

This month the Public Library of Science unveiled a free electronic, open-access journal based on author fees. Will this financial model work?

Opening the Books on Open Access

When Parisian scholar Denys de Sallo founded *Journal des Sçavans*, the world's first scientific journal, he charged 5 sous for the inaugural issue in 1665. Après de Sallo, le déluge: Science publishers now churn out more than a million papers a year in about 20,000 journals, with annual subscription prices as high as \$20,000.

This month marks the debut of a new, high-profile player on the science publishing scene: a “free” electronic journal in which

Skeptics, however, doubt that PLoS can live up to such lofty expectations. Some say that its \$1500 fee may need to be several times higher to sustain the enterprise and that the community isn't prepared to pay such prices. Others doubt that the publishing David can topple the commercial Goliaths of the \$7-billion-a-year science publishing industry. Many scientific organizations, meanwhile, are livid that PLoS has tried to rally support for a bill in Congress that they say would impose a one-size-fits-all business model

unlikely to cool anytime soon.

Such developments have brought “science publishing to a turning point,” says Carol Tenopir, an expert on scholarly publishing at the University of Tennessee, Knoxville. “We had one business model that worked well for generations. But what comes next?”

An evolving battle

PLoS Biology joins an industry already anxious about its future. For decades, academic librarians in the United States, Europe, and Japan—who buy the bulk of technical journals

—have complained that they can't keep pace with rising subscription prices. Faced with stagnating budgets, libraries have reluctantly pruned their holdings, a response that they say threatens the progress of science.

A major target of librarians' ire has been commercial publishers such as Anglo-Dutch giant Elsevier, which owns nearly one-fifth of the 10,000 core technical journals in the world and has often raised subscription prices in excess of inflation rates over the past decade. To make their tight budgets go further, librarians have tried everything from organizing opposition to mergers (which they say drive up prices) to backing lower-

priced competing journals. But their efforts have met with modest results.

Scientists have traditionally watched this fight from the sidelines. But they joined the fray 4 years ago after Nobel laureate Harold Varmus, then head of the National Institutes of Health (NIH), proposed a government-funded free electronic archive of biomedical research articles. Taxpayers had already funded the bulk of the science that produced the results being published, he argued, and they shouldn't have to pay again.

The idea, called E-biomed, ran up against fierce opposition from commercial publish-



Open for business. The first issue of *PLoS Biology* this month attracted throngs of online readers.

the contributors pay the freight. Marching under the banner of the Public Library of Science (PLoS), a group of prominent researchers last week unveiled the first issue of *PLoS Biology*. Available free online (www.plos.org), the journal charges authors \$1500 per published paper. The founders of PLoS, which is based in San Francisco, intend to launch dozens of journals within 5 years, sparking a chain reaction that, they hope, will usher in the era of “open access” (see graphic). “We aim to overturn an obsolete system that no longer serves the best interests of science or scientists,” says gene researcher Michael Eisen of the University of California, Berkeley.

that could put them out of business (see sidebar, p. 554). And university administrators worry that their institutions may be stuck with the bill for author charges in addition to the costs of subscriptions to conventional journals.

Not surprisingly, each side accuses the other of twisting the truth in an attempt to win over scientists and the public. “There is some lovely high-minded rhetoric, but a lot of people feel like they are getting kneed in the groin,” says Mary Waltham, a publishing consultant in Princeton, New Jersey, and a former publisher at Nature America Inc. The stakes are sufficiently high that the debate is

INSIDE THE PUBLIC LIBRARY OF SCIENCE

Journals

- **Roster:** *PLoS Biology* debuted this month; *PLoS Medicine* is due next year.
- **Goal:** Several dozen titles by 2008.
- **Fee:** Authors pay \$1500 per published paper (waivers based on need).


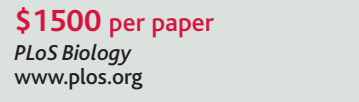




Management

- Vivian Siegel, executive director
- Harold Varmus, board chair
- 11 employees in San Francisco, California, and Cambridge, U.K.

