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-

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

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CO concentrations and, consequently, leaf N would necessitate an even greater L. Rice cultivars before the green revolution did not achieve an L as great as 7.

An assumed major benefit of erect leaves in light capture for photosynthesis is not supported by either experimental or theoretical evidence (*4*). We propose, however, that erect leaves are required in order to sustain the high L needed to store N. Leaf senescence is induced when light reaching leaves is less than about 5% of incident sunlight (*5*). The following exponential equation for light interception (*6*) is a concise relation between light level and L

$$I/I_0 = \exp(-GL/\sin(S))$$

where I/I_0 is the ratio between light levels in and above the canopy; G is the shadow projection of leaves, which is dependent on leaf and sun angles; and S is the sun angle above horizontal. The value of G must be decreased to obtain high L exposed to $I/I_0 \geq 0.05$.

If one assumes that S is 70° and a pre–green revolution leaf angle is 45° (G = 0.664), the viable L for N storage is calculat-

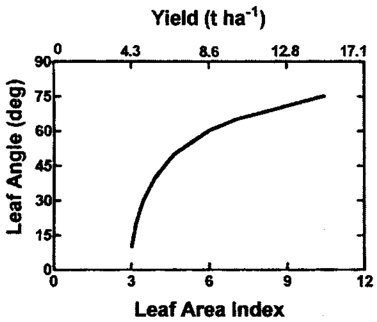

Fig. 1. Leaf angle above horizontal required in rice for adequate light penetration to achieve the leaf area indices and yields indicated on the abscissa. This plot assumes a sun angle of 70°.

ed to be 4.2. An L of 4.2 provides N to support a rice yield of about 6 tons per hectare. Higher yields demand a higher L for N storage, and this requires more erect leaves, as illustrated in Fig. 1. In studying the changes in rice varieties with year of release from the beginning of this century in Japan, Tanaka *et al.* (*7*) noted a progression toward higher yields associated with more erect leaves and higher L. We conclude that high N storage in leaves is essential for high yields of rice and that erect leaves are a necessary adaption to allow a high L for N storage.

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Einstein's "Kyoto Lecture": The Michelson-Morley Experiment

In the summer of 1996, I was asked by the editors of the Einstein Papers Project at Boston University to help prepare a new translation into English of a lecture by Einstein given at the Imperial University of Kyoto on 14 December 1922. The only source for this "Kyoto lecture" is a Japanese text (*1*) published by Jun Ishiwara (1881–1947) on the basis of notes, which have not been found, that he had taken during the lecture in order to be able to summarize its contents afterward for the Japanese audience. English translations of (parts of) this text were published by T. Ogawa (*2*) and Y. A. Ono (*3*). These have been cited as evidence that Einstein knew about the Michelson-Morley experiment much earlier than is usually thought. Much to my surprise, I discovered that these translations are unreliable in places, including the crucial passages dealing with the Michelson-Morley experiment. What Einstein really said, according to Ishiwara, is the opposite of what he is believed to have said on the basis of the existing translations.

Ishiwara was one of the earliest theoretical physicists in Japan and published several papers in first-rate journals (*4*). He studied abroad from 1912 to 1914 in Munich, Zurich, and Berlin under the direction of, among others, Arnold Sommerfeld and Max von Laue. He met Einstein in Zurich and Berlin. Because of the outbreak of the First World War, he returned to Japan and became a full professor at Tohoku University. During Einstein's stay in Japan, Ishiwara accompanied him almost everywhere. The following year he published his reconstruction of several of these lectures in Japanese.

The Kyoto lecture includes an account of Einstein's knowledge of the Michelson-Morley experiment, or, as Einstein apparently routinely referred to it "Michelson's experiment." He said that in his student days he made a plan to devise an experiment to demonstrate the relative motion of the Earth with respect to the ether. He hoped to detect an energy difference between a light beam