ated" cells had twice as many chromosomes as usual: They were the product of fusion between two cells. Terada doesn't think that fusion explains all the other reprogramming results. "We're not denying any of those data. We're just saying, 'Be careful' " about possible explanations for unexpected results.

Developmental geneticist Austin Smith of the University of Edinburgh, U.K., says he and the team "approached the issue with open but skeptical minds." "All our other data said cells do become lineage restricted" —unable to form new kinds of tissues—as they progress toward becoming a certain cell type. He and his colleagues grew cells from adult mouse brains in a culture that also contained mouse ES cells. They then selected for cells that expressed Oct4 (a protein characteristic of undifferentiated ES cells) and also carried a gene present only in the brain cells. The team recovered more than two dozen cell colonies that seemed to have been reprogrammed. But on closer inspection, the cells had enlarged nuclei and twice as many chromosomes as normal: signs of hybrid cells, not reprogrammed ones.

Several of the original researchers are not dissuaded. "What they're saying is, 'Hey, fusion happens,' " says Diane Krause of Yale University, who has reported that cells from bone marrow can become a variety of tissues when injected into adult mice. Her lab is now checking whether its apparently reprogrammed cells formed from fusion of donor and recipient cells. Jonas Frisén, whose lab reported that brain cells can become a variety of tissues when injected into embryos, is also checking for evidence of hybrid cells, but he does not believe that cell fusion can explain all of their results.

The new papers come on the heels of two others that have cast doubt on the reported malleability of adult cells. In the March issue of *Nature Medicine*, Derek van Der Kooy, Cindi Morshead, and their colleagues at the University of Toronto report that they could not replicate earlier reports that cells from adult brain could become blood cells (*Science*, 22 January 1999, pp. 471 and 534). Instead, they report, cells kept in culture for many generations—as occurred in the original research—tend to accumulate genetic alterations that might lead to an apparent reprogramming.

And in February, Margaret Goodell of Baylor College of Medicine in Houston clarified one of her earlier reports on cells from adult mouse muscle. As she explained in the *Proceedings of the National Academy of Sciences*, the adult cells that seemed to give rise to blood cells were in fact rare blood stem cells that reside in the muscle.

The new results are a needed reminder for the field to stay vigilant, says van Der Kooy. "Our own data fail to replicate transdifferentiation, but there are so many reports out there. I'm still unwilling to believe all of them are false."

–GRETCHEN VOGEL

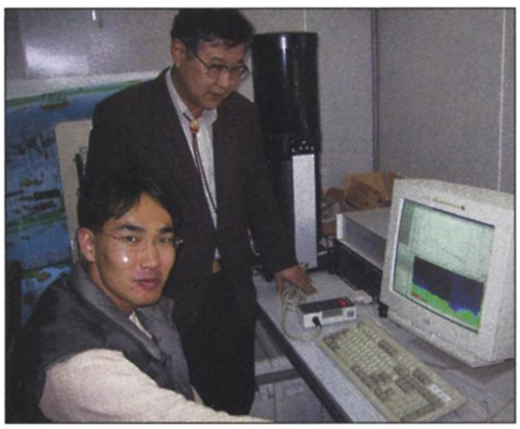
GRADUATE TRAINING

South Korea Scrambles To Fill Ph.D. Slots

SEOUL—Jae-Gwang Won is a member of an increasingly rare breed: a Korean graduate student working on a homegrown science Ph.D. This month Seoul National University (SNU), long considered the country's most prestigious university, failed to fill its quota of graduate slots for the new semester. More embarrassing still, SNU would have fallen short even if it had accepted every applicant.

Korea's postwar economic boom in the 1960s and 1970s certainly benefited from the belief that technical know-how was essential for a rising standard of living. Although many of those scientists were trained abroad, the strategy paid off: By 1995, for example, Korea's economy was the 11th largest in the world, and the country was second behind the United Kingdom in the percentage of its college-age population with technical degrees. "It was a good time for science in Korea," says Sung H. Park, SNU's dean of natural sciences, and there were plenty of good jobs.

Faith in technology as an economic driver hasn't disappeared, but it's being undermined by several factors. One is a loss in status. "When I was in high school, science was prestigious," says 53-year-old Yoon Soon-chang, an SNU professor of atmospheric science and associate dean of planning. "Being a scientist meant being proud." But today's students are more interested in careers that pay well, Yoon says.



