PERSPECTIVE

Science is still too closed

Open initiatives are promising, but we have much further to go if research data are to be as publicly accessible as they should be, says **Aled Edwards.**

To paraphrase Joy's Law, no matter where you work, most of the smartest people are somewhere else. This principle, coined by co-founder of Sun Microsystems Bill Joy, could also apply to the best data or the most cutting-edge technologies. Providing open access to these distributed assets would accelerate science and innovation. But, despite the promise that open access holds, it has so far proved difficult to implement.

Few would dispute that sharing science accelerates the rate of discovery. The fact that open science also boosts innovation in industry is less well appreciated. Economist Heidi Williams at the Massachusetts Institute of Technology in Cambridge retrospectively analysed the commercial activity that flowed from two large sets of sequenced human genes (H. L. Williams *J. Polit. Econ.* **121,** 1–27; 2010). One group was made up of sequenced genes that for a period of time had been available only under commercially restrictive terms. The genes in the other group had always been in the public domain. Over a 10-year period, Williams found, there was around 30% more commercialization activity from the open set of genes.

A look at the biopharmaceutical sector reveals a similar story. Both monoclonal antibody and phage-display technologies are used to identify precursors to antibody drugs. Both technologies were invented more than 25 years ago, and both have been used to discover successful medicines. But whereas the phage-display technology has been fiercely protected, monoclonal antibody technology was placed in the public domain. As of 2014, there were 47 approved monoclonal antibody drugs and only 7 derived from phage-display technology.

Although it may seem counter-intuitive, openness is good for innovation. No wonder, then, that the idea is gaining traction in biomedical research circles. 'Open' has become one of the hottest topics in boardrooms, funding agencies and the media, and dozens of initiatives have been launched under the open brand.

Open-access initiatives to make the scientific record more widely accessible are being championed by charitable and governmental organizations. Most of the largest funders now require that articles that are derived from research that they support are made freely available on the Internet after a period of time, often a year or less. These organizations are also working to ensure the publication of large data sets through initiatives that are modelled on the Human Genome Project (HGP), which released data daily and without restriction on their use.

These are positive steps, but there remains much room for improvement. Open-access publishing, for instance, is often possible only when publishers charge hefty publication fees (which are paid for with public funds) and some of the highest-impact journals continue to resist open-access policies. Few of today's open-data initiatives meet the 20-year-old standards set by the HGP — most allow data release to be delayed and let primary investigators control the data, and many place various restrictions on data use.

Indeed, few initiatives are truly open. The term open innovation, as defined in the management literature in 2003 (H.W. Chesbrough *Open Innovation: The New Imperative for Creating and Profiting from Technology;* Harvard Business Press, 2003), refers to a collaboration in which two or more companies share or license proprietary information between themselves — a far cry from true openness. More recently, companies have begun to embrace less restrictive collaborative approaches to access more ideas and technologies, including crowdsourcing projects (see page S62) and pre-competitive consortia (see page S56). However, industry-led initiatives that yield publicly accessible research are still rare.

The open-access movement has gained so much momentum that it can be tempting to believe that everything is awesome. The reality is more nuanced. Although the progress towards open access is encouraging, there is a long way to go before all scientific results are communicated in real time, at no cost and without restriction on use as a matter of course.

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Considerable change is needed. Research produced in universities should be available to all, but it is not. Universities often limit access to their research output because they continue to adhere to the ideology that secrecy and patents are obligatory foundations for commercialization and innovation. The imbroglio over who owns the rights to the CRISPR–Cas9 gene-editing technology will probably emerge as another case study for how the financial interests of institutions can inhibit innovation by limiting, rather than promoting, the uptake and application of foundational technologies.

Experimental reagents and protocols should be freely available to allow researchers to reproduce experiments; this is not always the case, and even when it is, most are encumbered by legal agreements that restrict their use.

Data from clinical and genetic studies should be made available to the study participants, but they are not. In most such studies, the data are considered to be proprietary, and there is no obligation to release them to the participants of the study, much less the public.

If this is to change, I propose that society first agree on a simple, guiding principle: all scientific discoveries first constitute a public good and only second are the property of individual scientists, institutions or countries. Agree on this, and it follows that anything that impedes the sharing of discoveries — either by prolonging the time or complicating the process of disseminating scientific outputs — should be eliminated entirely. We should not be satisfied with anything less. ■

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