

'Good citizenship' or good business?

Research in biology is proliferative. The impact of publications can be likened to the burst size of a phage. A big conceptual advance spawns work for many colleagues and competitors. A significant material resource showers the field with tools to tackle questions for which there was previously no means of entry. Reputations are made through the most explosively generative experiments, not from the number of times an experiment is replicated but from the propagation of explanatory tools and concepts into new research. This biological propagation is greatly aided by authors who provide a complete description of their procedures and who distribute their materials to their peers.

Because the immediate generative advantage goes to the lab in which the discoveries were made, there may be a temptation to retain essential details in order to get to the next set of experiments first. The advantage may not be as great as perceived, however, as the time to publication is getting shorter and referees and editors will do their utmost to ensure that the data pertinent to a piece of published work is all there. Funding bodies are increasingly following journals' lead, insisting as a condition of funding that resources they pay for be made generally available (*Nature* 430, 951; 2004). Research is becoming increasingly collaborative, so those researchers able to use their results to establish and maintain collaborations are likely to prosper from their strategic generosity. Finally, research companies are increasingly making use of peer review to establish the quality and utility of their research, hoping the usefulness of their materials will sustain the higher prices they sometimes charge.

We note that there is now no clear line between academic and corporate research. Academics can rapidly capitalize on their academic research and companies frequently make academic discoveries unrelated to their main commercial purpose. This trend has only strengthened our requirement for access to materials during the peer review process. Where a research company publishes with the aim of distributing a resource, we need to be able to examine the work from first principles, and to know that it does not involve unavailable or unexaminable proprietary software, reagents or protocols. Does the price cover distribution and encourage maximum uptake of the technology or does it discourage replication of the experiment even once? Are the conditions for distribution and access to the resource known to the referees and will they be fully defined in a convenient and legally appropriate form in time to publish with the paper? We invite researchers to provide us with guidance as to where academic and corporate researchers differ in

their standards concerning access to research materials and to identify issues that cannot be readily covered by peer review and by publishing material data transfer agreements and conditions for use.

With all the work required to meet referees' criteria for publication, it is easy to overlook the need to establish distribution arrangements in advance. After publication, many researchers are simply unprepared for the inconvenience imposed by their own success. Inevitably there is a barrage of email requests and customs declarations to make; there are couriers who won't handle dry ice; you fear that your live organisms won't arrive alive and unprepared security officers fear that they will. With experimental details as well as with materials, it is important to be prepared for the consequences of high-profile publication. Your paper feeds many disciplines, many of which are not competing directly: statisticians and bioinformaticians, clinical researchers and pharma industry. Issues we frequently find impair the transferrability of research are care in reporting how a haplotype was constructed and on a multitude of statistical procedures such as 'normalization', 'smoothing', multiple testing, model assumptions and comparison with pre-existing work. We are no longer constrained by the limits of the print journal, so please consult us about what kinds of supplementary methodological descriptions can be used to make your research useful to a wider set of researchers.

Increasingly, it is easiest to make materials available in the form of information, but even this imposes significant challenges, as high-dimensional biology generates very large files. We currently insist that sequences be deposited in databases such as GenBank and EMBL and, at least for expression data, in the microarray databases GEO and ArrayExpress according to MIAME criteria. But it is time to develop community standards for new kinds of large datasets, and we would welcome suggestions about how to proceed with array CGH, methylation, ChIP on chip and other epigenomic datasets.

Nature journals require sharing research materials because our core business is ensuring research quality and promoting research to the widest readership. Insisting that materials be available for refereeing and replication is necessary (*Nature* 430, 951; 2004) but insufficient to establish scientific reputation. That grows with the number of researchers inspired and enabled by your work and with the number who are able to make use of your data and your materials. We therefore suggest that this sort of 'good citizenship' (*Nature* 430, 953; 2004) is also good business. ■