CREDIT: SEOUL NATIONAL UNIVERSITY

Minority view. Jae-Gwang Won, seated, with SNU dean Yoon Soon-chang, is part of a dwindling pool of grad students.

ScienceScope

Southern Light Spain is joining the synchrotron club. The science ministry last week approved building Spain's first major facility for probing three-dimensional structures. Plans call for breaking ground next year on the $110 million, 2.5–gigaelectron volt radiation source to open in 2008 near the Autonomous University of Barcelona (UAB). The new center—proposed by a UAB-led team in 1997—will have room for up to 160 research teams, planners say. And it will be open to scientists from across southern Europe, notes Andreu Mas-Colell, head of the Catalán government's research department, which will split the project's cost with the national government.

Protein Probes Biologists who use small molecules to explore how proteins work—an approach known as "chemical genetics" —will soon have a major new resource. The National Cancer Institute has just awarded a $40 million, 5-year contract to Harvard University for a Molecular Target Laboratory. The facility, to be headed by Stuart Schreiber, will be an outgrowth of Harvard's 4-year-old Institute of Chemistry and Cell Biology. It will develop tools such as protein arrays and build a public database that will catalog up to a million small molecules—synthesized by Harvard and other labs—that block or interact with proteins.

The high cost of the robotics, protein assays, and other tools needed to systematically screen sets of molecular probes has prevented chemical genetics from taking off, notes chemist Brent Stockwell of the Whitehead Institute in Cambridge, Massachusetts: "It's not an easy method to implement; this will make it more accessible." Harvard's Rebecca Ward says it's not yet known when the data will go online.

Getting to Basics The U.S. government should fund only basic research that is of high quality, is relevant to government missions, and meets clear performance goals, according to draft guidelines released earlier this month by the White House Office of Management and Budget (OMB) (see www7.nationalacademies.org/gpra). Although no researcher argued with that holy trinity at a recent National Academy of Sciences workshop on the criteria, many wondered about exactly how they will be used to decide which programs deserve cash—particularly when it comes to high-risk research that is bound to stumble. Maybe, OMB's Sarah Horrigan suggested, the guidelines should include "a way to reward scientific failure." That and other changes could be included in OMB's next draft, due out later this year.

The country's rising standard of living is another part of the changing equation. From the 1950s to the 1970s, only the smartest students could study abroad by qualifying for scholarships, says Jung H. Shin, an associate professor of physics at the Korea Advanced Institute of Science and Technology (KAIST) in Taejon. With greater wealth, however, a growing number of less exceptional students are able to study abroad by paying their own way.

A third important factor is what Yoon and most Koreans simply call "the IMF era." That's shorthand for the financial restrictions imposed on the country by the International Monetary Fund after the economic crisis of 1997–98. Before the crisis, Korea's *chaebol*, or business conglomerates, hired large numbers of Ph.D. candidates, often after their third year. But many researchers lost their jobs as their companies shrunk or went bankrupt, and few new slots have opened up. The downturn has contributed to a plunge in the proportion of high school students who say they plan to study science or engineering, from 50% in 1997 to 26% last year.

At SNU, a combination of those factors resulted in only 800 students applying this year for the university's 884 Ph.D. slots in the sciences. (The size of graduate programs is set by the government.) Some 632 were accepted—an enviable outcome for students, perhaps, but one not conducive to maintaining high standards. Many of these students may not go the distance, some scientists suspect, and others may be driven by forces other than a love of learning. "To be honest," says the 30-year-old Won, who is close to completing his Ph.D. in earth and environmental sciences, "about one-third of my decision to go to graduate school was because it exempted me from mandatory military service."

SNU is not the only science institution feeling the pinch. At Pohang University of Science and Technology, the proportion of undergraduates who plan graduate studies in science had dropped in the past 2 years from 79% to 61%. And last year at KAIST, says H. W. Lee, dean of academic affairs, "the chemical engineering program had no preliminary Ph.D. applications" from undergraduates, forcing professors to beat the bushes for a few worthy students. At the same time, Lee hastens to add, "our electrical engineering and computer science programs are doing extremely well," because Korea's computer industry has weathered the latest economic storm and is once again growing strongly.

