phorus, potassium, and water), of which carbon is only one. Under optimum resource conditions, the rate at which a plant can process those resources into new biomass may be limiting. Both the rates of resource acquisition and the rate of processing are functions of temperature, salt, water, and so forth. A case for photosynthesis being rate limiting could be made if changes in photosynthesis mirrored growth-rate changes with changing environmental conditions, but in most instances this relation does not exist. Statements such as "the unexpected discovery of more efficient RuBisCO in red algae," without consideration of the conditions under which it is "more efficient," do not take into account the physical requirements imposed on the system by the environment. The "inefficiency" in carbon photosynthesis (photorespiration) is unlikely to be an uncorrected evolutionary problem, but rather is there for the purpose of allowing the energy-coupled reactions of photosynthesis to be optimized to variable temperature and light conditions. Because all of the metabolic processes of plants must be integrated together and optimized for their environment, understanding how the whole organism responds to short-term environmental change would seem to be the better approach to improving plant productivity.

Lee D. Hansen
Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT 84602, USA. E-mail: lee_hansen@byu.edu

Bruce N. Smith
Department of Botany and Range Science, Brigham Young University. E-mail: bruce_smith@byu.edu

Richard S. Criddle
Section of Molecular and Cellular Biology, University of California, Davis, CA 95616, USA. E-mail: rscriddle@ucdavis.edu

References and Notes

1. T. Demetriades-Shaw, M. Fuchs, E. T. Kanemasu, I. Flitcroft, *Agric. Meteorol.* **58**, 193 (1992); *ibid.* **68**, 231 (1994); D. W. Lawlor, *J. Exp. Bot.* **46**, 1449 (1995); C. J. Nelson, *Plant Physiol. Biochem.* **26**, 543 (1988); S. D. Wullschleger, P. J. Hanson, G. S. Edwards, *Plant Cell Environ.* **19**, 577 (1996).

Women in Biological Sciences

The National Science Foundation's annual survey does indeed show that the proportion of earned doctoral degrees in biological sciences going to women has steadily been increasing from about 19% in 1975 to 38% in 1995 (Random Samples, 15 Jan., p. 323). However, there is more to celebrate than these numbers convey. In that same time, the proportion of bachelor's degrees in biology awarded to women has also reached parity (49.7%) from a 1975 level of 29% (see www.nsf.gov/sbe/srs/seind98/append/c2/at02-20.xls). The difference in these proportions (Ph.D. to B.S.) has remained fairly constant, with a 12% deficit at the Ph.D. level representing a 10-year lag (see www.nsf.gov/sbe/srs/seind98/append/c2/at02-30.xls). If current trends continue, we should expect parity for doctoral degrees conferred in biology by 2005. There are also telling trends in the relative proportion of those earning a B.S. in biology who later complete a Ph.D. Assuming an average of 5 years to complete a doctoral degree, only 5% of women completing an undergraduate degree in the late 1970s and early 1980s later completed a doctoral program in biological sciences. Ten years later, the proportion continuing in academia is at 11%; a value that finally is identical to the proportion of men who continue (a proportion for men which, incidentally, is down from a high of 15% in 1990). With these numbers in mind, it is now critical that universities be proactive in retaining women faculty. Only 21% of senior faculty positions in biological sciences are occupied by women (see www.nsf.gov/sbe/srs/seind98/append/c5/ at05-24.xls). The proportion of junior women faculty exceeded that level

in 1981, and it generally does not take 15 years to get tenure.

Mark E. Siddall
Museum of Zoology, University of Michigan, Ann Arbor, MI 48109, USA. E-mail: msiddall@umich.edu

Virulent HIV Strains, Chimpanzees, and Trial Vaccines

We would like to comment on the controversy concerning the use of a virulent strain of human immunodeficiency virus (HIV) to assess the protective efficacy of candidate HIV vaccines (A. M. Prince and L. Andrus, Letters, *Science*'s Compass, 18 Dec., p. 2195; N. L. Letvin, *ibid.*). We believe that this must be viewed from both scientific and ethical perspectives.

The controversy stems from the report of a chimpanzee that developed an AIDS-like syndrome 10 years after infection with various laboratory isolates of HIV and which was euthanized in 1996 (*1*). Inoculation of 40 milliliters of blood from this chimpanzee to a second animal resulted in an extremely high acute viremia (>10^7 HIV RNA molecules per milliliter of plasma) and a rapid depletion of $CD4^+$ cells within 14 weeks after infection. The virulence of the primary infection in this animal is not representative of most primary infections in humans. Acute viremia in humans is characteristically 10- to 100-fold lower, and $CD4^+$ cell depletion does not occur until several years after infection. Use of a challenge virus having unusual virulence could seriously jeopardize the HIV vaccine effort, because protection against such viruses could be missed with vaccines that effectively protect against less virulent wild-type HIV.

Suitable challenge viruses for vaccine evaluation should have virulence characteristics similar to those of wild-type viruses that infect humans. They should also ideally be primary isolates grown only on peripheral blood lymphocytes because of the relative resistance of such viruses to antibody-mediated neutralization. An expanded stock of the HIV-1_{Han2} isolate was recently developed by Program EVA (European Vaccine Against AIDS) to fulfill these requirements (*2*). This clade-B primary isolate exhibits growth characteristics in chimpanzees similar to those seen in humans. It reliably infects chimpanzees using small challenge inocula (10 to 100–tissue-culture infectious doses) and maintains a detectable chronic viremia similar to that obtained with the laboratory isolate HIV-1_{Lai}. It does not cause AIDS rapidly, if at all.

From an ethical perspective, our concerns about the use of virulent HIV strains stem to a large extent from precedents set in the field of simian immunodeficiency virus (SIV)/SHIV (a genetically engineered hybrid virus with an HIV envelope and an SIV core) research in monkeys. Pathogenic SIV strains have emerged that have subsequently been passaged through monkeys to develop isolates with increased virulence for that species and which cause death within weeks after infection. We point out that euthanasia of chimpanzees (our nearest relative) is universally condemned. The development of virulent HIV strains that cause AIDS in a short time would necessitate euthanasia and should be opposed on that ground alone.

We urge those who carry out vaccine research in the chimpanzee model to seriously question the use of virulent HIV challenge inocula from both a scientific and an ethical standpoint.

Alfred M. Prince Laboratory of Virology, New York Blood Center, 310 East 67 Street, New York, 10021, USA. E-mail: aprince@nybc.org; **Jonathan Allan**, Southwest Foundation for Biomedical Research, San Antonio, TX 78228, USA; **Linda Andrus**, New York Blood Center; **Betsy Brotman**, Vilab II, Liberian Institute for Biomedical Research, Robertsfield, Liberia; **Jorg Eichberg**, Editor-in-Chief,