

Open science

The findings of medical research are disseminated too slowly

That is about to change



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ON JANUARY 1st the Bill & Melinda Gates Foundation did something that may help to change the practice of science. It brought into force a policy, foreshadowed two years earlier, that research it supports (it is the world's biggest source of charitable money for scientific endeavours, to the tune of some \$4bn a year) must, when published, be freely available to all. On March 23rd it followed this up by announcing that it will pay the cost of putting such research in one particular repository of freely available papers.

To a layman, this may sound neither controversial nor ground-breaking. But the crucial word is “freely”. It means papers reporting Gates-sponsored research cannot be charged for. No pay walls. No journal subscriptions. That is not a new idea, but the foundation’s announcement gives it teeth. It means recipients of Gates’ largesse can no longer offer their wares to journals such as *Nature*, the *New England Journal of Medicine* or the *Proceedings of the National Academy of Sciences*, since reading the contents of these publications costs money.

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That will hurt. Publication in such Premier-league journals is the stuff careers are built on. But it will also hurt the journals themselves. Their prestige is based on their ability to pick and publish only the best. If some work is out of bounds to them, no matter how good it is, that will diminish their quality. And if other patrons of science follow suit, those journals’ businesses could begin

to crumble. Moreover, by actively directing the beneficiaries of its patronage towards the repository in question, set up last year by the Wellcome Trust (after Gates, the world’s second-largest medical-research charity), the foundation is pointing to a specific type of alternative—and to a future for scientific publication that, if not completely journal-free, is likely to be at least, “journal-lite”.

Wellcome to the 21st century

Periodical journals have been the principal means of disseminating science since the 17th century. The oldest still around, the *Philosophical Transactions of the Royal Society* (pictured above), appeared first in 1665. Over the intervening three and a half centuries journals have established conventions for publication—such as insisting on independent (and usually anonymous) peer review of submissions—that are intended to preserve the integrity of the scientific process. They have, though, come under increasing attack in recent years.

One criticism, in a world where most non-commercial scientific research is sponsored by governments, is that there should be no further charge for reading the results of taxpayer-funded work. Journals, in other words, should have no cover or subscription

price. A second is that the process of getting a paper published takes too long. Months—sometimes years—can pass while a hopeful researcher first finds a journal willing to publish, and then waits for peer review and the negotiation of amendments. That keeps others in the field in the dark about new results for longer than is really necessary, and thus slows down the progress of science. Third, though this is less easy to prove, many researchers suspect that anonymous peer review is sometimes exploited by rivals to delay the publication of competitors' papers, or, conversely, that cabals of mates scratch each others' backs, review-wise.

To these criticisms, another may be added, which is not the fault of journals, but still needs addressing. This is the unwillingness of many researchers to publish the data on which their conclusions are based. Some journals do insist on full disclosure of data, but not all are so particular. And, even then, the data in question will not see the light until publication day.

Partial solutions to some of these problems have been tried. The Gates foundation is experimenting with carrots, as well as sticks. It has offered the publishers of one top-flight journal, *Science*, \$100,000 to make papers published this year about Gates-sponsored research free to read from the beginning. If this goes well, the experiment may be extended to other publications. Similarly, there is a movement among some publishers to make papers free to the reader by charging the authors (and therefore, ultimately, their patrons) for the costs of publication—usually in the range of \$2,000-\$3,000 per paper. But many now think these are half-measures, and that a real revolution in the idea of scientific publishing is needed.

Part of science has already undergone such a revolution. Since 1991 physicists have been able to deposit early versions of their papers, known as preprints, in an online repository called *arXiv* (the "X" represents a Greek "chi" rather than a Latin "ex"). *ArXiv* is paid for by Cornell University Library, the Simons Foundation, a charity, and through fees from around 200 members (mostly universities). Over the years the number using it has increased, to the point where around 300 preprints are deposited every day.