But government officials aren't content to leave the country's technological future in the hands of market forces. In 1999 the government launched the Brain Korea 21 (BK21) program, which provides generous stipends for graduate students in addition to supporting their research and providing a travel allowance. "BK21 has really helped," says Won, noting that it allowed him to spend 6 months at U.S. and Japanese universities and attend several meetings. The overseas trips were an eye opener, he says: "When I was in America, I was surprised and happy to discover my education was at the same level."

But although Won looks forward to a research career in either the United States or Korea, he's part of an apparently shrinking minority. A recent survey of Korean junior high school students found that only 20% plan to study science or engineering in college; even at the country's elite science high schools, the figure is only 60%. Those numbers suggest a tough road for SNU and other universities promoting the value of graduate training in science.

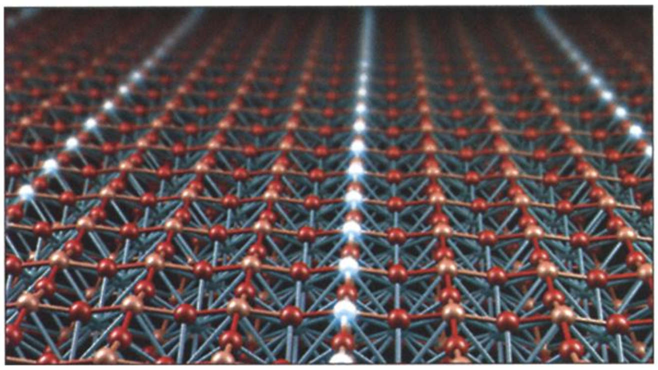
–MARK RUSSELL

Mark Russell writes from Seoul, South Korea.

SUPERCONDUCTIVITY

New Observations Give Stripes Theory a Lift

If three sightings make a trend, then a controversial theory of high-temperature superconductivity may have become a little more chic. The "stripes" theory states that current flows without resistance along lines of electric charge inside copper-and-oxygen–based superconductors. Such charge stripes had been spotted in only one superconducting material until two groups reported this month seeing them in two other superconductors, and a third group offered evidence that stripes do indeed conduct electricity.



Easy street. According to the stripes theory, holes fall into long lines along which they pair and move without resistance.

CREDIT: C. SLAYDEN

The new data indicate that stripes are a common feature of all so-called cuprate superconductors, says Steven Kivelson, a physicist at the University of California, Los Angeles, and a co-inventor of the stripes theory: "This means that this phenomenon is widespread. The evidence is crisp and clear." But others stress that the link between stripes and superconductivity remains murky, and some researchers think the new data reveal some more complicated pattern of charge.

For 15 years physicists have struggled to understand the cuprate superconductors. The materials consist of parallel planes of copper and oxygen atoms, with atoms of elements such as lanthanum, barium, and strontium sandwiched between the sheets. Sometimes an atom that is between planes will pluck an electron from a copper atom, leaving behind a positively charged "hole" that can move from copper atom to copper atom. Holes pair to glide along the planes without losing energy, but it's not clear how the like-charged holes manage to embrace one another.

The stripes theory provides a controversial explanation (*Science*, 19 February 1999, p. 1106). An isolated hole meets stiff resistance when it tries to hop from one copper atom to the next because the magnetic fields of neighboring copper atoms naturally point in opposite directions to create an up-down-up-down pattern. When an isolated hole moves, it disrupts this pattern, and that costs energy. To avoid the energy penalty, the stripes theory posits, the holes gather into stripes, which serve as little runways with no magnetism. Once in a stripe, holes can lower their energy even more by pairing.

Unfortunately for proponents of this theory, only one superconductor, lanthanum strontium copper oxide (LSCO), showed such activity. Now, three different groups are reporting similar results.

Herb Mook and colleagues at Oak Ridge National Laboratory in Tennessee have used a beam of neutrons to study the structure of a jumbo 25-gram crystal of yttrium barium copper oxide (YBCO), the most widely studied of the cuprate superconductors (*Science*, 1 February, p. 787). By carefully monitoring the reflected beam as the crystal rotates, the researchers detected stripes of holes lying along every eighth row of copper atoms, as they reported in the 4 March issue of *Physical Review Letters*. Meanwhile, Aharon Kapitulnik and colleagues at Stanford University in Palo Alto, California, used a tiny fingerlike probe known as a scanning tunneling microscope to study the surface of a crystal of bismuth strontium calcium copper oxide (BSCCO). They observed stripes of