

STEM CELLS

How Young Korean Researchers Helped Unearth a Scandal ...

SEOUL AND TOKYO—The announcement delivered a devastating blow to stem cell researchers around the world: On 29 December, a Seoul National University (SNU) investigative team said there was no evidence Woo Suk Hwang and his team had produced any of the patient-specific stem cells they described in a June 2005 *Science* paper. Many Koreans lamented that the revelations dashed the country's hopes for worldwide scientific respect. But the report also vindicated dozens of anonymous young Korean scientists who, without knowing one another, worked together and with the media to unravel a huge scientific fraud.

Two papers published in *Science* by Hwang and colleagues at several institutions in Korea and the United States were hailed as seminal breakthroughs in stem cell research. A March 2004 paper reported the first stem cell line produced from a cloned human embryo. The second paper, published in May 2005, reported the creation of 11 stem cell lines that genetically matched nine patients with spinal cord injury, diabetes, and an immune system disorder. Scientists hope such stem cells could someday lead to insights into many hereditary conditions as well as the creation of replacement tissues genetically matched to patients.

Those hopes, however, began to unravel shortly after midnight on 1 June 2005, when someone sent a message to the “tip off” mailbox on the Web site of a long-running investigative TV news program called *PD Notebook* aired by the Seoul-based Munhwa Broadcasting Corp. (MBC). According to one of the program's producers, Bo Seul Kim, the writer said his conscience had been bothering him over problems he knew of with Hwang's research. Asking *PD Notebook* to contact him, he closed his message by writing: “I hope you don't refuse this offer to get at the truth.”

They didn't. When *PD Notebook* execu-

tive producer Seung Ho Choi read the message several days later, he asked producer Hak Soo Han to meet the tipster that night. According to Han's recollection of the meeting, the tipster said he had been involved in the research leading to Hwang's 2004 paper in *Science*. He agreed to an interview on tape as long as his identity was concealed, during which he said he had left the team because of ethical and technical concerns. He claimed that despite Hwang's statements to the contrary, some of the eggs used for that research



Clear misconduct. Jung Hye Roe, SNU's dean of research affairs, announced that the investigative committee found no evidence of cloned stem cells in Hwang's lab.

came from junior researchers in Hwang's lab. Producer Kim says the scientist provided names, donation records, and an e-mail message he had received from one of the researchers saying she had donated eggs under pressure from Hwang. The tipster also claimed that based on his knowledge of the team's work, Hwang couldn't have produced the patient-specific stem cells reported in the 2005 paper, although he admitted having no hard evidence of fabrication.

“It was very difficult for me to believe what this person was suggesting,” Han told *Science*. But the tipster's documentation of problems surrounding egg donations seemed trustworthy. So Han decided to look into the 2005 paper as well. The producers persuaded two others with inside knowledge of Hwang's lab to help. Han also recruited three scientists from outside the Hwang team as consultants.

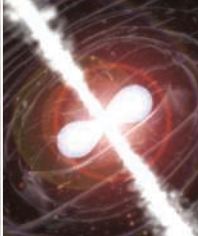
Han says the *PD Notebook* team and its advisers began to identify potential problems with the paper, using tactics that they later conceded were journalistically unethical. Claiming they were working on a documentary about Korean biotechnology, *PD Notebook* reporters interviewed co-authors of the 2005 paper and found that the majority had never actually seen the cloned embryonic stem cells. The TV crew also learned from their

advisers that teratomas, benign tumors that embryonic stem cells form when injected under the skin of experimental mice, had been produced only for stem cell lines 2 and 3; careful scientists would have produced teratomas from all 11 lines.

Kim says that because one of the informers suggested that the stem cell lines in the 2005 paper could have come from MizMedi Hospital in Seoul, the producers requested and received the DNA fingerprinting data for 15 lines derived at the hospital from embryos created through in vitro fertilization. Through one of their sources, the producers got a sample of stem cell line number 2 and passed it to an independent testing laboratory. The lab found that line number 2 genetically matched a MizMedi line. “Did we actually have evidence that Hwang faked his research?” Han recalls wondering. (SNU would come to the same conclusion months later, announc-

ing on 29 December that stem cell lines 2 and 3 from Hwang's lab came from MizMedi's stem cells.)

Han says he got the news of the lab test results on 19 October while he was in the United States preparing to interview Sun Jong Kim, another co-author of the 2005 paper who had left MizMedi to join the University of Pittsburgh research team led by Gerald Schatten, a Hwang collaborator and co-author of the 2005 paper. In an attempt to



Speak no evil. MBC's initial broadcast on irregularities in egg donation for Hwang's research set off a wave of protests.

get an admission of wrongdoing from Kim, Han says, the TV team resorted to some misrepresentation of its own. When the producers met him on 20 October, Han and his partner filmed Kim with a hidden camera; they didn't reply when he asked if they were recording him. In the interview, Han told Kim they had information that could prove Hwang's work was falsified. He also tricked Kim into believing that Korean prosecutors had begun an investigation and told Kim he didn't want to see him get hurt.

