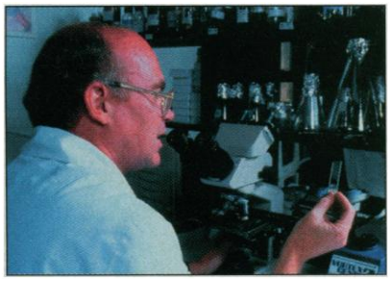
The fate of physician-scientists continues to be a topic that elicits many letters, most urging that something be done to "prevent the extinction of this species of scientist..." "The critical question is whether it is too late." Agricultural scientists propose that, for high rice yields, erect leaves are necessary to sustain the large leaf area necessary to store nitrogen. A new translation of Einstein's "Kyoto lecture" appears to resolve questions about his reported anomalous statement about the Michelson-Morley experiment. The importance of antimony in modulating arsenic's toxicity in drinking water is raised. And crystallographers challenge cell biologists to prove that experiments in microgravity are without value.

Physician-Scientists at Risk

The Policy Forum by Leon E. Rosenberg (*Science*'s Compass, 15 Jan., p. 331) and letters from William R. Brinkley and Ajit Varki (*Science*'s Compass, 5 Feb., p. 791) concerning the decline of physician-scientists and their research are commendable. However, a subtle but critical point, which has a major impact on the situation, has not been mentioned. The problem stems from the all-inclusive classification by Rosenberg of physician-scientists as those performing "basic, disease-oriented, patient-oriented, population-oriented, and prevention-oriented" investigation. Upon careful analysis of the data and consideration of the kinds of research being performed by the extremely diverse group of M.D.'s and M.D./Ph.D.'s, it is clear that the problem for prototypical physician-scientists (that is, those performing laboratory-based, disease-oriented research) is much more precarious than appreciated.



Can the classical physician-scientist survive?

M.D.'s performing typical clinical research and those doing pure basic science who do not see patients are in fact comparatively well off and therefore should not be included in the discussion. Rather, the critical decline in M.D.'s performing research has been limited largely to traditional physician-scientists, those performing laboratory-based investigation who extend into the clinical arena. The immediate future for this group is clouded by the almost complete exhaustion of M.D.'s who desire this classical career pathway.

Evidence for this comes from the trend in M.D.–focused National Institutes of Health (NIH) training grants. Although many of these slots are still being filled by M.D.'s (and this looks fine to NIH), most training programs have refocused their objectives to train clinical researchers. Therefore, these training grants are being filled by M.D.'s who will perform pure clinical research; indeed, in 1999, the emphasis on M.D. research has shifted squarely to evidence-based medicine/outcomes research. Furthermore, given the influence of managed care, the palpable emphasis now being placed on this type of clinical research in medical schools, and the new K23 and K24 awards (which have been designated for clinical researchers to the exclusion of laboratory-based M.D.'s), M.D.–driven clinical research is almost certainly assured of future success. This is not the case for laboratory-based M.D.'s. The depletion of these physician-scientists is only beginning, and the problem is going to be amplified dramatically in the next few years.

The critical question is whether it is too late. It very well may be. If there is any hope, however, then the steps highlighted by Rosenberg, Brinkley, Varki, and others must be endorsed by the entire medical community and acted upon immediately.

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Like many clinicians, I have identified common problems that are easily definable, but not easily treatable. I would like to have the opportunity to research some of these issues, but do not have the time as a full-time clinician. When I have discussed this with my boss, he has told me if I could produce some promising data, he would give me protected time to develop them. However, I can't get protected time to get the initial data with my busy clinical schedule. Thus, I am in a "Catch- 22." If I get the data, I can get protected time. Yet, without the protected time, it will be very difficult to get the data.

Despite these obstacles, I am trying to pull some of the early pieces together in my "off hours." This is difficult and may ultimately not be fruitful. I would love the opportunity to be able to apply for a starter program for mid-career clinicians who would like to research a clinical issue. I believe that I have insights into disease processes that are worth exploring. Yet, they will remain at the level of a hypothesis or an anecdote unless I am able to have the time to systematically develop an approach to study them.

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Unmentioned in Rosenberg's Policy Forum are the significant disadvantages for a physician-scientist being funded by NIH. For example, a physician-scientist earning $150,000 per year who receives NIH funding for 50% of time and effort would have a shortfall of $15,375, assuming a fringe benefit rate of 23%. He or she must cover malpractice insurance; support the training of medical students, residents, and fellows; and support the clinic operations. These expenses easily reach $60,000 per year; none is covered by NIH grants, and the physician-scientist is held responsible.

If one assumes that the physician-scientist can meet his or her financial obligations by a 47-hour work week seeing patients, he or she would have to work an additional 7.8 hours a week to make up the shortfall. Even being paid the NIH salary cap, he or she would still have to work an additional 5.3 hours a week to meet the uncovered costs. Most physician-scientists put in these hours, but is it any wonder that medical students would be leery of pursuing a career in research?

One could argue that these additional expenses should be covered by the clinical department or by indirect costs. However, there are numerous reasons why this is unlikely to occur. Further, the physician-scientist would have to go "hat in hand" in order to get special consideration.

One realistic solution is for NIH and other funding agencies to recognize the special and extra costs associated with a physician-scientist's work. These funding agencies should grant to the individual physician-scientist the necessary funds to cover these expenses in order to ensure that those funds directly support the physician-scientist doing the research. Otherwise, not only will we see fewer

physicians entering research; we will see more physicians leaving.

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Not that many years ago, a department in a medical school which provided clinical care could obtain enough money through its revenues generated by patient care reimbursement to underwrite a meaningful portion of the faculty effort required to do clinical research. While one might argue that such reimbursement was not intended for this purpose, it was a practice understood and accepted by all involved, and the money spent for these research efforts by and large was a good investment for the country in general. The cost-cutting efforts that have affected all of medicine, including but not restricted to managed care and HMOs (health maintenance organizations), are in the process of rapidly eliminating this subsidy to clinical science. I do not know the amount of money this represented, but it certainly ran to many millions—perhaps hundreds of millons—of dollars. Its loss will be strongly felt, not just by the physician-scientists whose efforts would have been supported in this way, but also by the many hundreds of thousands of patients who would have benefited.

Not only are changes in health care delivery practices making it extremely difficult to recruit patients into clinical studies, but paying for the time that is needed to complete these studies is becoming increasingly problematic. Any endeavor to prevent the extinction of this species of scientist will need to address these issues.

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Erect Leaves and Photosynthesis in Rice

Charles C. Mann's article "Genetic engineers aim to soup up photosynthesis" (News Focus, 15 Jan., p. 314) suggests an improved RuBisCO enzyme to "lower crops' need for nitrogen." A second article by Dennis Normile (News Focus, 15 Jan., p. 313) suggests that erect leaves are necessary for capturing more sunlight. Both suggestions do not take into account the essential fact that high yields necessarily involve harvests of large amounts of nitrogen (N) and that much of this N must be accumulated and stored in the leaves before grain development (*1*). For example, a yield of 10 tons per hectare of rice includes the harvest of 140 kilograms of N per hectare in the grain. Because about half the grain's N must be translocated from leaves (*2*) and leaves can transfer about 1.0 gram of N per square meter (*3*), a leaf area index (*L*, one-sided leaf area per unit of land area) of 7 is needed simply to store N before transfer to the grain. The proposed decrease in RuBis-

CREDIT: THE CHINA NATIONAL HYBRID RICE R&D CENTER

Chinese breeders hope a rice strain having narrow erect leaves will increase yields.