Budget

- \$9 million start-up grant from the Moore Foundation; operating costs are not available.

WHAT AN AUTHOR PAYS FOR ONLINE OPEN ACCESS

 <p>\$1500 per paper PLoS Biology www.plos.org</p>	 <p>\$500* Nucleic Acids Research nar.oupjournals.org</p>	 <p>\$560 New Journal of Physics www.iop.org</p>	 <p>\$500 Journal of Insect Science jbiol.com/home</p>
 <p>FREE Journal of Insect Science www.insectscience.org</p>	 <p>\$800* Development dev.biologists.org</p>		

* Introductory charge; could go up in the future.

ers and nonprofit scientific societies, including the American Association for the Advancement of Science (AAAS, publisher of *Science*). Some feared potential conflicts of interest if government funding bodies also became publishers. And many worried that giving away papers online could cause a dip in print sales, cutting revenue used to support their activities. Several nonprofit publishers, including AAAS, did, however, agree to make research papers freely available through their own Web sites after a period of time—1 year after publication in *Science's* case.

The tactics of open-access advocates shifted after Varmus left NIH in 2000 to become head of the Memorial Sloan-Kettering Cancer Center in New York City. Varmus teamed up with Eisen and Pat Brown of Stanford University on a petition that asked scientists to deny their manuscripts and labor to journals that refused to make their re-

search papers freely available online within 6 months of publication. Some 30,000 researchers signed up, but few were bold enough to cut ties to journals that can make or break careers.

After that setback, says Varmus, the group decided to start its own open-access journal—a high-quality online publication that would create a buzz and overcome the community's inherent distrust of untested publishing vehicles. "To change the culture, we have to show that open, online journals aren't poorly reviewed, low-level stuff," says Varmus. A \$9 million, 5-year start-up grant from the Gordon and Betty Moore Foundation has allowed PLoS to hire prominent editors away from rival journals and launch an unprecedented publicity campaign that includes TV ads and even a theme song. "We want to see scientists begging to get into *PLoS Biology* the way they now beg to get into *Science*, *Nature*, and *Cell*," says Eisen.

Leaping hurdles

The new journal appears to be off to a solid start. Its 13 October inaugural issue included nine research papers, including one headline-grabber on a monkey whose brain had been wired to move a robotic arm. Curious readers created gridlock on the PLoS Web site last week.

Each monthly issue is expected to contain about 10 research papers and an array of less technical offerings. PLoS is also distributing about 30,000 free print copies of the first three issues. (Annual print subscriptions will cost \$160.) The next issue is already "shaping up nicely," says PLoS Executive Director Vivian Siegel, a former editor of *Cell*.

But keeping up the pace will be a challenge, she says. So far, many of the submissions have been recruited from like-minded allies. PLoS "faces not just one hurdle but a whole race of hurdles" in ex-

WHAT AN AUTHOR COULD PAY IF THESE JOURNALS WENT OPEN ACCESS*

  <p>~\$10,000 per paper Science www.sciencemag.org</p>	 <p>~\$7000 BioScience www.aibs.org</p>	 <p>"more than double" \$1500 New England Journal of Medicine www.nejm.org</p>
<p>"far in excess of" \$1500 Nature www.nature.com</p>		

* Based on journal estimates.

panding that pool, Varmus acknowledges. “We’re unknown, online, and contentious—plus we’re asking them to pay.” Resistance, says Siegel, is particularly strong among young academics, who worry that publishing in PLoS will do less for their chances of securing tenure and research grants than would publishing in more established journals.

