Open-Access Publication of Medical and Scientific Research

A

Public Library of Science Background Paper

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I. Introduction

The Internet has made it possible to share scientific and medical knowledge more widely than ever before. Despite the potential for cost-effective and virtually instantaneous dissemination of new research, however, widespread access to scientific and medical literature has yet to be realized. "Open access" publishing is an exciting departure from the traditional subscription-based model of scientific publishing, a system that often frustrates the attempts of scientists, clinicians, and other interested users to search, read about and share important scientific discoveries.

While the prospect of freely available, comprehensive Internet archives of scientific literature is certainly a compelling vision, the financial logistics of open access remain a source of uncertainty for some stakeholders in scientific publishing. This Background Paper attempts to identify and address these concerns, and to provide a foundation for a timely and informed public discussion about open access.

II. About Open Access

A. *What is "open access" in the context of scientific and medical literature?*

Open access to scientific and medical literature allows anyone, anywhere, with a connection to the Internet to find and read published research articles online, and to use their contents in the course of scholarship, teaching, and personal inquiry. With open access, published material is expediently archived in a public digital repository (such as PubMed Central[1] or INIST[2]), which enhances the utility of all deposited papers by allowing sophisticated searching, manipulation, and mining of the literature, using existing and emerging tools. Storing works in a public repository ensures the long-term preservation of the literature as a freely accessible resource, irrespective of the fate of the depositing entity or of any change in its policies regarding open access.

B. *What is an open-access publication?*

The Bethesda Principles, developed during an April 2003 meeting convened by the Howard Hughes Medical Institute[3], provide the following definition of an open-access publication:

> An Open Access Publication[4] is one that meets the following two conditions:
>
> 1. The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative

[1] PubMed Central (PMC) is the U.S. National Library of Medicine's digital archive of life sciences journal literature. http://www.pubmedcentral.nih.gov/
[2] Institut de l'Information Scientifique et Technique (INIST) is the center for scientific and technical information of the CNRS (Centre Nationale de la Recheche Scientifique) in France. http://www.inist.fr/
[3] For a summary of the Bethesda meeting, see http://www.plos.org/news/OpenAccessPublishingMtg.pdf
[4] Open access is a property of individual works, not necessarily journals or publishers.

works, in any digital medium for any responsible purpose, subject to proper attribution of authorship[5], as well as the right to make small numbers of printed copies for their personal use.

2. A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (for the biomedical sciences, PubMed Central is such a repository).

C. *Why is open access important?*

The dissemination of scientific discoveries and ideas provides the foundation for progress in science and medicine. The more widely and freely accessible it is, the greater the value of peer-reviewed research. For authors, open-access literature maximizes the potential impact of their work. Anyone can find and access their manuscripts, increasing the likelihood that the works will be read, cited and used as the basis for future discoveries. For the scientific community, open access unleashes full-text literature into a single information space. Unrestricted access to scientific data, such as genetic and molecular information, has revolutionized life science research over recent years; open access to the treasury of scientific and medical literature will have similarly profound benefits for research. For research libraries, open access will help contain the spiraling costs of subscriptions to scientific serials. Mergers and market concentration within the publishing industry are placing increasing pressures on the budgets of university science libraries and other archives of research, and open access to peer-reviewed journals is a long-term solution to the problem that has become known as the "serials crisis". Beyond the community of researchers, open access will make scientific knowledge available to others who cannot afford access to subscription-based journals—clinicians and other health professionals, educators, students, and the general public. Open access to the literature will benefit research, education and health.

D. *How does open access work?*

Open access requires a systemic change in the way that scientific publishing is funded. Scientists have historically relied on print as the most effective medium for sharing and promoting their work. When information was encoded as ink on paper and distributed using trains, trucks and boats, a large portion of publishing costs was in printing and distribution, and each additional copy entailed an expense for the publisher. In this context, the subscription-based business model for scientific publication was sensible, relatively efficient and served science well.

Today, however, the costs involved in scientific publishing are almost entirely in the steps leading to production of the final electronic document, and the costs to produce and

[5] Community standards, as well as copyright law, will continue to provide the mechanism for enforcement of proper attribution and responsible use of the published work.

distribute each additional copy electronically are infinitesimal. If revenue can be generated to cover completely the costs of producing the electronic document, the document can then be made freely available to anyone with an Internet connection. Mechanisms for supporting the production of open-access articles and journals are discussed in section V.

