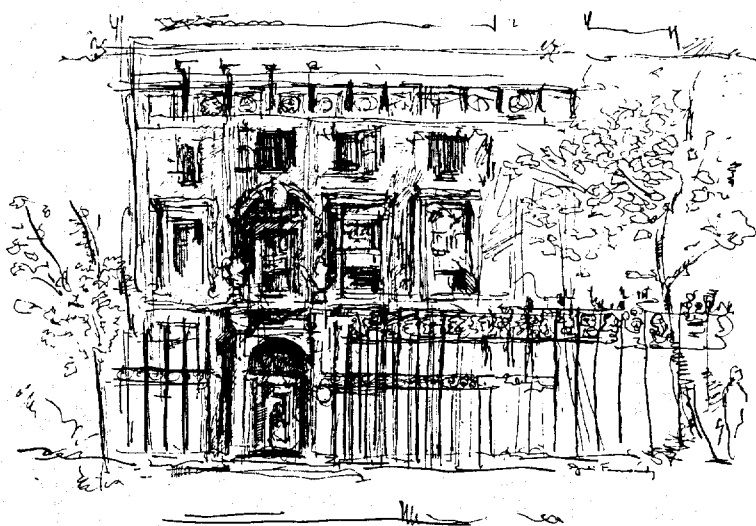


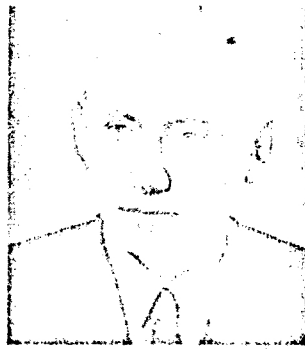
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biology and the rational animal



BY JOSHUA LEDERBERG

Dr. Joshua Lederberg shared the Nobel Prize in medicine in 1958 for his studies on the organization of the genetic material of bacteria. The year before that, he became a member of The National Academy of Sciences. He has taught genetics at the University of Wisconsin and Stanford University, and in 1957 was Fulbright Visiting Professor of Bacteriology at Melbourne University, Australia. He is now Professor of Genetics and Biology and Executive of the Department of Genetics at Stanford University.

Scientists are sometimes faulted for preoccupation with a search for abstract truth to the neglect of human utility. Insofar as the pursuit of science is nowadays almost impossible without extensive social support, the community can legitimately ask about the social payoff of its investment. The motivation of the individual scientist is by no means the criterion of that payoff. In many ways, he is exploited by society precisely for his dedication to abstractions, for example, when he works for considerably less pay than he might earn by using his intellect in more immediately utilitarian pursuits. The consequences of science must be judged independently of the motives of the individual researcher. Unfortunately, we have no overabundance of the appropriate combination of perspective, insight, and technical competence to help the community reach such judgments. It is easy to search for, and to find, short-run benefits arising in the most unexpected way from the discoveries of basic science, and this is sometimes cited as the main reason to justify social support of it. Most of my colleagues do not really believe this in their own hearts, however, but I do not know why they are afraid to articulate the most pervasive motive: that we live in a scientific culture; that our way of living through our objective understanding of nature is immediately dependent on the discipline that science alone knows how to teach. That is, the most important utility to man that comes from basic research is his learning how to deal with nature, how to be a rational animal.

The citizen's immediate confrontation with science is in his schooling. He learns from his teachers, from grammar school through the university. But how do his teachers learn? How can they be disciplined in intellectual rigor and honesty? Only by constant exposure to contemporary truth, a constantly evolving truth that arises from the scientific process: asking questions of nature, and exposing the claimed answers to the ruthless, objective criticism of the informed and highly competitive research community.

Nowhere do we see a clearer exposition of the pragmatic and humanistic functions of science than in biology. From a utilitarian standpoint, agriculture was the first main arena of practical biology, but this has been rapidly overtaken by medicine. The purported motivation of the most incisive aspects of modern biology is to buttress the attack on human disease. It is certainly true that the analysis of cellular constituents and how they are synthesized and organized is an absolutely essential part of our attack on cancer; we will not get very far in preventing and alleviating the diverse forms of mental retardation until we know much more about the development of the brain; the structure of proteins, and their chemical changes with time are indispensable knowledge for the arrest of aging. When we contemplate mental health, which, statistically, is by far our most urgent medical problem, we are not yet even sure what are the most likely avenues of biological research, and we need much more study simply to gain that outlook.

During the past decade, federal support of such foundational research has been vigorous and effective, building up an unprecedented momentum embodied in a cadre of seasoned scientists with excellent training, confidence and morale, and the beginnings of the needed research facilities—laboratory buildings and their armory of modern instruments.

But, it seems, we have fallen down on our responsibility for public education as to the actual proper place of these efforts among our social enterprises; we now hear that some inexorable law of limited growth rate must suddenly be invoked to stifle this momentum at the most exciting stage of its career. Such a principle might be more reasonable if it were applied to a platform that had once been established at some rational decided level, which has certainly never been done.

In a number of areas, we are undoubtedly not taking full advantage of existing basic knowledge; people are sick and dying who could be healthy. Nor do we make full use of our knowledge of nutrition; people are hungry who might be well fed. Making available the most advanced medical care, as well as food, shelter, and education, is an urgent social problem that pricks the sensitivities of the scientist no less than those of other human beings, perhaps more as he may have deeper insight into the unrealized potentialities of our technical culture. To focus on basic research as the place to fulfill these wider social needs is, however, rather like killing the goose that lays the golden egg. But there is many a naive ploughboy who will do just that if we do not teach him better.

We can also point to a technological gap, to innumerable medical machines industry could learn to make—artificial hearts, kidneys, livers, eyes, hands, ears—that could contribute immeasurably to the health and comfort of people. In many cases we have as nearly sufficient, albeit not perfect, basic information for technological health applications as we have had in physics and metallurgy to support new weapons or aircraft systems. But we have not learned the courage to try.

Public ignorance of biology has and will have its most grievous impact in the arena of human nature itself. For example, the contemporary debate about therapeutic abortion is founded on the most abysmal ignorance of reproductive biology. The myth that is man, the core of the religious impulses that are indeed uniquely human, is and must be cloaked in the most rigorous moral prescriptions. But how can the citizen exercise his moral responsibility of judgment when he does not understand the scientific biology of fertilization—which is by no means to insist that this is the only outlook on this judgment—and the techniques that are now available to anticipate monstrous malformations of an infant, or lasting psychic trauma to a mother. As medicine advances, its very successes pose new problems. We are rapidly passing into an era in which our conventional understanding of death is obsolete; there simply is no instant when a person dies, and we have learned many ways in which to prolong what used to be an evanescent transition. Hence, the end of life is becoming almost routinely a matter of decision, when the physicians have given up their own hopes of a “useful” result of further care. These are burdens that should not be left to physicians, but they will have to be until Everyman has learned the essentials of human life.

The confrontation of morals, law, and science is already vexing, but the biologist can promise that we have hardly seen the beginning. I do not subscribe to the expectation that we are about to use genetic science on a large scale for the fabrication of man by rebuilding his DNA; this is at least 10 or 20 years in the future, a very long time in relation to the present pace of the scientific revolution. But we are already in the “euphenic” era, having some tools for modifying the development of single individuals; take the reconstruction of sex by surgical and endocrine treatments as an example. And we can be sure that we are not too far away from rather direct interventions in monitoring the growth of the fetal brain. It may be hoped and expected that the political process will not intervene in the more constructive decisions that are domestically undertaken in such matters; but in the future, good parents will have to be better biologists.