process given comfort to those among their critics who suppose it to be an offence that people should believe that the world and even living things can be understood. For the truth is that by helping to throw light on the reasons why living things can be in some respects better understood as machines, they have unwittingly advanced the cause of rationalists, reductionists or whatever. So what, is Watson's and Crick's defence? Our purpose was simply to tell it like it is, and to train a few talented students in the process. If the Kuhns of this world seek to find a paradigm-shift, surely that is their business and not ours? How else would Newton have spoken?

The Watson and Crick discovery thirty years ago has worked two other magics. We may all be a little more reductionist than we used to be, but we are also collectively more skilled and more confident. Skill is too often demeaned, as if it were merely a craft. But suppose that the practice of the skill lies in the telling of the difference between a regular gene and an aberrant version of it, differing by one nucleotide in a thousand, and which in its altered form resembles the gene of a known retrovirus? Is that demeaning work? Or a way of helping to understand malignancy and get rid of it?

We are also more confident. In the south of England the celebrated tourist attraction called Stonehenge is also now recognized to be one of the first scientific observatories, given over to the provision of a calendar for a supposedly primitive people, only just converted from pastoral to agrarian ways. The modern marvel is that such primitive people should have assembled such a massive structure, incorporating massive stones carried from scores of miles away. The contemporary marvel must have been that the construction of a calendar should have been worthwhile. Taxation in aid of the enterprise would have weighed heavily on those concerned — they would have had to be forced to help move all those stones. Most of the labourers would have been dead by the time Stonehenge was completed. Their successors, children or more probably grandchildren, would however have benefited from knowing when best to plant their corn. They would have done so more confidently than previously, and would have been less afraid of other irrational assaults by nature. We are lucky that our modern equivalent of that bronze-age monument has been constructed so much more quickly, with so much less effort and with so much excitement for us all.

Who should test drugs?

The latest case of scientific fraud in the United States presents FDA with a challenge

CASES of fraud in research seem almost to follow a familiar script: a bright young researcher, working in a large laboratory with little supervision but under pressure to be "productive", is tempted first to cut corners and later to manufacture results wholesale. The outcome also follows the script. Sage words are uttered by senior people either about the triumph of the self-correcting process of science (because the culprit was discovered) or about the bankruptcy of the peer review system (because discovery took so long). The case of Dr Wilbert S. Aronow (see p.xxx) is a departure from this script. Dr Aronow, until last summer chief of the cardiovascular section at a Veterans Administration Hospital in California, was hardly a young man in need of proving his ability to perform. A well respected cardiologist, author of innumerable scientific papers, consultant to 21 scientific journals, principal investigator to the Food and Drug Administration (FDA) itself — the government agency that discovered his falsification of data — Aronow had nothing to gain and everything to lose. And in his case, more was at stake than the reputation of the research enterprise — potentially, the health and well-being of thousands of heart patients.

FDA, charged by law with reviewing drug companies' claims for the safety and efficacy of their products, is acutely aware that it cannot rely on the usual check provided by peer review. As well as a conventional evaluation of the results and methodology of clinical trials submitted by the drug companies, the agency conducts more than 200 audits each year. Investigators are despatched, for the most part on a routine and random basis, to pore over the records of clinical trials and to make sure that results reported match results obtained. It was through such an audit that discrepancies in Aronow's reports were uncovered. It can be argued that justice was properly served by FDA's conclusion of the case. Aronow signed a pledge that he would not participate in further clinical trials, sponsors of his research have been informed and he himself has paid a high personal price, of which loss of his post will seem only a small part.

But the case raises some deeply troubling questions. What can FDA do — and what is it willing to do — about deliberate falsification of the data on which it relies to judge the safety and effectiveness of new drugs? Unusual as Aronow's case may be, it raises the question of how many other researchers have at least felt the pressures (which apparently overcame Aronow) to produce results that make their drug-company sponsors happy. FDA's investigator noted that all of Aronow's discrepancies favoured the drugs' efficacy. And surely even the most incorruptible researcher is not immune from wondering where his next research dollar is to come from.

FDA has long maintained that it is easier to scrutinize the research of others than to do the work itself — not only easier but more likely to yield the truth. There is much in that contention, and it is easy to imagine the litigative nightmare that could be created if FDA performed all tests itself. Each unfavourable finding could be challenged by the drug companies, which meanwhile would have commissioned a private study anyway. The regulation of automobile safety and exhaust emissions (by the Environmental Protection Agency) is already a fine model of that nightmare. But FDA and the drug companies also maintain that it is in the companies' own best interest to ensure that the studies are accurate. Certainly this is true in the long run, particularly with regard to safety. But this argument is suspect when it comes to claims of efficacy. The battles FDA is continually waging over what the companies are permitted to claim for their products in advertising reveals the consuming need that possesses the companies to press efficacy claims to the limit, and not infrequently beyond. Aronow's case comes to light at a time when FDA is in the process of relaxing many of its requirements on the submission of data for new drug approval. Individual case report forms will no longer be required on a routine basis and foreign studies, which have often proved difficult to audit, will be accepted more readily. In so doing, FDA may be sending out the wrong signal at the wrong time. There is ample evidence that tighter scrutiny is what is called for.

FDA may also need to reconsider its procedures for disqualifying researchers who violate its regulations. The process has grown more cumbersome every year since its institution, to the point where it can now take more than three years from the time evidence of wrongdoing is discovered to the time the researcher is officially barred from conducting clinical trials. The proceedings have begun to take on the trappings of a court of law, complete with lawyers, delays and obfuscation. FDA officials concede that it is because of the cumbersomeness of the procedure that the agency has been willing to settle for consent agreements as in Aronow's case — by which the researcher pledges not to participate in clinical trials and by which he is spared the embarrassment of finding his name appended to a public list of disqualified researchers. But this solution does not fully serve the public interest. Journals that had published Aronow's questionable results, and the Environmental Protection Agency which had relied on Aronow for key studies of the health effects of carbon monoxide, had to learn of FDA's findings through an account leaked in the *Washington Post* months after the consent agreement was signed. FDA should not feel obliged to burden itself with quasi-legal proceedings in order to disqualify unreliable researchers. Conducting a clinical trial on a new drug is hardly a right protected by guarantees of due process — it is a privilege that carries with it the profound trust of society.

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