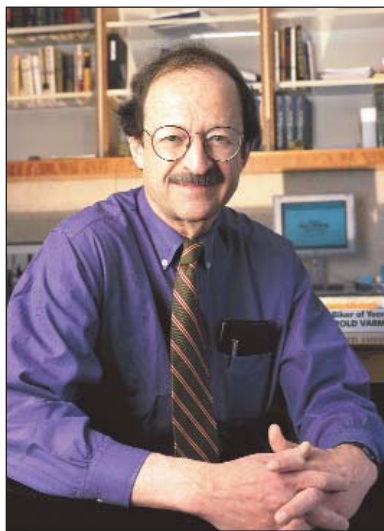
Indeed, interviews with a half-dozen randomly selected young scientists at major U.S. research institutions suggest that PLoS is not an easy sell. Despite the publicity blitz, most of the academics were only vaguely familiar with the concept. Nace Golding, a first-year faculty member at the University of Texas, Austin, voiced a typical view when he said he’d be “pretty skeptical” about submitting a paper that might win a slot in an established marquee journal.

“I’ve seen lots of new journals crash and burn,” says the 36-year-old electrophysiologist, who has had papers in prestige journals such as *Nature* and *Neuron*. And PLoS’s \$1500 fee “would be a major disincentive, especially since I can publish elsewhere for free.” Still, the concept of open access appeals to him, and not just for philosophical reasons: Free online papers are likely to

reach more readers, he figures, and therefore attract more citations.

The price of rejection

Along with goodwill in the community, the open-access movement needs a business model that can work. Just 2 years ago, PLoS organizers estimated that they could put out a first-rate journal for just \$300 per published paper. “We were a little



“We’re unknown, online, and contentious—plus we’re asking them to pay.”

—HAROLD VARMUS

naïve,” Eisen says now. Even PLoS’s current price tag of \$1500 per paper has many publishing executives wondering if the operation—which has hired six professional editors and five other staff members and promised to waive fees for scientists who can’t pay—can survive after its grant from the Moore Foundation expires.

The problem for PLoS is that prestige comes at a price. Selectivity means high rejection rates, with editors spending a lot of time processing material that is ultimately rejected, and even more effort recruiting and

polishing papers that are published. *Science*, *Nature*, and *Cell*, for instance, reject the vast majority of submissions; *Science* rejected more than 90% of the 11,000 manuscripts submitted last year. “We spend more rejecting papers than we do accepting them,” says executive publisher and AAAS head Alan Leshner. Fees would have to be \$10,000 per paper or more to cover the roughly \$10 million a year it currently costs to produce *Science*’s news and editorial content, not including production, he estimates.

Nature publisher Jayne Marks agrees with Leshner that it would cost “far in excess of PLoS’s per-paper fee” to publish her for-profit journal. *Cell*, also a for-profit, didn’t respond to a request for comment, but several other marquee biomedical publishers said that \$1500 per paper is below their operating costs. “We could not do what we do at that price,” says Chris Lynch, an executive at *The New England Journal of Medicine*.

Open-access advocates, however, take issue with such comparisons. *PLoS Biology* doesn’t plan to match the labor-intensive news sections and nonresearch content in such journals, and it won’t need to satisfy commercial profit margins that can top 40%. And, unlike many nonprofit societies, PLoS won’t need to subsidize other, non-journal activities.

Backers argue that their real accounting cousins are the journals that sit just below *Science* and *Nature* in the scholarly pecking order. For them, says consultant Waltham, “\$1500 per paper is not completely out of court.” It’s also roughly equivalent to what authors of a single article currently pay for page charges, reprints, or color graphics in some elite journals. Indeed, several nonprofits that have decided to experiment with the author-pays model, such as the U.K.-based Company of Biologists, have set introductory charges at just \$500 to \$800 per paper, although some warn that those prices are far below actual costs.

Open access’s biggest current player, meanwhile, has bet that it can profitably produce rank-and-file biomedical journals online for \$500 per paper. Since its start in 2001, the U.K.-based commercial publisher BioMed Central has started about 100 titles and attracted nearly 8000 manuscripts, rejecting about half. Using a highly automated manuscript management system, “we’ve demonstrated that open access works and is affordable,” says publisher Jan Velterop. Velterop projects that the company will become profitable within several years if submissions grow at current rates.

PLoS hopes to break even within 5

The Fight Over a Phrase

What’s the definition of open access? It depends on whom you ask.

