EDITORIAL

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Open access. A turning point in scientific publication

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The birth of Open Access

"Open access" is the term used to describe literature that is available to any reader at no cost on the Internet. The copyright owner—usually the author—allows the user to freely read, download, copy, print, distribute, search, link to the full text of the article, crawl it for indexing, convert the reported data to software, or use the article for any other lawful purpose. In open-access journals, authors either retain copyright or are asked to transfer the copyright to the publisher. In both cases, the copyright holder must consent to open access to the articles. The only role of copyright in open-access literature is to give authors control of the integrity of their work and the right to be properly acknowledged and cited [8]. Although open access is a concept that is most often applied to online publication, it is nonetheless compatible with print for those journals that also have a printed version. Open access is free of charge for readers of the online version, but does not exclude priced access to print versions of the same work.

It all started in Budapest, on December 1–2, 2001, when leading proponents of a new initiative in scientific and scholarly publication and archiving gathered under the auspices of the Open Society Institute (OSI). The OSI was founded in 1993 by the investor and philanthropist George Soros to serve his foundations, which currently have expanded to more than fifty countries. OSI and the Soros foundations aim "to promote open societies by shaping government policy and supporting education, media, public health and human and women's rights, as well as social, legal, and economic reform." The participants at the Budapest meeting, who had previous experience with the various initiatives discussed by the open-access movement, represented many organizations, scientific disciplines and countries. The objective of that meeting was to join efforts and unite the strategies of the separate initiatives into a plan of action aimed at achieving broader, deeper and more rapid success, and to determine how the resources of the OSI could be used to aid the cause of open access [1]. The primary outcome of the meeting was the Budapest Open Access Initiative (BOAI), which is a statement of principle, strategy and commitment. Since the BOAI was released, on February 14, 2002, around 270 organizations and 3400 individuals have added their names in support of the initiative.

By June 2004, the OSI had spent US$ 1,299,018 to support open-access projects that included: (a) tools, such as the Directory of Open Access Journals (DOAJ) and special software; (b) guides, such as the "Guide to Business Planning for Converting a Subscription-Based Journal to Open Access" and "Guide to Launching a New Open Access Journal"; (c) advocacy, by means of grants, to educate scientists, European funding agencies, libraries and publishers regarding the benefits of open access; (d) international conferences, seminars and workshops to increase awareness of open access; (e) grants to support the publication of articles by authors from developing countries in open-access journals; and (f) grants supporting the creation of institutional repositories for open-access articles.

Open access is compatible with high standards and high-quality science. In fact, the BOAI aims at establishing open access for peer-reviewed literature. The editorial process and standards used to accept or reject an article for publication should not depend on whether it is published online or in print, nor on whether readers must pay to obtain articles or can access them at no cost (Table 1).

Two leading projects in open-access publishing are the Public Library of Science (PLoS) and BioMed Central. The PLoS is a non-profit organization made up of scientists and physicians committed to making the world's scientific and medical literature a public resource [www.plos.org]. PLoS launched its first journal, in print and online, *PLoS Biology*, in October 2003. It is a peer-reviewed open-access journal, as will be the several dozen titles that PLoS plans to have launched by 2008. *PLoS Medicine* will be the second, and the first issue is scheduled for release on October 19, 2004. Start-up funds for PLoS publications are being provided through a US$ 9 million 5-year start-up grant from the Gordon and Betty Moore Foundation, which will be used mainly to cover

Table 1. Some differences between online open access and print non-open-access publishing

	Online open access	Print non-open-access
Who pays for the article	Authors or funding institutions	Readers or libraries
Steps in the publication process that differ	Preparation of the digital version followed by publishing online	Preparation of content followed by printing and mailing the journal
Articles	Can be published individually soon after their acceptance	Content of a single issue must be ready for publication by the same time
Availability	Electronically, wherever there is a computer connected to the Internet	In paper, by individual or institutional subscription
Impact factor (IF)	Increasing	Decreasing
Copying or distributing articles	Consent of copyright holders not needed	Consent of copyright holders needed

editorial staff salaries [10]. Authors publishing their articles in PLoS journals are charged US$ 1,500 per published paper, but those fees may be waived when authors of accepted papers cannot possibly pay them. Expensive as these charges may seem, they do not necessarily cover the actual costs.