III. Forces Driving the Shift to Open Access

The global movement toward the open-access publication of scientific and medical research is driven by the convergence of a number of independent and, many would suggest, irreversible forces. Recognition of these varied and dramatic shifts in opportunity, expectation and demand will serve as a valuable underpinning for the consideration of appropriate policy in this area.

These forces include:

- Developments in the scientific community, such as:

  —the powerful, unprecedented opportunity for the global exchange of scientific information afforded by the Internet;

  —the substantial research benefit generated by the placement of large datasets of biological information, such as the complete sequence of the human genome, in publicly accessible databases;

  —the increasing prevalence of inter-disciplinary research teams whose needs will be served by broader access to, and the timely cross-discipline transfer of, information and knowledge;

- Growing public interest in information about science and the way that public funds are used for research, as in:

  —the public's well-demonstrated desire (as evidenced by the number of "public hits" on PubMed Central) for direct access to credible science;

  —the demands for accountability regarding how public funds will be parlayed into discovery and treatments that benefit human health;

  —the increasing attention paid in the national news media and the medical community to the need for science to be immediately and more widely available to a diverse constituency (such as patient groups, students, and global public health practitioners) which does not have ready access to publications through subscriptions or licensing agreements;

- Market concentration within the publishing industry that is placing increasing pressures on the budgets of research libraries, including:

  —spiraling costs of institutional access licenses (the essential vehicle through which scientists "search" as opposed to "browse"); and

  —the "bundling" of journals by large commercial publishers, forcing many libraries to exhaust their budgets on the purchase of one or a small number of bundles of journals in order to assure access to a certain few essential publications.

With respect to this last, complex market force, a White Paper commissioned by the Information Access Alliance and published in June 2003, states:

> While publishers continue to reap the benefits of higher prices (despite fewer subscriptions), *the body of academic research is reaching an ever diminishing audience.*
>
> The work of individual researchers, who do not receive compensation for publications, and without whom publishers would not have goods to offer, will suffer further if mergers of publishers continue unabated. The publishers, who provide a distribution channel for the work of others, are actually impeding that distribution to increase profits[6].

While debates about the viability and logistics of open access persist, questions as to the potency of the forces driving the movement toward open access have been largely put to rest.

IV. Support for Open Access Among Funders

A genuinely systemic shift to open access in scientific publishing will, for reasons discussed in more detail in the following section, require the cooperation and support of research funders. Recently, the world's two largest private funders of biomedical research have formally expressed support for open access publication. The Howard Hughes Medical Institute (HHMI) adopted the "Bethesda Definition" in a letter dated September 2, 2003. HHMI encouraged its investigators to publish in journals accepting such open-access publications and committed to reimburse authors for open-access publishing fees in an amount up to $3000. On October 1, 2003, the Wellcome Trust issued its statement in support of open access[7], accompanied by a report highlighting concerns about the current state of scientific publishing[8]. Additionally, on October 22, 2003, the Berlin Declaration[9] in support of open access was issued and endorsed by, among others, the Max Planck Institute, DFG (German Research Foundation) and CNRS.

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[6] Thomas M. Susman, David J. Carter and the Information Access Alliance, *Publisher Mergers: A Consumer-Based Approach to Antitrust Analysis. (*Wash. D.C. June 2003) page 32. http://www.informationaccess.org/WhitePaperVSFinal.pdf . *Emphasis added.*

[7] See http://www.wellcome.ac.uk/en/1/awtvispolpub.html

[8] See http://www.wellcome.ac.uk/en/1/awtpubrepeas.html

[9] See http://www.zim.mpg.de/openaccess-berlin/berlindeclaration.html

V. Open Access and Scholarly Societies' Constituents' Interests

The majority of published scientific articles is disseminated in journals compiled by scholarly or academic societies. Granting the broadest possible access to scientific and medical literature serves the interest of scholarly societies by removing barriers to research and teaching. Like commercial publishers, however, many scholarly societies face the question of how to manage their journals' financial operations in an open access system. In the immediate future, societies also need to address how to transition their journals to open access without interrupting the invaluable flow of peer-reviewed articles that they process and publish and without jeopardizing the continued financial stability of their journals.