The American Society of Biochemistry and Molecular Biology (ASBMB), whose *Journal of Biological Chemistry (JBC)* is among the world’s most-cited scientific journals, touts itself as “The Open Access Publisher.” The journal was among the first to make its papers freely available online at the end of each year, proclaims its Web site, and since 2001 it has immediately posted accepted manuscripts for all the world to see.

But *JBC* “clearly isn’t open access by my definition,” says Jan Velterop of BioMed Central, the U.K.-based commercial open-access publisher. That’s because its edited, final papers aren’t immediately accessible to everyone, and the publisher, not the author, holds copyright. In pure open access, says Velterop, “anyone is free to do what they want with the paper.”

ASBMB’s publishing head, Barbara Gordon, says that *JBC* does everything it can to ease access without destroying the viability of the 50,000-page-a-year journal. *JBC* is offered free to scientists in developing nations, for instance. And holding copyright helps authors, she says, by providing one-stop shopping for those seeking permission to reprint an article.

Who’s right? Several groups have issued proclamations* that include definitions closer to Velterop’s vision than Gordon’s. But publishers “spend way too much time arguing about definitions,” says John Willinsky, an academic at the University of British Columbia in Vancouver, Canada. “I now say that I’m for anything that *expands* access.” —D.M.

* See, for instance, the Bethesda Statement (www.earlham.edu/%7Eepeters/fos/bethesda.htm).

Money Woes Force Some to Change Course

Although open-access journals have grabbed the spotlight recently, a countertrend has skeptics buzzing. Exhibit A for some critics was the announcement last year that funding troubles had forced the widely cited *Journal of High Energy Physics (JHEP)*, a 6-year-old free online publishing pioneer, to impose a subscription fee of about \$1000 a year. Authors pay no fees to the journal, which is published by the U.K.-based Institute of Physics.

Two months ago, the *British Medical Journal (BMJ)* also said it was scrapping its decade-old policy of allowing free access to its Web site. Dwindling print subscriptions and advertising troubles prompted the move, wrote editors Richard Smith and Tony Delamothe. *BMJ*'s print circulation dropped 9% last year, they reported, compared with just 4% for 25 sister journals that keep their content behind electronic walls. If *BMJ* remained free online, they noted, "we will have nothing to replace the revenue lost from cancelled paper subscriptions." It plans to charge up to \$30 for online access.

Open-access skeptics argue that the reversals highlight the movement's shaky financial assumptions. But advocates see them as growing pains and are quick to note that all is not lost. *JHEP*'s early archive, from 1997 to 2001, is still freely accessible. And *BMJ* isn't planning to block everything. Its research papers, for instance, are expected to remain freely available. Still, both sides agree that the changes suggest that open-access publishers are still in a very steep part of the learning curve. —D.M.

years by following BioMed Central's lead, says Varmus, who serves on the U.K. publisher's board. The key to its strategy is to launch a fleet of journals, starting next year with a second flagship title, *PLoS Medicine*. By 2008, the publisher could have up to 15 broad disciplinary journals covering major biomedical fields and up to 50 less labor-intensive specialty titles, Varmus says. Some could be journals published in cooperation with established societies, and author fees could vary by title, he adds. PLoS may also copy BioMed Central's effort to sell "memberships" to universities, government agencies, and companies at fees commensurate with their size; researchers working at member institutions could then publish in any of the allied journals for free.

But PLoS won't rely just on publishing fees to stay afloat, Varmus says. The publisher may also sell advertising or online sponsorships and seek grants to develop specialized software tools or educational services built around the journals. It's still seeking donations for start-up publishing costs, too, he says.

Finding the money

Although such added revenue will help, the success of PLoS's plan still hinges on authors' ability to pay. Government research grants currently include relatively small sums for publishing, and some funders bar grantees from paying page charges or related costs. To solve that problem, Varmus and others want funders to consider publishing fees as the final, relatively cheap step of a research project.