The other project, BioMed Central [www.biomedcentral.com], is an independent publishing company established in the UK in 1999. Currently, the company publishes over 100 peer-reviewed open-access journals covering all areas of biology and medicine. Most BioMed Central journals are published only online. To guarantee permanent accessibility to research articles, all BioMed Central articles are archived at least in PubMed Central and are included in PubMed (from the NIH, see below).

Controversy surrounding the Open Access Initiative

The future of the Open Access Initiative has been the subject of heated discussion among scientists, publishers, learned societies, librarians and even government funding agencies and individuals in charge of setting scientific policy. The main questions being debated are: (a) should all scientific literature be open access?, (b) if so, how should the costs of publishing be met?, and (c) who should cover these costs?

In the European Union, most scientific research is funded by public institutions, either regional, national or through the European Commission (EC). At the same time, the majority of scientific articles authored by European researchers are published in journals for which individuals or institutions have to pay subscription fees. Traditionally, authors have been compelled to transfer their copyrights to the publisher, which becomes the sole owner of the published material. In fact, under the old concept of copyright, the publisher had exclusive and unlimited rights to reproduce and distribute the article, as well as translation rights. Were this rule to be strictly followed, most copies of articles that researchers keep in their offices around the world would be "illegal". However, there is a tendency for publishers to allow authors to make their digital articles available on their personal websites or even to deposit them in a publicly accessible website. This last possibility is known as "green" (green journals are those that give a "green light" to self-archiving by the author) [7].

In June 2004, the European Commissioner for Research, Philippe Busquin, announced that the EC planned to study the economic and technical evolution of the scientific publishing system. Europe generates 41.3% of all scientific publications, as compared to 31.4% for the USA. Many European funding agencies and charities support the OAI, but in Europe there is also strong resistance from several of the largest companies in the scientific editorial market.

In July 2004, the US House of Representatives Committee on Appropriations recommended setting deadlines for depositing the full text of articles derived from research funded by the National Institutes of Health (NIH) in the online-searchable PubMed database. NIH director Elias Zerhouni went even further and claimed that NIH-financed research should be given immediate open-access status.

In the UK, the House of Commons Science and Technology Committee suggested to the government that British universities should be requested to ensure that all papers published by their researchers are made freely available online, and that free access to the results of government-funded research ought to be a condition of the grants.

A lively forum devoted to the freeing of online access to the peer-reviewed research literature has gone on since 1998, and contains around 4000 messages dealing with many aspects of open-access publishing. The forum—of course open access for readers—is available at: <http://www.ecs.soton.ac.uk/~harnad/Hypermail/Amsci/index.html>.

Open access and the Impact Factor

The results of an analysis of almost 120,000 conference articles in computer science and related disciplines made in 2001

[9] suggested that free online papers had greater impact than those published either in printed journals or not freely accessible from the Internet. Another, more recent, comprehensive study by the Institute for Scientific Information (ISI) tried to determine whether the open-access journals in their databases had higher Impact Factors (IF) than conventional journals. Of the around 200 open-access journals examined by the ISI, 148 had been monitored long enough to have their IF published in the *2002 Journal Citation Report*. These were analyzed and compared with the remaining journals indexed in the ISI database. The study revealed that, as a whole, open-access journals and the other journals analyzed have similar citation patterns, although articles published in open-access journals tend to be cited earlier [12].

