

Research culture is far from monolithic. Systems that underpin scholarly communication will migrate to open access by fits and starts as discipline-appropriate options emerge. Meanwhile, experiments will be run, start-ups will flourish or perish, and new communication tools will emerge, because, as the Bethesda Open Access Statement puts it, “an old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, for the sake of inquiry and

knowledge. The new technology is the internet. The public good they make possible is the worldwide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students, and other curious minds.”

There is no doubt that the public interests vested in funding agencies, universities, libraries, and authors, together with the power and reach of the Internet, have created a compelling and necessary momentum for open access. It won't be easy, and it won't be inexpensive, but it is only a matter of time.

Disclosure forms provided by the author are available with the full text of this article at NEJM.org.

From MIT Libraries, Massachusetts Institute of Technology, Cambridge.

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Open but Not Free — Publishing in the 21st Century

Martin Frank, Ph.D.

Since the founding of *Philosophical Transactions* in 1665, journals have been the vehicle of choice for the dissemination of scientific knowledge. Over the years, the number of active, peer-reviewed learned journals has expanded to approximately 28,000, collectively publishing more than 1.8 million articles per year. Most of these journals are accessible by subscription, and before the mid-1990s, they were available only on paper. By the end of the 20th century, most journals had moved their content to online platforms, greatly increasing the accessibility of scientific information.

Online dissemination served as the impetus for the open-access movement and the call for free dissemination of the information contained in journals. Open-access advocates adopted as their slogan the words of author and editor

Stewart Brand (famously of the *Whole Earth Catalog*): “Information wants to be free.” They promoted their cause to legislative bodies by arguing that the taxpayers pay for research, so they shouldn't have to pay again to read the results. But what, exactly, has the taxpayer paid for? And can information dissemination truly be free?

A scholarly journal serves several functions for authors and readers. It serves to register the ideas of the authors, date-stamping them to provide appropriate credit for discoveries. It disseminates the authors' ideas and results to an interested community of scholars. It certifies the validity of articles through peer review. Finally, it archives articles, preserving them for future reference and citation. According to a study conducted by Cambridge Economic Policy Associates, in 2010,

the average journal's cost per article for production in print and electronic formats was approximately £2,500 (\$3,957), once surplus or profit is eliminated from the calculation.¹ For the American Physiological Society, the average cost per article was approximately \$2,635.

Digital technology enhanced access to journal content, but it did not appreciably reduce the cost of publication. Although paper and postage costs were eliminated, they were replaced by costs associated with online submission-and-review systems and hosting platforms. Online journals did not reduce the cost of acquisition for libraries. This fact was especially important, because libraries' acquisition budgets had not increased in parallel with the doubling of the budget of the National Institutes of Health (NIH) between 1997 and 2003. Instead,

libraries' funds were constrained, in part because commercial publishers worked to tie up their budgets by creating large journal collections that expanded libraries' periodical offerings but at an increase in cost. As a result, many libraries ended up canceling their subscriptions to underutilized journals in niche areas and those from small, independent association and university-press publishers, reducing the overall size of their journal collections. For many libraries, the only way to maintain users' access to needed content was to advocate for open access and promote immediate free access or the deposit of research results into institutional repositories where the content would be free.

Open access now comes in two flavors, gold and green. Gold open access provides immediate free access to the literature. The costs of publication are covered by an author processing (or publication) charge. Green open access requires the author to deposit a peer-reviewed manuscript in an institutional or central repository such as PubMed Central. Publication costs are covered through subscription fees, but the content is generally made available free of charge after an embargo period. Green open access duplicates what publishers already do, making content freely available from their own platforms after an embargo period.

PubMed Central is a repository of peer-reviewed and published manuscripts designed to provide the public with access to the research supported by their tax dollars. PubMed Central actively promotes itself to readers, and its abstracts of articles direct the reader to the free article within PubMed Central, as opposed to

the free article in the journal that published it. Reference links are directed to other articles in PubMed Central. This diversion of readers may cause a journal to lose subscribers or readers — and therefore advertising. A longitudinal cohort analysis of 12 subscription-based research journals in physiology revealed that PubMed Central drew approximately 14% of full-text article downloads away from journal websites when articles deposited in PubMed Central became freely available to the public 12 months after publication.² Similarly, the open-access journals from the Public Library of Science (PLOS) had a 22% loss of traffic to PubMed Central.³ The persistent reduction in full-text downloads from journal websites contributes to a loss of the advertising revenue that partially offsets the cost of publication. PubMed Central also competes with online platform providers, serving as the exclusive host for at least two journals, the *Journal of the Medical Library Association* and the *Journal of Biomolecular Techniques*.

