

belief in science and faith in my fellow scientists which led me to set my threshold of suspicion so high.

I wish to state unequivocally that I have never condoned falsity by a scientist. I do not believe it could ever be appropriate to represent that a test that was not performed was in fact completed, or that anything other than the actual results were obtained. Fraud in the laboratory is not only wrong from a moral and legal standpoint, but it impedes the pro-

gress of science, as it makes the review and retesting of hypotheses and conclusions impossible. Deliberate falsification demeans all members of the scientific community because it undermines public trust and confidence in our enterprise.

For their work, scientists are entrusted with public funds. I have come better to appreciate the legitimate role of government as the public sponsor of scientific research and to respect its duty to protect the public

interest and hold the scientific community accountable for its stewardship of public funds. Such accountability can be entirely consistent with the essential objectivity of scientific inquiry.

The case has highlighted the need to conduct our research and review in a manner the public can appreciate, because continued public support is necessary for the continued life of the scientific enterprise and the nurturing of the academic environment in which we enjoy the freedom to experiment and learn. It is only because public support has been translated into federal financial support that scientists have been able to expand dramatically the range of human knowledge and apply this new knowledge to achieve extraordinary practical advances in such fields as medicine and public health. In the light of this creative partnership, I remain firmly committed to the importance of governmental oversight of federally funded projects, and I look forward to continuing to participate in a healthy and necessary dialogue to improve the process.

I have learned from this experience that the accountability to ensure the responsible use of public funds rests not only with each individual scientist but with the scientific and academic communities as whole. Better self-policing and record keeping will facilitate the government's oversight function and may obviate the need for the repeated hearings and investigations that were needed in this case. This matter has also highlighted the need for clear procedures which guarantee the prompt and thorough investigations of allegations, and I hereby commit myself to participate actively in the study and formulation of new guidelines. Questions raised, whether by junior or senior scientists, must be pursued with vigour, and because junior colleagues may be reticent about alleging outright misconduct, it is incumbent upon those more senior to press for a full airing of their suspicions. Any procedures must include the means to protect those who raise concerns from retribution or discrimination. Scientists must ensure that they do not wait too long or set the threshold too high before calling for the application of close scrutiny to ferret out potential falsity. Finally, the questions raised in this investigation have also underscored the need for greater attention to detail in the handling and recording of data, to further effective peer review and to establish an impeccable record for verification of results.

In conclusion, I commend Dr O'Toole for her courage and her determination, and I regret and apologize to her for my failure to act vigorously enough in my investigation of her doubts. I recognize that I may well have been blinded to the full implications of the mounting evidence by an excess of trust, and I have learned from this experience that one must temper trust with a healthy dose of scepticism. This entire episode has reminded me of the importance of humility in the face of scientific data.

David Baltimore

The Baltimore case — a chronology

May 1985: Thereza Imanishi-Kari carries out transgenic mouse experiments at the Massachusetts Institute of Technology (MIT) in an attempt to determine if transplanted foreign genes can affect an animal's own genetic material.

April 1986: Original paper based on the mouse data and finding evidence of genetic changes triggered by the transplanted genes is published in *Cell*, with Imanishi-Kari, David Baltimore and others as authors.

May 1986: Laboratory postdoctoral fellow Margot O'Toole discovers an Imanishi-Kari notebook containing 17 pages that suggested to her that some of the key experiments in the *Cell* paper had never been done; at the request of O'Toole, Tufts University, which is preparing to hire Imanishi-Kari, convenes an *ad hoc* committee headed by biologist Henry Wortis to investigate charges.

June 1986: MIT professor Herman Eisen meets O'Toole, Imanishi-Kari and Baltimore to review O'Toole's allegations. His memorandum finds possible minor errors, but no fraud.

October 1986: Contacted by Charles Mapplethorpe, one of O'Toole's former MIT colleagues, National Institutes of Health (NIH) researchers Walter Stewart and Ned Feder begin investigating the case. After they obtain the 17 notebook pages from O'Toole and examine them, they inform NIH officials that they suspect misconduct in the *Cell* paper.

May 1987: NIH Office of Extramural Research begins first inquiry; Tufts committee submits report concluding that there was no deliberate falsification or misrepresentation in the *Cell* paper.

September 1987: After a year of NIH review, Stewart and Feder receive permission to try to publish their 34-page critical analysis of the *Cell* paper, in which they conclude that Imanishi-Kari's experimental records contradict some of the paper's key conclusions. Over the next year *Cell*, *Science* and *Nature* all reject the paper. It is never published.

May 1988: Congressional Investigations subcommittee of Representative John Dingell holds its first hearings, focusing on the response of Tufts and MIT to the O'Toole allegations; Baltimore issues a "Dear Colleague" letter attacking Dingell and asserting that congressional interference "is totally unnecessary".

July 1988: Dingell subpoenas Imanishi-

Kari's laboratory records and turns the notebooks over to Secret Service for analysis.

November 1988: Baltimore and Imanishi-Kari publish a correction in *Cell* indicating that the original paper contained an 'overstatement' of the specificity of BET-1, a key reagent.

January 1989: First NIH investigation ends, finding "significant errors of misstatement and omission... but no evidence of fraud, conscious misrepresentation, or manipulations of data." In a letter, NIH director James Wyngaarden chastises the *Cell* paper authors: "Even though the allegations have been known to you... at least since spring of 1986... you never met to reexamine the data." Such a meeting, he writes, "may have made a full investigation unnecessary."

April 1989: Based on new evidence from the continuing Dingell investigation and subsequent O'Toole findings, NIH reopens the investigation within the newly created Office of Scientific Integrity (OSI).

May 1989: Dingell holds two hearings, at the first of which the Secret Service testify that 20 per cent of a critical notebook is forensically questionable; at the direction of NIH, Baltimore and Imanishi-Kari publish a second correction in *Cell*, giving additional data on the specificity of BET-1.

Summer 1989: Baltimore publishes an article in *Issues in Science and Technology* giving his side of the story and attacking Stewart, Feder and the Dingell staff for unwarranted meddling. "If the sad history of this investigation demonstrates nothing else, it shows that uninformed or malinformed outsiders cannot effectively review the progress of scientific activity," he writes.

May 1990: Dingell holds fourth hearing. Secret Service investigators present additional forensic data showing that Imanishi-Kari's notebook records and purported experiments were "not contemporaneous with respect to time." Findings cast doubt on the data in the second *Cell* correction.

March 1991: Draft report of second NIH investigation reverses previous report, finds "serious scientific misconduct", including data fabrication. Dingell staff announce plans to hold hearings in May on "who-knew-what-when." OSI also states intention to pursue allegations of a cover-up. Baltimore announces that he will retract the *Cell* paper. **C.A.**