NRSA recommended levels, but there's no mechanism to bring up the rest," says Trevor Penning, director of postdoc programs at the University of Pennsylvania, who sees it as part of NIH's duty to meet the full cost of sponsored research but who admits that the idea has gotten a chilly reception from NIH officials. "I don't know how much it would cost, but NIH has to step up to the plate and address the issue."

Of course, the more NIH or any other agency pays postdocs, the less money it has for the rest of its research portfolio. Unless their budget rises sharply—as NIH's did last year, allowing director Harold Varmus to boost NRSA's $430 million budget by $81 million—agency officials must either shrink other portions of a grant or make fewer awards. Neither scenario is appealing to researchers, who say grants are already too small and success rates too low.

Absent a sudden windfall, however, universities and faculty members must scramble to make up the difference. Johns Hopkins University is planning to match the new levels for all its postdocs over 3 years, for example, although Jeremy Berg, chair of the department of biophysics, says that "[researchers] are encouraged to meet those levels as soon as possible" for postdocs on their grants.

For investigators with large labs, that's not a big problem. "We use the NRSA pay scale as a starting point," says Cliff Tabin, a professor of genetics at Harvard Medical School in Boston with a current roster of 10 postdocs. "If someone is making less, I supplement them to that level. If somebody gets a fellowship that pays more, that's great. And since I don't want anyone to take a pay cut after 3 years [when the fellowship ends], I try to keep them at that level and raise up everybody else."

But smaller labs may have a more difficult time. "The Yale standard is the new NRSA levels, which is barely livable," says Marina Picciotto, an assistant professor of psychiatry at Yale Medical School, who has three postdocs and a mixture of NIH and private funding for her work in molecular neuroscience. "And they recommend that you supplement it. But some of my grants are expiring, so it could be tough right now to move anybody up."

Postdocs with their "own money"—the standard phrase used to describe those on any type of fellowship—often receive slightly higher pay. NSF's new bioinformatics fellowship for postdocs, for example, offers an annual stipend of $36,000 for 3 years to about 20 fellows a year, up from $28,000 for an expiring fellowship in molecular evolution. "An incentive needs to be a healthy one, and we had fallen behind the times," says NSF program officer Carter Kimsey, who also recommended to her bosses that the stipend of an existing award for minorities she runs be bumped up from $28,000.

The competition for good candidates comes from other organizations offering similar portable fellowships. The Burroughs-Wellcome Fund, for example, gives out about 25 fellowships a year that also cover the transition from postdoc to junior faculty members. The stipends are even more generous, growing from $38,000 to $44,000 over 3 years as a postdoc, plus $16,000 a year in research funds; junior faculty members get a total annual package of $120,000 for 3 years of salary and research funding. "We want to fund the cream of the crop and pay them commensurate with their expertise," says program officer Martin Ionescu-Pioggia. "As a foundation, we can make a decision that we're going to pay them at a reasonable rate."

But such generosity can sometime cause resentment, even outside the field. "We got some flak from biology and chemistry because we were offering higher stipends," recalls NSF's Alvin Thaler, who designed a postdoc fellowship in mathematics in the early 1980s to bolster the quality of those going into academia. "We wanted to keep it comparable to starting [faculty] salaries at major institutions," he says, a philosophy out of step with the much lower pay levels for postdocs in other fields.

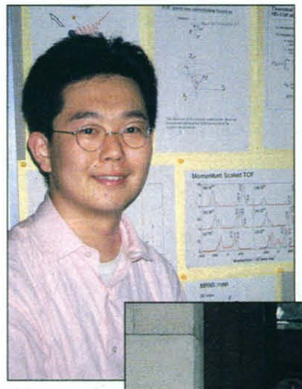
A 1946 history of Johns Hopkins University applauded Gilman's approach to building up the fledgling school's research capacity. "Probably no expenditure of ten thousand dollars in American education has ever had so large and so enduring a return on investment," wrote Hopkins librarian John French. Perhaps not. But that investment may have also left another, less positive legacy: the creation of a corps of cheap scientific labor to fuel U.S. academic excellence.

