such as an enzyme;
2. genetic modification of higher plant organisms to increase their productivity with respect to yield, caloric and nutritional content, and the special challenge of developing cereal having symbiotic relationships with nitrogen-fixing microorganisms;
3. transfer of animal (mammalian) genomes to microorganisms for the synthesis of specific proteins or hormones such as insulin; and
4. genetic transformation of somatic cells to correct genetic defects such as sickle cell anemia or phenylketonuria through transformation

of the cells *in vitro* or *in vivo* with virus vectors. The risks of harmful consequences to man and his environment appear to increase in the same order.

The analogy with nuclear physics is not inappropriate, but the uncertainties of potential for risks appear to be greater than those predicted or encountered after the first successful nuclear chain reaction. The threat of nuclear technology was initially identified as a human threat, that is, deliberate use of the technology for destructive purposes. Later, with the advent of nuclear power generation, the risks of errors in judgment or accident received the major emphasis. The primary emphasis of risks in molecular recombinant research is addressed to errors of judgment and accident. This places the issue of risks in a slightly different ethical framework.

Most of the discussions and deliberations held in the past and continued in this volume have been concerned with the mechanisms by which society reaches decisions for minimizing the risks and then establishing standards of conduct to implement those decisions. Some thought has been given to the appropriateness of the goals and benefits to be accrued from molecular recombinant research, although the motivations behind these goals are highly diversified. It is appropriate at this time to reflect on the philosophical ramifications of this new technology with special attention given to proper historical perspective. So revolutionary is this new technology that there is a tendency to consider it a unique event in history without precedent. In fact, there is a precedent that has run throughout the entire history of mankind and should be examined in terms of society's attitude toward and response to the uncertainties of any new technology that threatens to alter traditional beliefs and status quo or promises to bring forth a new utopia. This social environment in which the molecular recombinant research is carried out should be recognized and understood by the practitioners of research and by those who control and support this research. It should also be recognized by those groups in society who assume an adversary position with respect to decisions for goals and their implementation by society.

Two elements of society's attitude and response that strike me as significant are (a) an anti-intellectual attitude and (b) an unjustified expectation that the new technology can be used to solve major problems of society without concurrent institutional and behavioral reforms. I use the term intellectual to identify the rational activities of the human mind as distinguished from any philosophical interpretation of what is intellectual or nonintellectual.

Man's response to uncertainty generated by knowledge is recorded in biblical times in the first few chapters of Genesis. Knowledge provides the basis for control over the present and the future, that is, power. Yet, because knowledge is often incomplete, so is the power it provides, hence the source of the uncertainty. Indeed, the incompleteness of that power has led to the

creation of the major religions of the world. Depending on one's religious convictions, man either created or discovered a transcendental Being to compensate or make allowances for the incompleteness of his own knowledge and power. Intercession in man's behalf has been sought through supplication and ritualistic sacrifices, a form of power bargaining. Inevitably, this struggle for certainty through power developed a strong ethical character that eventually became highly legalistic in its interpretation and enforcement. The key ethical component that is today as important as at the time of Genesis is the assignment and acceptance of the moral responsibility for the possession of that power.

Two major institutions of civilization evolved in parallel and inevitable conflict. In broad terms, one is religious or transcendental, the other is intellectual or scientific. Each proclaimed itself as the authority for the ultimate source of knowledge, and each asserted its right to use that knowledge in its quest for power and certainty. The boundary of these two areas has, of course, shifted dramatically during the last 200 years in favor of the intellectually based institutions: science and technology.

However, the struggle over the authority for power and the responsibility for the use of that power still remains a major struggle today. Indeed, the dilemma facing mankind is an imponderable paradox: absolute power controlled by either of these institutions contains the seeds of destruction not only of civilization but of man, the species. Authoritarian institutions are on the increase worldwide. The transcendental Being may not be recognized as such, but any ideology whose power resides in its position of authority provides the basis for governing a society as if a transcendental Being existed and was not accountable to the critical intellectual processes of man. On the other hand, the imperfect state of man's knowledge and, hence, his capacity to predict and control his future is equally dangerous if this limitation is not clearly recognized by society. Scientism is the ideology that does not recognize those limitations.

The struggle today is not over the ownership of the source of knowledge but rather over the assignment of the responsibility for the use of that knowledge. Perhaps the clearest example of this is seen in the current posture of the Roman Catholic Church toward the goals and methods of controlling the size of the human population. Underlying its refusal to sanction a technological solution is the explicit premise that the responsibility for meeting this problem cannot be given to man. In other words, whatever conclusions man may reach regarding the need for controlling populations and the immediate as well as long-term means for meeting that need, the authority to assume this responsibility and, therefore, the power to implement the means are *de facto* denied to man.

This is an extreme case of what has become during the last half of the twentieth century a growing threat to the assertion that the human mind through its intellectual processes can indeed be the basis for man's assum-