A. *Payment for open access*

Electronic distribution makes possible a more effective system of sharing scientific information—provided that journals can remain financially solvent while much of their content is available for free online. Since open access eliminates subscription fees for online journals, it requires that funders, authors and institutions treat publication as the final stage of a research project by paying fees to journals to help disseminate scientific discoveries. Publishing costs must therefore be recognized as legitimate research expenses—like presenting a poster at a scientific meeting—and funds will have to be provided to allow scientists to pay for this critical stage of their work.

Pragmatically speaking, there are many different ways to subsidize open-access publication costs; it is not necessary for the thousands of existing peer-reviewed scientific journals to adopt the same business model[10]. It seems likely, however, that many successful strategies for open-access publishing will use some combination of the following options:

- publication charges to authors
- institutional membership arrangements—whereby publication charges are waived or discounted for scientists affiliated with the member institute
- decreased publication costs—made possible by the increased efficiency of digital technologies in journal management, publication, and distribution
- grant support from research sponsors and other funding bodies with an interest in the dissemination of knowledge

[10] For a more detailed presentation of open-access publishing business models, see Crow, R. and Goldstein, H. (2003) *Guide to Business Planning for Converting a Subscription-based Journal to Open Access*, Open Society Institute, Edition 2, July 2003.

- continuing revenues from existing sources—such as print subscriptions, advertising, and corporate sponsorship

- new revenue streams—such as the sale of value-added content or services

To expand on the second of these points, funds that are currently used by institutions for subscriptions to journals in some instances have been partially converted to "institutional memberships" to help subsidize open-access publication. BioMed Central (BMC), for example, which produces more than 100 open-access journals, has arranged such relationships with more than 300 institutions. Those groups have agreed to pay fees depending on the size of their faculty, postdoctoral, and graduate student bodies, which entitles affiliated contributors to publish in BMC journals at no cost[11].

Another potential source of revenue for open-access publishing is scholarly societies, themselves. One of the functions of scholarly and academic societies is to provide a vehicle for publishing and promoting their members' work. Currently, membership dues paid by society constituents often earn them a "free" or discounted subscription to the society's journals. In the future, those dues could continue to help scholarly associations pay for the production of peer-reviewed journals—but the revenue could be used to subsidize publication fees, rather than subscription charges.

Some critics of open access have charged that society members would have no incentive to pay dues if they could read and search their association's journals for free online. Scholarly and academic societies must be encouraged to explore a variety of vehicles through which to sustain this vital membership revenue stream. These might include a benefit offered to society members in the form of a discounted publication fee in the society's journal. When coupled with other incentives for society membership—including the promotion of science communication, lobbying, outreach, discounted conference registration rates, community building and newsletters—such a system may be structured to give society members ample reason to continue paying membership fees.

Finally, the most direct way to sustain open-access publishing in the long term will be reliant upon funding bodies recognizing that open access to research maximizes the impact of the research they are subsidizing[12], is a valid research expense, and therefore must be included in grant funding. If major funders of research conclude that open-access publishing is an important component of successful proposals, and commit to earmarking funds for reasonable open-access publication fees, the market will respond with creative and sustainable publication models. The costs of such a policy for biomedical research have been estimated at 1-2% of the costs of the research itself[13].

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[11] It is worth clarifying that the publication costs that institutional memberships cover—and indeed all costs to authors and institutions in most open-access models—are for *published* articles, not *submitted* articles. Few, if any, open-access journals charge authors to have their papers reviewed.

[12] For a study of the comparative impacts of open- and restricted-access articles, see Lawrence, S. (2001) "Online or invisible?" *Nature*, 411 (6837), 521. http://www.neci.nec.com/~lawrence/papers/online-nature01/

[13] Based on an analysis by The Wellcome Trust (Robert Terry, Wellcome Trust). During the period 1995-99, there were estimated to be 16,646 publications resulting from Trust-funded research. During that period

B. *Models for gradual transition*

In the short term, there are several different strategies that existing journals can use to transition to open-access business models. Since open access applies not just at the level of the journal, but at the level of the article, journals can adopt mixed open-access and restricted-access policies, depending on authors' ability and willingness to pay open-access publication charges.