They've made some headway with that argument. Earlier this year, the Chevy

Chase, Maryland-based Howard Hughes Medical Institute, the largest biomedical research charity in the United States, said it would give each of its 350 investigators up to \$3000 a year to publish in open-access journals. And the Wellcome Trust, the U.K.'s largest research charity, recently took a similar step, urging grantees to use discretionary funds in their grants for open-access charges. So far, NIH and other U.S. government funding agencies haven't taken a stand, although both allow researchers to pay publishing charges out of their grants.

Some doubt that the author-pays model will fly outside the relatively flush biomedical sciences, however. "I just don't think that the PLoS business model is

“ I don't think that the PLoS business model is easily applicable to the rest of science.”

—RICHARD O'GRADY

easily applicable to the rest of science," says Richard O'Grady, executive director of the American Institute of Biological Sciences (AIBS), which represents 60 nonbiomedical life science societies. "Some ecologists are lucky if their whole grant is that big."

Along with many other society executives, O'Grady is running the numbers to see if AIBS can afford to turn its monthly journal, *BioScience*, into an open-access

publication. "Our costs would be about \$1000 per page," he says, meaning \$7000 for a typical article. The author-pays model "doesn't seem to be a good fit for our kind of journal," he says.

Physicists probably have the most experience with the concept of open access, having pioneered the online preprint archive that allows researchers to post papers long before they appear in journals. The field also has several successful open-access publications. But many of the biggest titles still charge for subscriptions, and that's unlikely to change soon, predicts Martin Blume of the American Physical Society (APS), one of the discipline's biggest publishers. He estimates that per-paper fees for APS's *Physical Review Letters* journals would have to be in the \$1500 range if the journals went open access, a sum that could spark an author rebellion.

A major chemistry publisher is also standing pat for now. "We have a model that is working perfectly well; our authors aren't demanding we adopt some other," says Robert Bovenschulte, head of publications for the American Chemical Society in Washington, D.C.

Rough transition

PLoS backers acknowledge that their approach may not suit all disciplines. But they believe that, like it or not, scientific societies must begin to wean themselves from their dependency on print-based revenues. Li-

braries and online readers have already begun to cancel print subscriptions, they note, eroding circulation for many journals. And that trend is expected to worsen. "We bash the open-access people for not having a sustainable model," notes one society executive, "but it's not clear ours is going to last, either."

Some publishers, including AAAS, have introduced "site licenses": subscriptions that provide full access to online journals for anybody at a subscribing

institution. These have broadened access to papers and helped shore up society revenues. But they have also put more pressure on print circulations and library budgets.

One big problem for societies interested in making the switch to open access is finding new sources of revenue. A slew of studies have concluded that converting a typical journal can cut costs by about 30% by eliminating printing and distribution expenses.



House Bill Triggers Internecine Battle

The debate over open-access science publishing is often abrasive. But the jousting got especially rough earlier this year after a political thrust by the Public Library of Science (PLoS).

The contretemps started in late June, when Representative Martin Sabo (D-MN) introduced a bill to prevent private publishers from monopolizing information by barring copyright protection for "any work" derived from research "substantially funded" by the government (*Science*, 4 July, p. 29). PLoS's Michael Eisen endorsed the bill (H.R. 2613) at a Washington, D.C., press conference, saying it was needed to fix a "scandalous" system that forced taxpayers to "pay twice": once for the research, and again to see the results. Eisen also talked about cancer patients not being able to freely access the results of studies that might improve their prospects.

That idea was picked up by the general media. But it also triggered an immediate backlash from many scientists and their societies, who saw it as an attack on the tried-and-true means of communicating new research findings. "It was absurd; they left the impression that people are dying because of mean old publishers," says Lisa Dittrich, managing editor of *Academic Medicine*, published by the Association of American Medical Colleges in Washington, D.C.

Margaret Reich, publications director for the American Physiological Society, took aim at the double-payment claim in the August issue of *The Physiologist*. "Some of my tax dollars also go to ... farm subsidies, and I don't see anyone handing me free loaves of Wonder Bread," she wrote. And Michael Held, executive director of the Rockefeller University Press, wrote in the *Journal of Cell Biology* that the Sabo bill is "a thinly veiled attempt by Harold Varmus and ... PLoS to eventually force all publishers into" open access.