On hidden camera, Kim then told Han he followed directions from Hwang to make photographs of two cell lines appear to represent 11 cell lines. The falsified photos appear in the supplementary online material accompanying the 2005 *Science* paper. Han says he now "really repents" their unethical reporting ruses. And those lapses nearly led to their work being dismissed entirely.

But on 11 November, before *PD Notebook* broadcast any of its findings, Schatten announced he was terminating his relationship with Hwang because of concerns about "ethical breaches" in oocyte collection. Schatten emphasized that he was still confident of the research results. On 22 November, MBC broadcast the *PD Notebook* program containing allegations that donors were paid for eggs used in the research leading to the 2004 paper, that junior lab members were among the donors, and that Hwang had lied about the oocyte sources in the *Science* paper. Two days later, Hwang admitted in a press conference that he knew about junior members donating eggs but lied to protect their privacy. He resigned as director of the newly announced Stem Cell Hub but vowed to continue his research (*Science*, 2 December 2005, p. 1402).

Despite Hwang's admissions, *PD Notebook* producers bore the brunt of public anger over the revelations. The backlash intensified after Han and another top producer held a 2 December press conference announcing that a report questioning the authenticity of Hwang's work was yet to come. After Sun Jong Kim and another colleague in Pittsburgh, Jong Hyuk Park, told another television program that the interview with *PD Notebook* had been coerced, all 12 of the *PD Notebook* sponsors canceled their ads, and on 4 December, MBC apologized for the producers' use of unethical tactics.

Producer Kim says that 20,000 angry postings filled up MBC's online bulletin boards, and that the network received so many threatening calls that reporters had a hard time using the phones for work. On 7 December, MBC

suspended *PD Notebook* and decided not to air the segment covering questions about the 2005 paper and the interview with Sun Jong Kim.

Given Hwang's popularity among the Korean public and the trust he enjoyed among researchers worldwide, the matter might well have ended there. But, according to an official of the Biological Research Information Center (BRIC), which provides online news on scientific trends and careers primarily for young researchers, at 5:28 a.m. on 5 December, a contributor to a BRIC Internet message board placed a cryptic post with the English header, "The show must go on ..." The anonymous poster suggested that readers look for duplicated pictures among the supporting online material accompanying the 2005 *Science* paper. The poster ended his message with the tease: "I found two! There are rumors that there are more ..."

More than 200 posts followed, identifying apparently duplicated photographs. There was also an online discussion about whether someone

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... And How the Problems Eluded Peer Reviewers and Editors

The paper landed in *Science*'s online database on 15 March 2005, a Tuesday. Immediately, the journal's editors recognized a submission of potentially explosive importance. A group in South Korea was describing 11 embryonic stem (ES) cell lines created from the DNA of ailing patients. The advance, eagerly anticipated in the stem cell world, would be a first, and critical to using stem cells to combat disease.

Little did *Science*'s editors, or the nine outside researchers who would examine the paper with varying degrees of scrutiny, realize just how explosive the paper would be. Today, its lead author Woo Suk Hwang stands accused of one of the boldest scientific frauds in memory. Investigators at Seoul National University (SNU), where most of the work was done, announced on 29 December that they could find no evidence of any of the 11 stem cell lines claimed in the paper. On the 10th floor of *Science*'s offices in Washington, D.C., meanwhile, members of the editorial department are spotting problems in Hwang's 2005 paper, as well as another landmark paper from his group published in 2004.

Could *Science* have detected the fraud? *Science*'s editors and many stem cell researchers

believe not: The 2005 paper was positively received by its peer reviewers, upon whom *Science* relied heavily to determine whether the paper was worth publishing. "Peer review cannot detect [fraud] if it is artfully done," says Donald Kennedy, *Science*'s editor-in-chief. And the reported falsifications in the Hwang paper—image manipulation and fake DNA data—were not the sort that reviewers can easily spot.

Martin Blume, editor-in-chief of the American Physical Society and its nine physics journals, says that peer review overlooks honest errors as well as deliberate fraud. "Peer review doesn't necessarily say that a paper is right," he notes. "It says it's worth publishing."

That said, *Science*, like other high-profile journals, aggressively seeks firsts: papers that generate publicity and awe in the scientific community and beyond. The practice comes with some risks, critics say, because by definition firsts haven't been replicated. "Is the reviewing looser" on a potentially high-impact paper? asks Denis Duboule, a geneticist at the University of Geneva, Switzerland, who sits on *Science*'s Board of Reviewing Editors. "Frankly, I don't ▶

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should inform *Science*. Someone did e-mail *Science* editors pointing out the duplicated photos. By that time, however, Hwang had already notified the journal of what he termed an accidental duplication of some of the photos. *Science* editors and scientists around the world were still willing to give Hwang the benefit of the doubt, believing that photos had been mixed up sometime between paper acceptance and publication online.

But the BRIC posts continued. On 6 December, another anonymous BRIC poster wrote that there appeared to be duplications in the DNA fingerprinting traces and posted evidence to support that claim the following day. At about this time, the BRIC postings were reported in the general Korean media and then picked up worldwide. On 12 December, SNU said it would launch an investigation. With public opinion starting to turn, on 15 December, MBC broadcast the *PD Notebook* segment showing Kim—with his face blurred—admitting that he doctored photographs at Hwang's direction. The next day, Hwang and Schatten told *Science* they wanted to withdraw the 2005 paper.