–JEFFREY MERVIS

NEWS

Japanese Jump on Postdoc Bandwagon

Overcoming the stigma of temporary workers, postdocs have become an integral part of science in Japan. But there's a price to pay for their popularity



Plant scientist Yuji Kamiya expected some rough spots 8 years ago when he was setting up a new plant hormone laboratory at the Institute of Physical and Chemical Research (RIKEN) outside Tokyo. Although his generous Frontier Research Program grant provided funding for postdocs—then a relatively new idea in Japan—Kamiya knew that recruiting and utilizing them would be a challenge. But one problem came as a complete surprise: "The postdocs couldn't get credit cards," he says. Finance companies had never heard of anyone with the title of postdoctoral researcher, and Kamiya unintentionally made the problem worse by calling one company and explaining that the postdocs' decent salary was guaranteed for 3 years. Company officials recoiled in horror: As a matter of policy, they explained, nobody with temporary employment was issued a card.

Postdocs in Japan have come a long way since Kamiya's first attempt to hire them. The pioneering efforts of the Frontier Research and other programs proved so successful that the Japanese government decided in 1995 to raise the number of postdocs from the 3775 then employed under a few special programs to 10,000 by 2000, spread throughout the nation's entire research establishment. The government has just

Change agents. Part of the first group of postdocs at the University of Tokyo's Institute of Medical Science pose with oncology chief Tadashi Yamamoto, right. But old habits die hard. Todai's Atsushi Iwamae (*top*) ended his postdoc 3 years early to grab a permanent post at Kyoto University.

CREDITS: D. NORMILE

Going Abroad Needn't Mean Going Into Exile

Sometimes it pays to be uninformed. Among ambitious young U.S. scientists, conventional wisdom says that doing a postdoc abroad is a bad career move because it takes one out of the scientific mainstream and makes it tougher to enter an already tight job market. But William Skarnes, now an assistant professor of molecular and cellular biology at the University of California, Berkeley, hadn't heard that received wisdom when he weighed his options after receiving a Ph.D. in 1990. Instead, he accepted a postdoctoral fellowship from the international Human Frontiers Science Program (HFSP) to work in the lab of a particular scientist in the United Kingdom.

"I wanted to learn about early mouse embryology from Rosa Beddington [then at the Medical Research Center laboratory in Edinburgh, Scotland]," says Skarnes, who turned down other offers to go there. "I don't think that I would have learned as much about mouse development anywhere else. ... I didn't realize until I came to Berkeley that some people consider it a liability to do a postdoc abroad."

Indeed, Skarnes and others who have done one say that a postdoc abroad can sharpen one's skills, broaden one's perspective on how other countries do science, and augment one's network of contacts—without draining one's bank account. "So when I heard about the good stipend and bench money that goes with the [HFSP] fellowship, I thought it would be a great opportunity," he adds.

The 2-year HFSP fellowships, created in 1989 and funded by the United States, Japan, and the European Union, are available for Ph.D.s from participating countries who wish to study abroad. But demand from U.S. scientists is not high. Last year they made up only 4% of the applicants, while 54%—and 62% of the 160 winners—chose to come to the United States. And programs aimed specifically at U.S. postdocs have a hard time overcoming the conventional wisdom. "We have a lot of problems attracting [U.S.] applications," admits Rolly Simpson of the Burroughs Wellcome Fund, who says a 9-year-old program to study in the U.K. attracts barely two dozen applicants annually for its 10 slots, despite generous stipends and support for travel, supplies, and other research needs. To sweeten the pot, last year officials stretched its 3-year Hitchens-Elion postdoc fellowship into a 5-year award that includes 2 years' salary and start-up funds as a new faculty member at any institution. But the response this year was no better. "People just don't want to go to the U.K.," he says.

> **"I didn't realize until I came to Berkeley that some people consider it a liability to do a postdoc abroad."**
>
> **—William Skarnes**

That's too bad, say postdocs who have left home. Many U.S.–based HFSP fellows who have studied in Europe say that they enjoyed the more collegial and personable atmosphere than they had found in the United States. "You interact more with people. All the doors are open and everybody shares. They even borrow things right off your lab bench, which takes getting used to," says Rebecca Hartley, a molecular biologist at the University of Iowa, Iowa City, who worked with H. Beverly Osborne at the University of Rennes in France. Marina Picciotta, an assistant professor of psychology at Yale Medical School, says that her postdoc under Jean-Pierre Changeux of the College de France, whose lab is at the Pasteur Institute in Paris, "gave me a broader focus on neuroscience—and since the community is smaller, I got to meet some of the best scientists in Europe."

For some fellows, their stint overseas began with an unscientific but nevertheless compelling desire to travel. "I thought that a postdoc would be a perfect time to go abroad," says Picciotta. "I was warned that it would set me back, but I was willing to do a second postdoc in the States, if necessary."