Several factors can explain the differences between the results of the two studies mentioned. The open-access items analyzed in the 2001 study were from only one technical field, computer science, whereas those in the ISI study covered all of the natural sciences. In addition, in the ISI study, the items analyzed were journals and not articles. ISI did not take into account that many articles published in non-open-access journals can be found online because their authors have put them on their websites or have self-archived them in public repositories. It often happens that scientists are given free access to articles through their libraries' institutional subscriptions. Thus, non-open-access journals considered in the ISI study may have contained articles that are virtually open access. Another bias of the ISI study may have resulted from the fact that, at the time of the study, open-access journals analyzed by the ISI comprised only 2% of the around 8700 selected journals covered by the organization.

Currently, under a contract provided by the ISI, an international team (Canada, UK and Germany) is further evaluating the effect of open access on IF. The study will assess the possible advantages of open access across all disciplines in a 10-year sample of 14 million articles. In the field of physics, analyses up to 2001 have already been completed. The results evidence that open access indeed confers an impact advantage [6]. Between the years 2000 and 2001, citations of open-access articles rose from 32.2% to 56.7% even though they comprised only 18% of all articles in 2001. It is clear that open-access publishing neither lowers the IF nor prevents journals from being included in ISI databases.

International Microbiology and the Open Access Initiative

In the previous epoch of the journal of the Spanish Society of Microbiology (SEM), when the journal's title was *Microbiología*, initial steps were taken to make the journal available online to everyone [5]. Since 1998, the beginning of the latest epoch of the journal, renamed *International Microbiology*, free access to its content has been provided to the extent that the contract with the publisher has allowed. The policy of the Editorial Board has been to contribute to making the scientific literature universally available, so that scientific researchers from both developed and developing countries have equal access to information. It can be said that, like other journals published by scientific societies and not by private companies, we joined the OAI even before it existed.

International Microbiology is now immediately available (i.e. as soon as the articles are placed on the Internet) at its own website and at a public repository, SciELO Spain, which is the electronic virtual library (SciELO stands for Scientific Electronic Library Online) set up by the Biblioteca Nacional de Ciencias de la Salud (Spanish Library of Health Sciences, Madrid, Spain) through an agreement established between the Pan-American Health Organization/World Health Organization (PAHO/WHO) and the Instituto de Salud Carlos III, Madrid, Spain.

Like other journals published by most scientific societies, *International Microbiology* is not expected to make a profit. Nevertheless, publishing—either in print or electronically—implies significant costs, which are continuously increasing and have to be covered. As is the policy of other societies, *International Microbiology* in print is provided to all SEM members. However, the actual cost of publishing the journal, not to mention its release online, exceeds by far the annual contribution of the SEM; in fact, the Society's contribution is one third of the total cost. By contrast, journals pertaining to the field of medicine, or those published by learned societies with huge memberships, distribute thousands of copies of every issue and thus tend to attract large amounts of advertising revenues. In addition, some medical journals earn significant profits by selling thousands of reprints of articles published by researchers from pharmaceutical or medical companies.

Richard T. O'Grady, Executive Director of the American Institute of Biological Sciences, which publishes the monthly journal *BioScience*, commented that "the true and full publication costs of a scientific journal published by a nonprofit society publisher, including staffing, peer review, editing, text formatting, distribution, overhead, and so on, can easily exceed $500 per page", and that "[t]hese costs are reduced by only 25 per cent if no paper copies are produced." [11]. O'Grady did not mention the cost per page in the case of journals published both in print and online. When most of the staff of a journal, as well as peer reviewers, must do their job by stealing time from other activities, without expecting an

economic reward, as is the case of *International Microbiology*, the cost is substantially reduced—but there are always other expenses that absolutely must be covered.