This sort of "pre-publication" is rapidly becoming physics's method of choice. Depositing a paper in *arXiv* both establishes that a researcher has been the first to arrive at a discovery and makes that discovery available immediately to others. It does not provide formal peer review, but physicists are not shy of criticising the work of

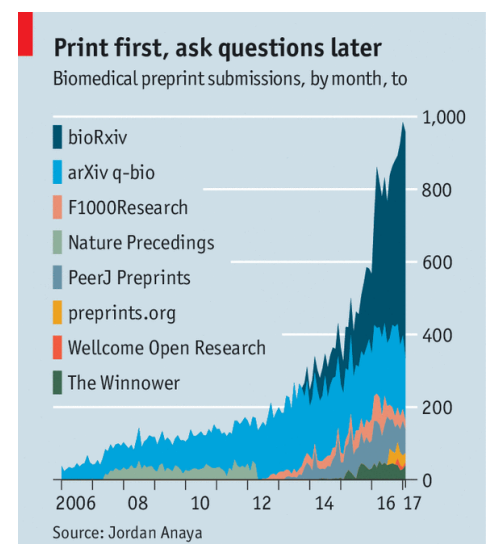
others, so a lot of informal (and un-anonymous) feedback can accumulate rapidly. This potential flak is a deterrent to publishing half-baked work. Nor does appearing in *arXiv* preclude later publication in a journal. The editors of periodicals were once sniffy about accepting material previously available elsewhere. In physics, they can no longer afford this luxury.

The Gates foundation's announcement is part of an attempt to extend this idea to the rest of science, particularly biomedical research. Biomedical equivalents of *arXiv* exist, but they are not much used. One of the largest, *bioRxiv*, received around 600 submissions in February. That is but a fifteenth as many as *arXiv*, even though many more biomedical papers are published per year than physics papers.

Why biologists have failed to follow physicists' lead is unclear. It may simply be a historical accident. *ArXiv* was started before most journals went online, so was initially more distinct from such journals than online databases are now. By the time biologists, less computer-literate as a clan than physicists, caught up with the idea, the online-offline distinction had blurred, and the journals saw online repositories as rivals. But whatever the cause, the result was clear: an unwillingness by non-physicists to embrace preprints.

The time, however, seems ripe to change that. Though its absolute numbers are still low, the use of *bioRxiv* is growing fast (see chart). And it is not just outside nudges that are bringing this sort of thing about. In February, for example, ASAPbio, a group of biologists who are trying to promote the use of preprints, began looking for bidders to create a website which will index all life-science preprints published in public repositories.

Outside nudges do help, though. It will not harm ASAPbio's chances of success that its plan has the backing of America's National Institutes of Health, the country's main source of taxpayer finance for medical research. And other philanthropic organisations besides the Gates foundation are also pushing in the same direction. The Wellcome Trust's creation of the repository Gates has just joined is one example. Another is the Chan



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Zuckerberg Biohub in San Francisco, brainchild of Mark Zuckerberg, a founder of Facebook, and his wife, Priscilla Chan. In February the Biohub announced it would disburse \$50m to 47 local scientists on condition they made their work available as preprints.

There is even room for commerce in this brave, new world. The Wellcome-Gates repository is actually run by a firm called F1000, that also has its own preprint repository, F1000Research. This operates in a slightly different way from *arXiv* and its imitators in that it does include a formal process of peer review. F1000's review process involves named rather than anonymous reviewers, which many regard as a strength. But who those reviewers should be is suggested by a submitted paper's authors, which carries obvious risks of partiality. Revenue comes from a fee of up to \$1,000 that authors pay on submission.

The wider use of preprints might also help reduce the problem of pre-publication data-hoarding. Once a preprint is published, its authors need not fear that others will take credit for their work. And it is becoming easier to make data available in a way that lets the originator retain control and garner credit. Sites such as Figshare let researchers assign a unique alphanumeric code (called a Digital Object Identifier) to data sets, figures, video and so on, meaning their origins are clear.

None of this necessarily means that non-physicists will eschew journals and rush to publish their work in open repositories. Over time, though, more may come to see the advantages of doing so. As more researchers submit preprints and make their data available to others, they may find the comments they receive regarding their work helpful. Even the kudos of publication in the premier journals may slowly fade in the face of data about a piece of work's actual, rather than potential, impact (see [article \(http://www.economist.com/news/science-and-technology/21719441-alternative-metrics-extend-concept-citation-beyond-journal\)](http://www.economist.com/news/science-and-technology/21719441-alternative-metrics-extend-concept-citation-beyond-journal)). Having survived three and a half centuries, scientific journals will no doubt be around for a long time yet. With luck, though, they will return to being science's servants, rather than its ringmasters.