



Explaining "Linguistic Features" of Noncoding DNA

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ministic, they do not provide useful information on deciding whether or not to pursue various programs to enhance the capabilities of different members of society. Those decisions are moral, social, and political ones.

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References and Notes

1. R. J. Herrnstein and C. Murray, *The Bell Curve: The Reshaping of American Life by Differences in Intelligence* (Free Press, New York, 1994).
2. A longer version of this statement was endorsed by the National Society of Genetic Counselors.

Genetic Patents

I would like to comment on the article "Scientists attacked for 'patenting' Pacific tribe" by Gary Taubes (News & Comment, 17 Nov., p. 1112). The Rural Advancement Foundation International (RAFI) is not questioning molecular biology but rather the ethics of patenting human genetic ma-

terial. The basis of RAFI's concerns about patenting genetic material from the Hagahai tribe in Papua New Guinea have been clearly laid out in the "Blue Mountain Declaration," which states

The humans, animals, microorganisms and plants comprising life on earth are part of the natural world into which we were all born. The conversion of these life forms, their molecules or parts into corporate property through patent monopolies is counter to the interests of the peoples of the world.

No individual, institution, or corporation should be able to claim ownership over species or varieties of living organisms. Nor should they be able to hold patents on organs, cells, genes or proteins, whether naturally occurring, genetically altered or otherwise modified.

Substantial numbers of people around the world are developing a consciousness that there is something ethically wrong with the patenting of life forms, particularly human genetic material. For example, the Parliament of the European Union voted last 1 March against the issuance of such patents. Those of us who discuss these matters at churches, union halls, and community assemblies find that ordinary Americans are appalled when they find out about the patent applications that have been filed.

The members of RAFI are not "anti-

science." They have not attacked the Institute of Medical Research in New Guinea. They have asked how and in what fashion the Hagahai gave their approval to the patenting of their genetic material. They have asked how and in what fashion the individual whose cell line has been immortalized gave "informed consent" to this procedure. They have asked how having a "clear understanding of the concept of ownership" can be construed as approving the ethics of patenting a human cell line, as many people in Europe and North America who understand ownership also oppose such patents.

To raise such questions is essential to the necessary public discourse that must be conducted about these scientific and institutional developments.

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Explaining "Linguistic Features" of Noncoding DNA

In the article "Hints of a language in junk DNA" (Research News, 25 Nov. 1994, p. 1320), Faye Flam described the statistical

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analysis by Rosario Mantegna *et al.* (1) which suggested that "junk" or noncoding DNA has the structural features of a language. We argue that most of the observations in their analysis, which was based on Zipf's law and Shannon redundancy, have a much simpler origin: In the sequences examined, noncoding DNA had greater variance in nucleotide composition than did coding DNA, a fact which is implicit in figure 3 of their paper (1).

For their statistical analysis, Mantegna *et al.* subdivided the DNA sequences into "words" of fixed length, n , and then computed the "word" frequencies. Mantegna *et al.* then show that the Shannon redundancy, $R(n)$, is nonzero in noncoding DNA (as in natural languages) and is significantly larger than that of coding DNA.

The redundancy $R(1)$ of single "letters" A (adenine), C (cytosine), G (guanine), and T (thymine) reflects the nucleotide composition and increases with increasing variance of the distribution. Thus a larger $R(1)$ for noncoding than for coding DNA simply means that nucleotide frequencies are more uneven in noncoding DNA. The increase in $R(n)$ with increasing n observed by Mantegna *et al.* (1) is the same in both kinds of DNA [see figure 3 in the paper by Mantegna *et al.* (1)] and thus does not serve

to discriminate between coding and noncoding DNA.

Unequal nucleotide compositions also go a long way toward explaining the differences in the Zipf plots obtained for noncoding DNA (2). Most of the observations made by Mantegna *et al.* (1) may thus be trivial consequences of uneven nucleotide frequencies. This explanation does not rule out the existence of a hidden "language" in noncoding DNA, but it removes any superficial evidence for this hypothesis. A more detailed discussion will be published soon in *Physical Review Letters* (2, 3).

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1. R. N. Mantegna *et al.*, *Phys. Rev. Lett.* **73**, 3169 (1994).
2. S. Bonhoeffer *et al.*, *Phys. Rev. Lett.*, in press.
3. N. E. Israeloff *et al.*, *ibid.*, in press; R. N. Mantegna *et al.*, *ibid.*, in press; R. F. Voss, *ibid.*, in press.

Coral Bleaching

A Random Samples item (10 Nov., p. 919) erroneously reports that a "National Science Foundation-sponsored meeting of reef scientists concluded in 1991 that global warming was not the culprit" for the widespread bleaching of reef corals in the Caribbean.

The 1991 interdisciplinary workshop did not exculpate global warming completely. The summary of the report (1) produced by the workshop and unanimously endorsed by the participants, states clearly

With respect to the issue of coral reef "bleaching," the group concluded that recent increases in reported events were indicative of increasing ecosystem stress, and that many of the events appear to be associated with local high temperatures. However, other stresses are also known to cause bleaching, and our knowledge of both coral stress responses and the detailed nature of climate change make it impossible at present to claim that coral bleaching is an early indicator of the global greenhouse effect. This detailed finding was seen as strong reinforcement of the perceived need for systematic monitoring as a basis for research.

In our zeal to observe the phenomenon of coral bleaching and to ascribe a cause to it, we must exercise appropriate scientific

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