Several journals—such as *Physiological Genomics*, published by the American Physiological Society, and the three journals published by the Company of Biologists (*Development*, *Journal of Cell Science* and the *Journal of Experimental Biology*)—offer authors the option to pay to have their articles made freely available immediately upon publication. This approach was pioneered by the Entomological Society of America[14]. In a mixed free-access/restricted-access model, both society and commercial publishers are able to move gradually towards open access without immediately inviting a torrent of subscription cancellations (due to free online availability) before alternative revenue sources can be stabilized. Many existing mixed-access journals do not currently deposit "freely available" articles in centralized information spaces like PubMed Central. In order to be considered open-access, these works need to be archived in stable digital repositories that are available to the public.

Since open access applies only to electronic versions of scientific articles, another transition strategy could be for publishers to use continuing revenue from print subscriptions to help sustain the financial viability of open-access journals, at least in the short term. It remains unclear what the demand will be for print editions of open-access online publications. Insofar as the demand for "hard copies" does indeed decline for journals whose peer-reviewed research becomes freely available online, enlightened institutions could nevertheless agree—in light of the long-term benefits of open access for their libraries and researchers alike—to continue paying for print subscriptions for a limited time. This revenue stream would serve as another means of allowing journals a window in which to implement business models appropriate for open-access publishing. If the demand for print subscriptions to open-access journals does not decline appreciably, print-subscription revenue could be used to support open-access electronic publishing in perpetuity.

Another alternative still is for journals to seek grant funding (such as the recent programme announced by JISC[15]) or commercial sponsorship to support a transition to open access. In light of the extensive benefits to science of open-access archives, public-private partnerships may be structured to support innovative mechanisms for underwriting portions of a widespread shift toward more useful archiving and more efficient data manipulation.

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the Trust invested £1.5 billion in research. If Open Access publication fees are set at £1000-£1500 per paper, this would represent 1.11-1.66% of the research budget.

[14] Prosser, D. (2003) From here to there: a proposed mechanism for transforming journals from closed to open access. *Learned Publishing* Vol. 16, 163-166.

[15] See http://www.jisc.ac.uk/index.cfm?name=funding_open_access

C. *Open access and scholarly societies' constituents' interests*

Removing access barriers to academic society publications is a means of serving constituent interests. To the extent that academic societies would face decreased revenues with open-access journals, John Willinsky suggests a re-evaluation of the society's service mission:

> [t]he scholarly association has, then, to put the question to its membership: Is this organization devoted to maintaining its current revenue levels, or is it devoted to serving the professional interests of its members in fostering greater development and circulation of knowledge?[16]

And of course, for scholarly societies that rely less on surpluses from publishing, a transition to a business model that supports open access may be an easier decision.

Open access to scientific and medical literature will make the particular area of science which is the primary focus of each specialty society progress more efficiently. Scientists will be able to search freely accessible centralized information spaces, and use colleagues'—not to mention their own—work in the course of teaching, without violating the terms of copyright agreements with profit-driven journals. The results of the research that funding bodies underwrite will be available to educators, health professionals, and other interested parties, in addition to the scientific community in its entirety. Clearly, a system of disseminating information that provides such benefits serves the best interests of scholarly societies and their constituents.

[16] Willinsky, J. (2003) "Scholarly Associations and the Economic Viability of Open Access Publishing," *Journal of Digital Information* Vol. 4 iss. 2. http://jodi.ecs.soton.ac.uk/Articles/v04/i02/Willinsky/#Crow03.

VI. Common Questions about Open Access

• *Archive Sustainability*

Concern: *How will the archival record of science be sustained in an open-access world?*

Response: One of the main benefits of open-access publishing is that papers are archived in stable, centralized repositories such as PubMed Central and INIST. In fact, open-access archiving is in many ways more robust than restricted-access archiving (as far as Internet archiving is concerned), because articles can be deposited in multiple archives without the arduous process of securing copyright permission from many different publishers separately. Open-access journals and archives also protect against corporate contingencies (mergers and bankruptcies, for example) that may remove archives previously considered secure.

