An exchange of letters explores the "tension between privatization and the public domain in the use of genomic data." A writer explains why the "end of public higher education" is upon us. How "rising atmospheric carbon dioxide" affects "soil fungi" and "total microbial biomass and bacterial composition" is examined. And "subchrons" are said to have "important implications...for providing a better understanding of the origin of the geomagnetic field."

Patenting Genes

The recent Review commentary by Michael A. Heller and Rebecca S. Eisenberg (*Science*'s Compass, 1 May, p. 698) is a comprehensive analysis of the tension between privatization and the public domain in the use of genomic data. One of the questions raised is, Given the complexities of the situation, would the companies owning gene-related patents and their potential licensees work out mutually beneficial licensing agreements? We believe the answer is yes.

The actual and potential investments of various pharmaceutical companies in the genomics area has been reported as being tens and even hundreds of millions of dollars. This is an indication that companies that are not owners of, or licensees under, gene-related patents will be reluctant to abandon the use of genes or gene fragments covered by those patents. In that case, the patent owners will be hard-pressed to ignore any activity they see as infringing on their patent claims. On the other hand, companies accused of infringement will have the option to challenge the validity of patent claims that they reasonably believe to be invalid and to similarly challenge the scope of patent claims asserted against them. A full-scale patent suit can cost each side several million dollars and be extremely disruptive. Hundreds or even thousands of genes and gene fragments will probably be patented. Even given the possibility for consolidating some of the litigation, the economics of frequent litigation are daunting. Furthermore, the outcome of litigation can be difficult to predict. Therefore, it is likely that the parties involved will be highly motivated to arrive at workable licensing agreements.

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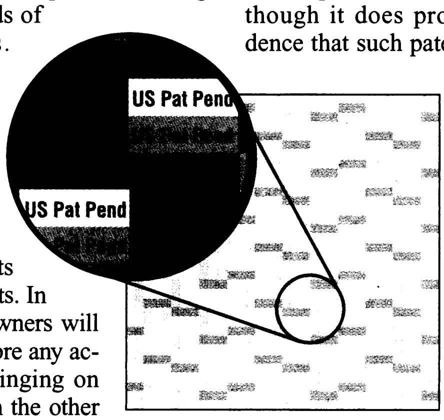

Can mutually beneficial licensing agreements be worked out?

Response

Both sides of this debate suffer from the absence of empirical evidence to support predictions about whether owners and users of genomic patents will be able to overcome the barriers to licensing that we discuss in our commentary. Alhough many pharmaceutical firms have invested substantial sums in "one-stop shopping" transactions to obtain access to large databases of, as yet, unpatented genomic information, this fact does not indicate that these firms will manage to collect rights to fragmented and overlapping genomic patents from multiple owners (although it does provide compelling evidence that such patents are unnecessary to promote investment in genomics). Nor do high litigation costs ensure that intellectual property owners will "arrive at workable licensing arrangements." Most negotiation breakdowns are not litigated; other negotiations never even begin because of the high costs of identifying multiple owners. We are particularly concerned about the deterrent effect of high transaction costs on the use of patented genomic information in academic and other fundamental research for which the ultimate commercial value is remote and speculative. The Patent and Trademark Office appears to share the optimism of Fried and Watson. We remain agnostic, but are rather less sanguine.

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The End of Public Higher Education

Five years ago, I wrote a piece entitled "The end of public higher education?" (Letters, 24 Sept. 1993, p. 1661). I now remove the question mark. Here is why.

From the beginning, the establishment and maintenance of U.S. public higher education has been supported from two main sources: (i) principal and income from public lands set aside, and in some cases privately donated, for the support of education; and (ii) direct appropriations by the states. Beginning with World War II, the support of basic science and of some applied science, especially in medicine, marine resources, and technology, has made several of the "public ivies" true research universities. Recently, support from state government—long the main source for the central budgets of these institutions—has been in a steady decline. Five years ago, it was only 35 to 40% of the total budget from legislative appropriations. Today it is often less than 20%. There has also been increase in micromanagement from state capitals.