One possible solution that some open-access journals, such as those published by the PLoS, have already adopted is to shift the cost of publishing from readers to authors or granting agencies. In the traditional publication system, the reader—or his or her institution—is not always the only one to pay. In order to publish in some highly cited journals, authors must pay page charges and are often obligated to buy a minimum number of reprints. As far back as 1965, Eugene Garfield stated that reprint distribution meant that authors and not readers had to pay, and that the overall cost of even "the free reprint system" was not trivial [4]. Garfield, the van Leeuwenhoek of bibliometric analysis, has been also a pioneer of self-archiving. All of his publications, including articles and essays published over 40 years in *Current Contents*, can be freely accessed at his own website [www.garfield.library.upenn.edu], located at the University of Pennsylvania server, where *The Scientist*—the journal he founded and which has always been freely available online, either in print or online—is archived.

The American Society for Biochemistry and Molecular Biology has supported open access since 1996, when it started to release all back issues of its *The Journal of Biological Chemistry*—starting with the first very issue in October, 1905(!)—online free to everyone. In 2001, ASBMB initiated *JBC Papers in Press*, in which papers are made available online for free on the day they are accepted for publication. Publication costs are covered by a combination of income sources: authors must pay page charges, which take care of about one third of expenses, while the rest is recovered by subscription revenues, especially from libraries. One may wonder, however, why libraries would keep paying for a subscription to a journal when it is available online to everybody.

The *Proceedings of the National Academy of Sciences of the USA* (PNAS) has adopted a semi-open-access policy. The journal is accessible immediately, at no cost, in 132 developing countries, and worldwide 6 months after publication. This policy responds to the campaign led by Nobel laureate Harold Varmus in 2000 that asked scientists not to submit their papers nor to collaborate as peer reviewers for journals that refused to put research articles freely available online within 6 months of publication. To determine how PNAS authors felt about both the Open Access Initiative and the possibility of being charged to have their articles freely available online, the journal conducted a survey, the results of which were published on February 3, 2004. Almost half of the authors that answered the survey were willing to pay a surcharge to make their PNAS articles open access. However, the maximum amount they would be willing to pay for this was US$ 500, which covers only one fourth of the cost of the mean article [3].

Gutenberg's *im-printing*

Online publication reinforces the idea that articles, as opposed to journals, are the "main characters" in scientific publishing. Once published, each article takes on a life of its own in the form of reprints—now e-prints—that are distributed separately from the journal and which are cited independently. It has always been the case that many authors do not even see the printed journal in which their articles appear. Since funding institutions started devoting significant attention to the IF of those journals in which applicants for grants had published the results of their research, there has been a tendency for authors to lay claim to the scientific impact of their article by citing "its" IF. This is an erroneous concept, however, because it is the journal and not the article that receives an IF, and on a yearly basis only [5]. Currently, an increasing number of printed journals with counterparts online offer, as an added service to authors, an online version of the article that is released as soon as editing has been completed. The article is fully retrievable, searchable and citable by its "digital object identifier" (DOI). Thus, publishers have adopted the technique usually used in open-access publications, with a small difference: only by paying for the article or subscribing to the journal can the article be downloaded and read. It must be added that other publishers consider DOI "labeling" as being not only expensive but also unnecessary.

The contents of an article is the same from the moment in which it is accepted for publication to its public release. At the beginning, it is arranged as a continuous text followed by tables, figures and figure legends. In the final layout, the article usually has two columns and tables and figures are inserted within the text. The HTLM version of articles can be similar to the original, with tables and figures put in separate files that are accessed from the main text. Readers tend to prefer the print presentation, thus the success of pdf, actual Internet *facsimiles*—in fact, keeping the essential aspect of the printed pages started by Gutenberg in the fifteenth century.

The future of open access

Every year, around 1.2 million articles are published in about 16,000 scientific journals. Although there are over 2,000 publishers in the scientific, technological and medical publishing business, "scientific publishing is having to

change rapidly to respond to growing pressure for free access to published research" [*The Economist*, Aug 5, 2004: freely available at <http://www.economist.com/science/displayStory.cfm?story_id=3061258>]. Since publication has become concentrated in the hands of a few gigantic multinational companies, in the prospect of a decline in the "golden age" of scientific publishing, some of these companies have tried to reduce their costs by hiring the services of people in developing countries, where labor costs are low. Moreover, the "outsourcing" of work is no longer exclusively the fate of routine low-skill tasks, but is increasingly also the case for more highly skilled work, such as copy-editing, as evidenced by the recent decision of a major European scientific publisher.