Open-access publishing has gained traction over the past 10 years because of the success of the PLOS and BioMed Central families of journals. The annual volume of articles published in open-access journals has increased from 20,702 in 2000 to 340,130 in 2011 — accounting for 17% of all articles published in 2011.⁴ These articles were published in 6713 journals with full and immediate open access; 49% of them were published in journals requiring an author fee. The growth in open-access publishing has encouraged professional societies, commercial publishers, and even funders to launch new open-access journals.

There is, however, a cost as-

sociated with this openness — a cost that may reduce the funds available for research. PubMed Central diverts approximately \$4 million from the NIH budget in order to collect, process, and convert NIH-funded manuscripts into PubMed Central's archival format.⁵ Universities divert an average of \$150,000 from their library budget to establish institutional repositories. Funding agencies are encouraging or requiring their grantees to publish in gold open-access journals, allowing them to pay their author fees with money from their research grants or funds allocated by the agency. For example, in response to a 2012 report from sociologist Janet Finch about making publicly funded, peer-reviewed research available free of charge, Research Councils UK allocated £100 million (\$161 million) to promote gold open access in the United Kingdom.⁵ A 2004 study at Cornell University showed that shifting from a subscription-based to a "producer-pays" model would require an additional \$1.5 million for the library budget (ecommons.cornell.edu/handle/1813/193). Similarly, assuming that all articles had to be published with gold open access, Harvard Medical School would have to pay \$13.5 million (at \$1,350 per article) to publish the 10,000 articles authored by its faculty in 2010 — considerably more than the \$3.75 million that was in its serials-acquisition budget that year. Research-intensive institutions will thus bear the burden of funding free access to the research literature, subsidizing access for less-research-intensive institutions, including pharmaceutical companies.

Open-access publishing has evolved over the past dozen years.

Although publishers and authors are increasingly embracing the model, there remains concern about efforts by funding agencies and institutions to mandate use of gold open access. At a time of limited resources, should we be diverting funds from research in order to fund open-access publishing? Personally, I think not.

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Creative Commons and the Openness of Open Access

Michael W. Carroll, J.D.

The Internet has inspired multiple movements toward greater openness — most prominently, open access, open data, open science, and open educational resources. None of these is based on the belief that there should be such a thing as a free lunch, but each recognizes that the Internet changes the economics of publication and digital-resource sharing so that changes can feasibly be made to traditional practices that are in some ways “closed,” requiring payment for access to information or prohibiting myriad reuses of accessible information. The quality of “openness” applies to both the terms of access and the terms of use. Advocates in each movement — and I am one, serving on the boards of directors of two organizations promoting open access, Creative Commons and the Public Library of Science (PLOS) — share an understanding that an open resource is freely accessible over the Internet. Opinions vary about the terms of use necessary for a resource to be open.

Copyright law supplies the

baseline terms of use for almost all information on the Internet. These terms can be altered if the copyright owner grants a license or permission to do something that would otherwise infringe copyright. Traditionally, copyright owners granted licenses to specific persons or entities. More recently, copyright owners seeking to grant permission to everyone have issued public licenses broadening the range of permitted uses, subject to certain conditions. Creative Commons licenses are the most widely used of these public licenses for all kinds of copyrighted works except software, for which free and open-source licenses are most common.

Within the open-access context, debate focuses on whether an article is “open” when it, like this one, is freely accessible over the Internet but still subject to the standard restrictions imposed by copyright law. The question also applies to most articles posted in PubMed Central under the Public Access Policy of the National Institutes of Health or

in institutional repositories under most university policies, such as that recently adopted by the University of California, San Francisco.¹ The three major declarations of purpose for the open-access movement (the Budapest Open Access Initiative, the Bethesda Statement on Open Access Publishing, and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities) say no: openness requires making the literature freely accessible under liberal terms that permit nearly all reuses so long as the author receives credit for the work when it’s republished or adapted.²

The rationale for seeking open terms of both access and use is as follows. Free access provides the literature to at least five overlapping audiences: researchers who happen upon open-access research articles while browsing the Web rather than a password-protected database; researchers at institutions that cannot afford the subscription prices for the growing literature; researchers in disciplines other than that of a