For others, the HFSP fellowship allowed them to link their scientific progress to interest in a particular culture. Marc Lamphier of Eisai Pharmaceutical Co. in Andover, Massachusetts, a subsidiary of Eisai Co. Ltd. of Japan, majored in Japanese studies as an undergraduate and had worked as a translator and interpreter before getting his Ph.D. in molecular biology at Harvard in 1991. He parlayed a postdoctoral fellowship at Osaka University into a post with a Japanese research agency before returning to the United States in 1997. "Eisai is moving to set up labs in the West, and they need people who can bridge the gap," says Lamphier. "And industry seemed like a good place to apply my international experience."

Overseas postdocs may even offer advantages for academics facing tenure review, says immunologist Janis Burkhardt, who did a postdoc at the European Molecular Biology Laboratory (EMBL) from 1992 to 1996 before joining the University of Chicago faculty. "At EMBL I had colleagues from all over the world," she says. "So when I come up for tenure, it will be a lot easier for me to show evidence of an international reputation."

In December, HFSP will hold a 10th anniversary celebration featuring successful postdocs touting the benefits of doing science in another country. Meanwhile, Burroughs Wellcome Fund officials hope that helping postdocs establish their careers will appeal to an audience that "is reluctant to leave the U.S. system," says program manager Martin Ionescu-Pioggia. "This new program not only gives them a chance to study in the U.K., but it helps them in getting a job, too."

—JEFFREY MERVIS

achieved the goal, a year ahead of schedule. And the system gets an enthusiastic thumbs-up from those most involved. The postdocs themselves welcome the opportunity to try their hands at research. Senior researchers say that their own productivity has soared. And policy-makers credit postdocs with helping to reinvigorate the country's rigid system of national labs.

In fact, the Japanese initiative has worked so well that the new talent pool is beginning to face a problem plaguing the nearly 40,000 postdoctoral fellows in the century-old U.S. system: a dearth of academic jobs. "There are many postdocs who cannot get [permanent] jobs," Kamiya says.

Japanese policy-makers were targeting several problems when they set a goal of hiring 10,000 postdocs. One was the need to expand the scientific workforce rapidly to match Japan's growing research budget. Creating temporary positions also helped them sidestep strict restrictions on expanding national employment rolls. Finally, they wanted to give newly minted Ph.D.s an opportunity to break out of a system in which entry-level positions mark the start of a long apprenticeship. (The first rung on the academic ladder, *joshu*, is typically translated as "assistant professor" but more closely resembles a "professor's assistant.") The new blood was also expected to pump life into the aging, tenured staff at national labs.

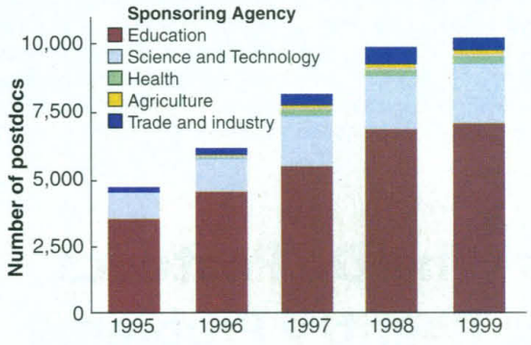
"We concluded that [the postdoc plan] has been very effective," says Tetsuhiko Ikegami, vice president of the University of Aizu in Aizu-Wakamatsu, Fukushima Prefecture, who headed a committee that recently completed a study of the postdoc situation for Japan's Science and Technology Agency. One of the main indicators has been the number of publications in international journals. "The number of papers has increased substantially," Ikegami says (see graph). The presence of postdocs, he adds, has also created a more competitive environment.

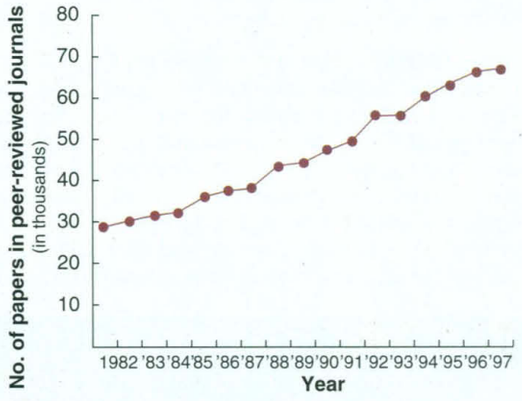
The senior researchers who are directing postdocs are quite enthusiastic about the program. "Without postdocs, I couldn't have done many things," says Robert Geller, a geophysicist in the Department of Earth and Planetary Physics at the University of Tokyo, who has had five postdocs over the past 15 years.