The response from PLoS and its allies included some needling of Held, whose journals charge subscriptions, for posting his editorial freely online. "Thank you for making so abundantly clear what the benefit and power is of open access," jibed Jan Velterop of BioMed Central, the U.K.-based open-access publisher. "Not so much by what you say, but definitely by what you do."

Recently, however, PLoS has backed away from actively promoting the Sabo bill (which isn't expected to pass). It has also moved to make peace with some societies, realizing that it may need to work closely with them on future joint ventures. Says Varmus: "We generated some hostility that I would just as soon not have." —D.M.



No love lost. Although its logo mimics the 1970s "Love" postage stamp, PLoS has sparked a war of words.

are betting that income from sophisticated online archives of their journals, which put millions of papers in one pot that subscribers can access, will sustain journal profit margins that *The Wall Street Journal* and publishing insiders put at 35% or higher.

Looking ahead

Science publishing's complexity clouds the crystal balls of forecasters. Some foresee a bipolar world of open-access journals and commercial titles with little in between. Lower-tier journals would become open-access titles run on bare-bones budgets, according to this scenario. Elite journals might split their content, offering free access to basic research reports, for which authors would pay publication fees, and charging subscribers for news, reviews, and other more labor-intensive products. Few see the top titles fading away, although their ability to support other operations could be hurt. "We'll always have our *Science* and *Nature*," says Varmus.

The impact on academia is equally uncertain. Some university officials worry that they will be forced to pick up per-paper charges, on the grounds that such fees are the equivalent of an institutional subscription. That could further squeeze library budgets, says Mary Case, head of the Association of Research Libraries in Washington, D.C., who nevertheless favors a move to open access if libraries are given sufficient resources.

Critics of the author-pays model say that journals might be forced to lower their standards to generate greater revenue, and they may gravitate toward longer, less polished papers. "It puts more emphasis on the author's demand for publishing space rather than a reader's demand for filtered, quality information," says Brian Crawford, an executive at commercial publisher John Wiley & Sons in Hoboken, New Jersey.

Open-access advocates dismiss such ideas, saying that such practices would alienate readers. A more likely scenario, they say, is that journals will strive to improve customer service—speedier reviews or better Web interfaces, for example—in a bid to snare authors willing to pay higher fees. But that competition must not be allowed to create a gap between the haves and have-nots, they hasten to add.

It will be years before anyone knows whose predictions are right. In the meantime, watching the once-sleepy world of academic publishing has become a spectator sport. "I'm loving it," says Leshner. "We are scientists, and we believe in empirical tests of hypotheses. So, let's see the results!"

—DAVID MALAKOFF

With reporting by Edna Francisco.

That leaves publishers scrambling to cover the remainder with author charges and other sources. Journals that earn significant advertising income face an even rougher road, because online advertising hasn't proved nearly as lucrative as print. The worst-case scenario, say executives, is that current revenue sources will dry up before a journal has established new ones.

A few publishers are experimenting with approaches that they hope can get them through the bottleneck. One idea is a surcharge—roughly equivalent to what it would cost to order reprints—for authors who want instant open access for their papers. Another tactic sets initial author fees artificially low and then raises them as subscription revenue tails off.

Both approaches appear to be working for a few mid-tier specialty journals, but only recently have several top titles taken

the plunge. The Company of Biologists, for instance, last month announced a 1-year test during which authors publishing in its flagship journal *Development* and two other titles can pay an \$800-per-paper charge to make their papers freely available. And Oxford University Press (OUP) says it wants to convert *Nucleic Acids Research* into an open-access title over the next 5 years, with author fees starting at \$500. (The actual cost is closer to \$2000, it says.) In announcing the experiment, however, OUP journals chief Martin Richardson warned that "unless funding conventions change, and all authors have access to sufficient financial resources ... it is unlikely that open-access publishing would be widely adopted by well-established journals."

Commercial publishers, meanwhile, are watching carefully. Giants such as Elsevier