Like most scientists in Korea, Hong Gil Nam, a chemist at Pohang University of Science and

Technology and BRIC's first director, has mixed feelings about how the drama has played out. He's sorry to see the scandal unfold but hopeful that the postings on BRIC indicate that "young scientists have a good attitude toward research integrity."

The SNU committee is continuing its work, investigating the legitimacy of Hwang's 2004 paper in *Science* and the group's more recent paper in *Nature* claiming to have produced the first cloned dog. A host of questions remain about whether and when other people at the lab learned about the fraud. Korea's Supreme Public Prosecutors' Office says it is considering a probe of possible criminal activity, pending the outcome of the SNU investigation. The BRIC message board is as lively as ever. And MBC resumed broadcasting *PD Notebook* on 3 January, this time with more people from within Hwang's lab who were willing to talk about what their disgraced boss had done. Among the revelations, *PD Notebook* alleges that Hwang's team collected more than 1600 oocytes from egg donors—not the 427 originally reported—for cloning research for the 2004 and 2005 papers.

—SEI CHONG AND DENNIS NORMILE

With reporting by Gretchen Vogel.

TERRORISM

Indian Scientist Slain in Surprise Attack

HYDERABAD, INDIA—A retired mathematics professor was shot and killed, and four colleagues were wounded, at the Indian Institute of Science (IISc), one of India's premier research outfits, on 29 December. Police have branded the incident in Bangalore a terrorist attack, although as *Science* went to press, no group had claimed responsibility.

The slain scientist, M. C. Puri of the Indian Institute of Technology in New Delhi, was a specialist in operations research, or the use of mathematics to aid in decision-making. Among the injured is IISc's Vijay Chandru, co-inventor of Simputer, a hand-held computing device. The injuries of Chandru and the other victims were not life-threatening.

The attack came without warning on the last day of an international meeting on operations research. "There were no security alerts issued to us," says IISc Director Padmanabhan Balaram. According to eyewitness accounts, at about 7:30 p.m., a single gunman wielding an automatic rifle began spraying bullets into a crowd of scientists filing out of an auditorium after the day's last talk. "A few of us were walking to the next building when we heard sounds like the heavy use of firecrackers," says S. Sadagopan, direc-

tor of the Indian Institute of Information Technology in Bangalore. On 3 January, police announced the arrest of a suspect: a 35-year-old man who claimed to be a member of Lashkar-e-Taiba, a Pakistan-based militant organization.



Victim. M. C. Puri.

The incident has sent jitters through India's vast R&D establishment. At the annual Indian Science Congress here in Hyderabad this week, police assigned 5000 officers to protect the 5000 participants, including 75 foreigners. And aftershocks are being felt in Bangalore. In addition to IISc, the region, India's Silicon Valley, is home to more than 150 information technology firms, the Indian Space Research Organization, and several high-profile defense labs. The space and defense labs say they have enhanced

already tight security. But IISc, with more than 400 researchers and 2000 students, is an academic campus largely open to the public. Balaram says he does not want IISc to become a high-security zone as a consequence of the attack: "The ambience of the university will be lost if you convert it into an armed fortress."

—PALLAVA BAGLA

Some Things on the Horizon for 2006:

European Thumbs Green for GM

BERLIN—The new year is looking brighter for European researchers and farmers who want to plant genetically modified (GM) crops. On 14 December, the German government approved the first three varieties of GM maize to be allowed in the country, and a few days later, new agricultural minister Horst Seehofer said he would encourage the planting of GM crops. That's a stark contrast from Seehofer's predecessor, Renate Kunast, who as a member of the Green Party pushed through restrictions on GM planting that researchers said made field trials impossible (*Science*, 25 June 2004, p. 1887).

In late December, the European Commission proposed new rules that would allow organic foods to be labeled as such with up to 0.9% accidental contamination with GM products or seeds from neighboring farms or during processing. Several consumer groups have vowed to fight the proposal to protect what Friends of the Earth Europe says are consumers who want food free of "genetic contamination."

—GRETCHEN VOGEL

Lobbyists Tout Funding Poll

Science boosters believe that the results of a November poll offer one more reason for lawmakers to jump onto the bandwagon this year and increase federal support for academic research—especially if nobody thinks too much about what the answers might mean.

Commissioned by a coalition of business leaders, educators, and professional societies (futureofinnovation.org), the survey reports that 78% of 800 adults, all registered voters, favor spending tax dollars on academic science. Some 70% say they like a key component of one plan being peddled to Congress (*Science*, 21 October 2005, p. 423) that would increase federal funding for the physical sciences by 10% annually for the next 7 years. Support tops 80% among Democrats and those with postgraduate training.

Still, answers to an open-ended question about the value of "university research" revealed some fuzziness about what that phrase actually signifies. One respondent, for example, wrote that "it is very important that young kids get an opportunity [to learn math and science]"; another noted that "education is one of the most important issues we face today."

—JEFFREY MERVIS