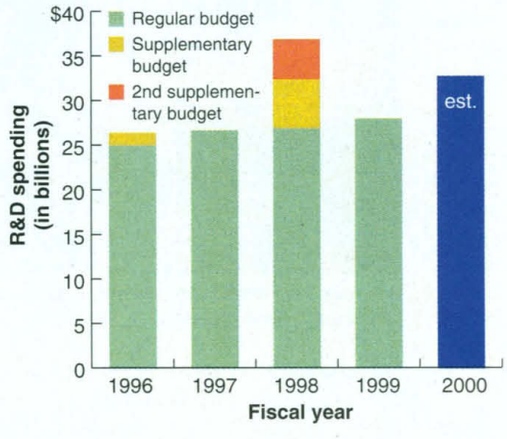
Amid the general satisfaction, one acknowledged shortcoming is the tendency for postdocs to remain at the lab where they received their graduate training. "We had hoped the postdoc system would introduce more mobility among researchers," says Ikegami. Japan's universities are notoriously inbred, and the historical pattern has been for academics to earn undergraduate and graduate degrees from the same institution, remaining there to work their way up the academic ladder. So far, most postdocs seem to be following the same pattern. "I wanted to continue the work I was doing for my Ph.D.," says Miho Ohsugi, a cancer postdoc at the University of Tokyo's Institute of Medical Science, who's studying proteins involved in spermatogenesis in the same lab where she had worked as a grad student.

A second disappointment has been the inability to attract non-Japanese applicants, particularly from the United States. Americans accounted for a paltry 80 of the more than 1300 postdoc fellowships granted in 1998 by the Japan Society for the Promotion of Science (JSPS), an arm of the Ministry of Education, Science, Sports, and Culture (Monbusho). "It's nothing personal [toward Japan]," says William Blanpied, director of the U.S. National Science Foundation's (NSF's) Tokyo office. "A relatively small number of American postdocs go anywhere other than the United States," he adds (see sidebar). The NSF and the JSPS keep trying new schemes, but no one is optimistic. "We would like to get more Americans here," Ikegami says, "but given [America's] active research environment and the strong economy, I can understand why they're reluctant to go abroad."

Postdocs themselves are generally happy with their situations. Most say they welcome the opportunity for greater independence, even if they have to sacrifice some job security. Miki Nakazawa, a plant molecular biologist, gave up a lifetime position as a research assistant at a university institute for a postdoc position in Kamiya's lab at RIKEN. "In Japan, young scientists have very few chances to work on their own [research] themes," she says. "It may depend on the lab, but as a postdoc I can easily have my own theme to work on." "It's not completely free," says Taishin Akiyama, a postdoc in molecular biology at the Institute of Medical Science, but once a postdoc meets with the professor and chooses a research theme, he or she works fairly independently. Postdocs with fellowships have greater latitude than those funded under a project grant, who are constrained by the terms of the grant.







Looking up. With Monbusho leading the way, the rising number of Japanese postdocs has benefited from the government's increased support for research and is seen as one factor in the country's increased scientific productivity.

Despite their growing popularity, postdocs are still struggling for public recognition. Although credit card issuers long ago realized that postdocs are worthy credit risks, there is a stigma attached to temporary positions in a land where employment for life is still an ideal. Ohsugi says people outside the scientific community are surprised that someone with a Ph.D. "has to settle for a temporary position. To me, it's not such a serious problem," she adds. "But it really worries my parents."

What worries Ohsugi and her compatriots is the gloomy outlook for post-postdoctoral employment. The problem is the lack of new permanent positions, a consequence of a government decision to shrink public payrolls. One unofficial calculation shows that the 10,000 postdocs will be chasing just 1000 to 2000 full-time academic job openings over the next few years.

That estimate has caused Atsushi Iwamae, a chemistry postdoc at the University

CREDITS: (TOP TO BOTTOM) SCIENCE AND TECHNOLOGY AGENCY, JAPAN; INSTITUTE FOR SCIENTIFIC INFORMATION; SCIENCE AND TECHNOLOGY AGENCY

of Tokyo, to flee his 5-year postdoc position after just 2 years to become a research associate at Kyoto University. The permanent position won't give him as much freedom to pick his own research targets, he acknowledges, but Iwamae didn't want to be caught without a job at the end of his postdoc. "There are very many candidates for each open position," he says. While acknowledging the tough job market, Ikegami and others say that the increased competition should raise the quality of research at national institutions. "We can choose those who are really the most talented," says Ikegami.