Serious consequences already are emerging. On the eve of the next big population bulge of college-age students, the slots in the state institutions will simply not be there. Tuition charges—once free or nearly free at state and city universities—have been growing much faster than inflation, financial aid, or family incomes. More and more nontenured, low-paid temporary instructors with heavy teaching loads are staffing the state-supported institutions. The percentage of students who work full time is sharply increasing. Growing rapidly is severe denial of access, especially for middle- and lower-income students, single mothers, and minorities. Changes in funding available to students compound the problem.

It gets worse. State legislators and higher-education coordinating authorities have begun, as a basis for appropriations, to impose performance measures on state colleges and universities. These will, if not handled right by academia, be the coup de grace to public higher education.

What to do? At the heart of the academy's response must be a credible analysis of the difficult questions. Are there some things that are unmeasurable? Must all measures be numerical? What numerically measurable indicators taken together give a reasonably reliable measure of performance? Can we convince legislators that measurable successes in research and public service should figure in accountability? Can we prove that we don't shield incompetence with tenure? Aren't the established peer-review standings sufficient measures and, if not, how can they be improved or used effectively? With these questions answered, constructive proposals must be made by the institutions themselves.

Surely academia has the wit to reverse this trend.

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Elevated Atmospheric CO_2 and Soil Biota

In their report "Impacts of rising atmospheric carbon dioxide on model terrestrial ecosystems" (17 Apr., p. 441), T. H. Jones *et al.* found that elevated atmospheric carbon dioxide (CO_2) alters the composition of soil fungi and Collembola, but has no effects on total microbial biomass and bacterial composition in model Ecotron ecosystems.

Plant production in many terrestrial ecosystems is nitrogen (N)-limited, and elevated CO_2 generally stimulates plant growth, carbon allocation below-ground and strengthens the plant N sink, intensifying plant-microbial competition for N in soil (*1*). Enhanced C inputs and reduced N availability in soil may result in a surplus of C relative to N and thus benefit fungi over bacteria (*2*), leading to a soil microbial community of greater fungal dominance (*3*).

Collembolan grazing of mutulistic, pathogenic, and saprophytic fungi may become more important in regulating microbial community structure and plant-microbe interactions (*4*) and potentially in feed-back to elevated CO_2 by modifying decomposition, nutrient cycling, and plant community structure. The results observed by Jones *et al.* may therefore be the result of C and N interactive controls on microbial community structure and activity resulting from elevated CO_2. These model ecosystems may thus reveal C- and N-mediated microbial feedback mechanisms important in natural ecosystems under elevated CO_2.

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References and Notes

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3. J. N. Klironomos, M. C. Rillig, M. F. Allen, *Funct. Ecol.* **10**, 527 (1996).
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5. S. Hu is supported by the National Science Foundation under a fellowship awarded in 1996.

Geomagnetic Reversals

In their report "Lake Baikal record of continental climate response to orbital insolation during the past 5 million years" (7 Nov. 1997, p. 1114), D. F. Williams *et al.* present a sedimentary record of biogenic silica from Lake Baikal in Siberia. Magnetic polarity reversal data provided age control points that were used to arrive at a constant and continuous sedimentation rate of 4 centimeters per thousand years. In figure 1A of the report (p. 1115), a reference geomagnetic polarity time scale shows a number of short periods of normal polarity that do not appear in the references (*1*) listed in that figure. These periods appear to be based on the magnetic inclination record derived from the Lake Baikal samples, but are not shown in another publication related to the Baikal Drilling Project (*2*). "Events" at about 0.85, 1.2, and 2.4 million years ago appear to be the Kamikatsura, Cobb Mountain, and "X" subchrons, respectively (*3*). Normal events at about 1.55 and 2.03 million years ago do not appear in reference geomagnetic polarity time scales. The latter may argue for a split Reunion Event (*4*), although only a single event has been dated at 2.14 million years ago in the "type locality" (*5*).