• *Quality control*

Concern: *Since open-access publishers rely largely on "publication fees" from authors, institutions, and funders, open access may require journals to publish high volumes of papers in order to remain solvent. Published papers in open-access journals may not, therefore, be vetted with the same precision they are accorded in restricted-access journals.*

Response: One of the key factors that influences authors' decisions about where to publish their work is the perceived quality of the journal. This depends on a network of cooperation among authors who submit their hard-won papers, reviewers who apply appropriate standards of quality control for the journal, and editors who select the papers and reviewers. The quality of any journal diminishes if selection criteria are lessened, with the result that the journal becomes less attractive to authors, and of less interest to readers. Open-access publishers are therefore subject to the same pressures as restricted-access journals to maintain scientific standards, so that their journals are valued by authors and readers.

• *Protecting authors' rights*

Concern: *The 83% of scientific, technical and medical (STM) journals that currently require authors to transfer copyright to their works to the publisher do so because publishers are better equipped than authors, to protect authors' rights*[17]*. Authors would forfeit a considerable asset—namely legal protection—by publishing with open-access licenses rather than restricted-access licenses.*

[17] Cox, John and Laura (2003) "Scholarly Publishing Practice: the ALPSP report on academic journal publishers' policies and practices in online publishing," for the Association of Learned and Professional Society Publishers. http://www.alpsp.org/news/sppsummary0603.pdf

Response: Publishers claim to offer two kinds of legal protections to authors—protection against unauthorized duplication and protection against misattribution.

On the first count: the protection against unauthorized duplication does not benefit the author; it benefits the publisher. Authors want their works to see the widest possible distribution and citation; they are publishing for impact, not for profit. Publishers, on the other hand, take substantial revenues from reprints, particularly when the article is used as part of a coursepack, and have a strong incentive to prohibit the free duplication of works. Open access does indeed this eliminate this protection for the publisher; open access permits reproduction and distribution of the work for any responsible purpose, which is fully in line with the interests of authors and readers.

On the second count: STM publishers virtually never go to court to defend an author's work against copyright violations involving misattribution. The vacancy of this historical record is due in part to the fact that legal questions of attribution are governed more by legislation pertaining to fraud than by legislation pertaining to copyright. Furthermore, the real protection of scientific works against misattribution comes from standards of the scientific community. Since an author's reputation is his or her most valuable asset, the expectations of peers will always enforce proper compliance with codes of attribution more effectively than legal statutes can. And, of course, open access makes plagiarism far easier to spot—since open archives are more inclusive and more easily searched.

• *Critical Mass*

Concern: *Open-access journals will not be sustainable until a critical mass of authors commits to publishing in open-access journals—which will never happen because open-access publishing is more expensive to authors than restricted-access publishing and because open access journals do not yet have impact factors, which are used to judge the worth of scientists and their institutions.*

Response: In scholarly arenas that have limited open-access publishing options, new high-quality open-access journals (such as *PLoS Biology*) are rapidly emerging to fill the void. Universities, government institutions and funding bodies can play a role in making these new journals attractive choices for authors by assuring researchers that decisions regarding the award of grants, job applications, promotion and so on will be made on the basis of the quality of their work, not on the perceived prestige of the journal in which they publish. Funders, academic institutions and governments are increasingly encouraging open access, as evidenced by BioMed Central's (BMC) 300-plus "institutional members" across 33 countries, and the recent commitments of financial support for investigators to publish in open-access journals by some of the worlds biggest sponsors of research (see section IV). In response, open-access options are emerging not just in the form of new open-access journals (of which there are over 100 in BMC), but also in the form of publishers taking transitional steps toward open access (as have the American Physiological Society, the Company of Biologists, Oxford University Press, the Entomological Society of America, and others). Those transitional steps provide

authors the opportunity to choose open access regardless of how many others are doing so. This gradual migration represents a stable, sustainable movement toward open access.

VII. Conclusion

Clearly, there remain outstanding questions about the logistics of open access, as there would be about the logistics of any systemic change of a similar scale.

Institutions will face the issue of how, precisely, to dedicate to open-access journals some of the funds that their libraries currently use to pay expensive subscriptions to restricted-access journals. Universities will be challenged to develop systems to reward authors for publishing in journals which archive works in the emerging open-access repositories that will catalyze a new, open, global interchange of ideas. Finally, funders of research, and especially public agencies who hold a special trust to maximize the impact of the work they fund, will be challenged to consider open-access publishing in the context of their mission.

These challenges, while significant, are worth overcoming because, simply stated, the end result—the removal of barriers to scholarship and the global interchange of scientific ideas—holds spectacular promise for the future of science, education and health.

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