A more lasting solution, proposed by Ikegami's committee, would sidestep the limits on permanent positions for scientists by creating "super" postdoctoral positions for younger researchers who have completed one postdoc and are ready for more independence (*Science*, 9 April, p. 233). More experienced researchers capable of leading a team would be eligible for independent researcher positions. Both types of positions would be for fixed terms and would be filled through an open, competitive selection process. The trade-off for impermanence, says Ikegami, would be more money and more freedom for a researcher to pursue his or her own interests. The proposal is being reviewed as part of a larger package of prospective science initiatives.

–DENNIS NORMILE

NEWS

Europeans Who Do Postdocs Abroad Face Reentry Problems

A stint abroad is crucial for many European Ph.D.s, who must overcome government resistance to temporary positions in order to become academic researchers

HEIDELBERG, GERMANY, AND PARIS, FRANCE— Florence Horn is fast becoming a scientist of the world—but not necessarily by choice. Born and raised in Normandy, France, Horn received her Ph.D. in bioinformatics from the University of the Mediterranean in Marseilles, and this fall she'll complete a 3-year postdoctoral fellowship at the European Molecular Biology Laboratory (EMBL) in Heidelberg. Then she's headed off to the University of California, San Francisco, for a second postdoc —if she can find salary support.

Horn would like to return to France. But at 32 she's 1 year over the age limit to compete for an entry-level position at the French research organization where her expertise might be most welcomed—the basic science agency CNRS. And the French government funds no domestic postdocs for people in her field, in keeping with a 3-decade-old policy that says it would be unfair to offer people temporary posts with no promise of permanent employment. Officials acknowledge that postdocs represent a rich vein of scientific talent that could bolster French science. But except for a few specially targeted programs, France's research policy-makers are reluctant to put public money into the pockets of French postdocs.

Many young European scientists share Horn's dilemma. *Science* met recently with nearly a dozen EMBL postdocs who, although they come from a wide variety of countries and backgrounds, have all been encouraged to do their postdocs outside their home countries. Now they are struggling to reintegrate themselves into their native scientific communities. Some have been luckier than Horn: When Guillermo Montoya, a structural biologist from Spain, leaves EMBL at the end of next year, he will become a group leader at the Biophysics Institute now under construction in Bilbao. But Austrian structural biologist Susanna Lüdemann's experience may be more typical. With few opportunities in her native country, she has resigned herself to being a permanent expatriate. "If I wanted to pursue a scientific career, I had to leave Austria," she laments. German postdocs who seek an academic career at home must also overcome the formidable Habilitation, a lengthy process of qualification for university posts. Although the Habilitation's days may be numbered (see sidebar), the road to a permanent position remains long and rocky.

Bon voyage. Florence Horn's quest for postdoc training is taking her around the world.

CREDIT: DON YOUNG/EMBL

The problems faced by many European postdocs reflect differences in scientific culture between continental Europe on the one hand, and the United States and the United Kingdom on the other. Whereas U.S. and U.K. graduate students are seldom pushed to do postdocs outside their countries, continental Europeans see a foreign stint as a feather in a postdoc's professional cap. "A postdoc abroad is generally considered necessary for your CV," says neuroscientist Markus Missler of the University of Göttingen in Germany. A U.S. posting in particular is so highly valued that some German researchers jokingly add "iAg"—*in Amerika gewesen* (been in America)—to their abbreviated titles.

Yet despite the luster that foreign travel can add to a résumé, the tight job market for researchers can make reentry difficult for even the most promising young scientists. And although continental postdocs might envy their British colleagues for being able to stay home, a domestic postdoc in Britain has its own downside: a huge corps of Ph.D.s who find it hard to get off the postdoc treadmill.

A major reason many countries shove their newly minted Ph.D.s out the door is the hierarchical European university systems. A change of scenery is deemed essential for the nurturing of scientific talent. "We strongly encourage them to leave the place where they have been trained as graduate students," says Ernst-Ludwig Winnacker, president of the Deutsche Forschungsgemeinschaft (DFG), Germany's basic research granting agency. "The idea is for people to have mobility."

Indeed, "mobility" has become a mantra for European research policy-makers. "We have decided not to fund French postdocs in French research organizations," says geophysicist Vincent Courtillot, director of research in France's science ministry. "It prevents mobility, and we don't think that is healthy." As a result, nearly 70% of French postdocs do their post-Ph.D. training outside France. Another reason for the flight of young talent is that most European countries are not strong in all scientific fields. Thus, postdocs wanting to apprentice in the best labs often must dig out their passports and hop on a plane.

Government funding policies reinforce these political and scientific realities. For ex-