The Association of Learned and Professional Society Publishers (ALPSP), along with the American Association for the Advancement of Science (AAAS) and HighWire Press recently started a survey to study the financial and non-financial effects of alternative business models for scholarly journals. (HighWire Press, located in Stanford University, hosts the largest repository of free full-text life science articles in the world, with more than 750,000 free, full-text articles online. It was established in 1995, with the publication of *The Journal of Biological Chemistry*.)

To counteract the arguments used by several publishing large companies to attack the open-access publishing model, BioMed Central has released a pamphlet—of course, online and freely available—with the title "(Mis)Leading Open Access Myths" [available at <http://www.biomedcentral.com/openaccess/inquiry/myths.pdf>]. It dismantles some of the most prevalent arguments against open access that had been presented to the House of Commons Science and Technology Committee Inquiry into Scientific Publication. In the scientific community, the OAI has been widely accepted. Most researchers are willing to have their articles made universally available. The main problem of open access that must be solved is making journals accessible not only to readers but also to authors who cannot afford to pay the page charges in order to have their articles published. Otherwise, those authors will be forced, as a researcher from Slovakia stated in a letter to *Nature* on March 5, 2004 [2], "to read the articles from *PLoS Biology*—for free—and try to publish [their] work in *Science* or *Nature*—also for free."

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rhagic fever" (Chap. 10), the "Modulation of innate immunity by filoviruses" (Chap. 11) and the "Cellular and molecular mechanisms of Ebola pathogenicity and approaches to vaccine development" (Chap. 12).

The structure of the book facilitates its reading, due to the division of each chapter into brief and precise sections, and to the length of the chapters, which does not exceed 40 pages each. The language, even though technical in some parts, is not difficult to understand, even for non-scientists. The tables and graphics provide good supporting material for the chapters and help in understanding topics such as the filoviral replication and transcription system (p. 8), the expression strategies of the glycoproteins of filoviruses (p. 61), the molecular model for filovirus entry (p. 115), and the Ebola viral genes and gene products (p. 139). In Chap. 5, devoted to the "Roles of filoviral matrix and glycoproteins in the viral life cycle", some very interesting electron micrographs of Ebola virus particle formation are shown. Images of the result of Ebola virus infection and its development in non-human primates can be seen in Chap. 7, as well as a "Paradigm showing key cellular events in EBOV (Ebola virus) pathogenesis in non-human primates" (p. 224), which summarizes the steps that take place in the host response to infection such as the "induction of monocytes/macrophages to release a variety of soluble factors that likely trigger a host of downstream events including bystander apoptosis of lymphocytes, activation of the coagulation cascade, and disruption of the vascular endothelium. The end result is loss of homeostasis and dysregulation of the host immune response."

As a whole, this book is an excellent compilation of all currently available data concerning filoviruses. Ebola and Marburg viruses are of particular public concern due to their ability to cause highly lethal epidemics, especially in countries with limited resources to contain viral infections. Thus, the development of vaccines is crucial to preventing outbreaks of these viruses, while continuing investigations into their biology will help in treating victims of infection.

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CORRIGENDUM

Open access. A turning point in scientific publication
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The last sentence of the Editorial in the September issue (p. 161) should have read:
Otherwise, those authors will be forced, as a researcher from Slovakia stated in a letter to *Science* on March 5, 2004 [2], "to read the articles from PloS Biology—for free—and try to publish [their] work in *Science* or *Nature*—also for free."

In addition, reference No. 2 should read: Celec P (2004) Open access and those lacking funds. Science 303:1467