Letters

Human Genome Sequencing

The answer to the question of whether the human genome should be sequenced is not so obvious as Daniel E. Koshland, Jr., suggests in his editorial of 1 May (p. 505). The notion that "it is time to start running" along the human chromosome sounds much like other clarion calls for a headlong rush into technological advances for which little or no political, legal, regulatory, or even ethical preparation has been made. The sequencing of the human genome will certainly be the Manhattan Project of biology and, as such, will share many of the pitfalls seen in the application of technologies developed from the discoveries made in nuclear physics.

The United States and other nations who committed to the design, construction, testing, and deployment of nuclear weapons did so without a clear assessment of potential global environmental and health risks. While one can plead the case of geopolitical strategy and national defense for the production of nuclear weapons, even the application of this technology to such peaceful purposes as electric power generation has resulted in a staggering waste-disposal problem, the potential for devastating health effects from reactor accidents, and the probable proliferation of nuclear weapons throughout the Third World. Nuclear technology was clearly introduced before the world was ready to deal with its consequences, and such may be the case of sequencing the human genome.

One of the rationalizations for unleashing the power of the atom was the "unlocking" of the elemental secrets of the universe. To sequence the human genome will certainly unlock the secrets of the chemical basis of humanity—its diseases, defects, even its intelligence. While this is undoubtedly an undertaking of great intellectual interest, it, like the other unlocked secrets of 20th-century science, holds out the possibility of perversion. If, with a complete sequence map for human chromosomes, it will be possible to "turn on" the genes controlling resistance to some disease, will it not be equally possible to switch them "off"? In view of our poor record in nuclear physics, is there any reason to suppose we will have any better success with the uses to which a detailed knowledge of the human genome will be put?

The major facet of the debate concerning the sequencing of the human genome should not be who controls the budget or other Big Science–Little Science internecine warfare. These are minor details. What should concern the scientific community is that adequate preparation for the ramifications of the results from this undertaking is made in the spheres of influence outside of science. Unless the people who will undoubtedly regulate the uses of these results are thoroughly educated about their dangers, as well as their benefits, we may fall victim to yet another scientific triumph gone awry. Until a concerted effort at such education is made, even walking along the human chromosome may be too fast a pace.

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Carcinogenicity and Allergenicity

An interesting feature of the nonradioactive metallic elements is the concordance of their allergenic and carcinogenic properties. There are 15 metals for which studies of both carcinogenicity in humans or animals *and* allergenicity in humans have been reported (Al, Sb, As, Ba, Be, Bi, Cd, Cr, Co, Cu, Fe, Pb, Ni, Se, and Zn) (*1–3*). Four of these elements (As, Be, Cr, and Ni) are well accepted as being carcinogenic in either animals, humans, or both. It is striking that these four elements are those for which allergenicity is generally accepted.

Two metals (Ba and Be) are reported to be neither allergenic nor carcinogenic. Of the nine remaining metals for which reports are available, the evidence is ambiguous for *both* carcinogenicity and allergenicity. All metals that have been shown unambiguously to be carcinogenic in either animals or humans have also been shown to be strongly allergenic in humans.

The carcinogenic and allergenic properties of the metals are well known to industrial health specialists, but the concordance of the two types of response has apparently escaped notice. There may be a common underlying factor that could be of interest to investigators in the field of carcinogenesis.

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REFERENCES

1. *Proceedings of a Workshop/Conference on the Role of Metals in Carcinogenesis* [*Environ. Health Perspect.* **40** (entire issue) (August 1981)]; E. Cronin, *Contact Dermatitis* (Churchill Livingstone, London, 1980); L. Friberg *et al.*, *Handbook of the Toxicology of Metals* (Elsevier, Amsterdam and New York, 1986).

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Scientific Fraud and Prosecution

Colin Norman (News & Comment, 29 May, p. 1057) states in his article "Prosecution urged in fraud case" that "no previous case of alleged scientific fraud is known to have resulted in criminal prosecution."

As a matter of record, a number of actions have been taken by the Food and Drug Administration (FDA) (through the Department of Justice) against investigators involved in clinical research who have been found to have violated pertinent sections of the Food, Drug and Cosmetic Act or Title 18 of the U.S. Code, or both. Title 18 specifically addresses, among other things, submission of false data to the government, conspiracy, and obstruction of justice.

Since 1975 the FDA has submitted to the U.S. Attorney 20 cases of fraud and other criminal violations uncovered in clinical research with investigational new drugs. Thirteen of these cases have resulted in convictions of clinical investigators, some of whom received prison sentences. In addition, evidence gathered from inspections under our Bioresearch Monitoring Program has resulted in 84 administrative sanctions in which clinical investigators have been prohibited from receiving investigational drugs or have been restricted in some manner in using such drugs.

Poorly conducted or fraudulent clinical trials not only place the subjects at unnecessary risk but may result in a much greater hazard should the drug be approved on the basis of inadequate safety and efficacy data. We believe that, since the institution of our Bioresearch Monitoring Program, human research subjects have been afforded a greater degree of protection through continuous monitoring of physicians and others engaged in clinical drug research.

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Luminous Arcs: Universal Scaffolding?

The galaxy-spanning luminous arcs reported by M. Mitchell Waldrop in Research News on 6 February (p. 631) have a very simple explanation. They are part of the scaffolding that was not removed when the contractor went bankrupt owing to cost overruns.

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