Peer review is an integral part of the scientific enterprise. Misconceptions around peer review abound, and it is seen in some quarters as an opaque and slightly mysterious process. But the concept behind it is really very straightforward – simply that of review by experts.

Peer review is important because science involves many tough choices. Research funders need to decide how to allocate limited public and charitable funds between the many competing grant proposals they receive. Scientific journals need to decide which research papers are worthy of publication and which are not. And commercial enterprises and investors need to decide which scientific innovations will have the greatest potential to reach application and generate returns.

Peer review ensures that these key decisions are informed by the views of experts in their field, based on a robust and independent appraisal of the underlying science. Whatever the limitations and challenges of peer review may be, the alternative – effectively, that such decisions do not involve the input of genuine experts – is surely far worse.

Peer review at the Wellcome Trust

As a global research charity dedicated to achieving extraordinary improvements in human and animal health, the Wellcome Trust is committed to ensuring that we use the funds we have to support the very best researchers with the brightest ideas. We want to identify those researchers who, based on their track record and research vision, have the potential to make real breakthroughs in advancing knowledge and its application to improve health. We believe that it is practising scientists who are best placed to make such appraisals, based on their experience and expert judgement.

As such, peer review lies at the very heart of our decision making processes. Grant applications are assessed by independent committees made up of leading scientists from around the world. Their deliberations are informed by the comments of external referees who are experts in the subject areas covered by a particular grant application.

Careful selection of reviewers is absolutely key to the success of peer review. At the Wellcome Trust, we put considerable effort into ensuring that we get the right mix of reviewers for a particular grant application. Because the field of possible reviewers in some areas is quite small, we will often try to include some reviewers with a broader perspective in addition to those with specialist expertise in the specific area covered by the application. We also have robust conflict of interest policies to mitigate risks that reviewers will be subject to undue influences in their appraisals.

No one is under the illusion that peer review is a perfect system. In particular, the quality of review will only ever be as good as those who undertake it. It depends crucially on their rigour, generosity, fairness, expertise and sound judgement. Several recent high-profile cases have illustrated that when peer review is done badly, the consequences can be highly damaging and can erode public trust in science. All of us in the scientific community have a key obligation to uphold the integrity of peer review, and to be open and transparent in communicating its importance and its limitations to the wider public.

The Cost of Peer Review

Perhaps the most pressing challenge associated with peer review is the burden it places on the academic research community. The Wellcome Trust alone makes between 15,000 and 17,000 approaches to potential referees each year, and on average around 45 per cent of these approaches will result in a review being submitted. We consider this to be a good hit rate. However, with the mounting volume of requests for reviews being generated by research funders and journals and the pressures that exist on researchers’ time, there is a risk of increasing ‘review fatigue’. This will result in falling response rates and could ultimately compromise the quality of reviews.

At present, peer review is a service that researchers usually
provide on an unpaid basis, and
which many conduct in their
own time – fitting it around their
research and teaching duties,
often in the evenings or at
weekends. Most do not resent
the time they invest, and view
their contribution as crucial to
the successful operation of the
wider scientific enterprise of
which they are part. In addition,
peer review can provide genuine
benefits for their professional
development and helps them to
keep abreast of advances at the
cutting-edge of their field.

Nonetheless, the current
down scenario does raise
important questions. At present, it is
funders and publishers who
benefit from the use of peer
review, but it is the researchers
themselves and their employing
institutions who bear almost all
of the cost. Ultimately this
situation will probably have to
change. Peer review is a
professional service, and it
seems appropriate to recognise
properly this activity as part of a
researcher’s role. At the
Wellcome Trust, we are
developing plans for a peer
review college to cover our
major funding programmes,
which would reimburse referees
for the reviews that they provide.

The longer-term sustainability
of peer review will depend
critically on a continued pipeline
of quality reviewers. Developing
the skills necessary to conduct
reviews is a key part of a young
scientist’s development, and is
already fostered through
informal mechanisms in
academic departments, such as
journal clubs. Nevertheless,
there is a strong case for
ensuring that formal training is
also available; this is something
that we would encourage
research institutions to develop
as part of their training and
professional development
activities.

**ADDRESSING THE CHALLENGES**

While the system is definitely
not at the point of collapse, there
is a pressing need for both
funders and publishers to explore
actively innovative ways of
reducing the burden of review,
whilst upholding its quality.

As a funder we adopt a
combination of different
approaches to peer review, which
we endeavour to apply in a
judicial manner at the
appropriate stages of the
application process. In particular,
the use of methods such as
triage can help to reduce the
number of requests to external
reviewers, without compromising
the rigour of the overall process.

An excellent example is our
Investigator Awards. These
Awards provide outstanding
eye-care and established
senior scientists with long-term
flexible funding to pursue their
research visions. Preliminary
applications for these awards are
first triaged by subject-based
expert review groups, and only
those that are successful are
sent to international referees for
review. Candidates are then
interviewed by an Interview
Committee, again consisting of
international external experts,
who make a final decision,
based on the outcome of the
interview and the comments of
the referees.

**INNOVATION IN PUBLISHING**

There is also considerable
scope for innovation in the
publishing sector to address
some of the challenges
associated with peer review. This
has been enabled in part by the
rapid growth of the open access
publishing movement over the
last decade, which ensures that
the published outputs of
research papers are freely
available to all at the point of
use. A popular myth persists that
open access equates to less
rigorous peer review – but this is
simply not the case, proper peer
review is as integral to open
access publishing as it is to
traditional scientific publishing.

Indeed, open access
publishers have been
responsible for some of the
most exciting innovations in this
area. The model pioneered by
*eLife* – where review
focuses solely on whether the
findings are justified by the
results and methodology
presented, rather than on
assessment of the relative
importance of the research –
has both reduced the burden on
reviewers and the time it takes
to get a paper published. Open
access publishers have also led
the way in the development of
more sophisticated metrics to
measure the impact of individual
research papers, taking us
beyond the blunt tool that is the
journal impact factor.

Recognising the opportunities
for transformative change in this
area, the Wellcome Trust has
joined with the Howard Hughes
Medical Institute and the Max
Planck Society to establish
*eLife* – a new top tier, open access
e-journal. *eLife* will place
scientists at the heart of the
publication process, ensuring rapid,
transparent and scientifically-
based editorial decisions. It will
adopt innovative approaches to
accelerate peer review and to
maximise the potential of online
technologies to enhance access
to scientific information.

In pursuing such
opportunities, it will be
important to recognise that
different scientific disciplines
have very different cultures and
ways of working, and there will
never be a one size fits all
approach for peer review. For
example, whilst pre-publication
review works well in the high-
energy physics field, it would not
be appropriate for the medical
sciences – where the
publication of results ahead of
expert scrutiny can sometimes
carry significant risks for public
health.

**DEBUNKING THE MYTHS**

There are a number of myths
which have permeated the
debate on peer review. These
merit challenge. First, there is a
widespread view that peer
review serves to promulgate
conservatism and inhibits ideas
that challenge established
norms. While this may happen
on occasion, it is our experience
that the vast majority of
reviewers work with
genuinely wish to embrace
innovative, cutting-edge research
and to take risks where the
underlying science is sound.

It is also widely claimed that
peer review disadvantages
research that cuts across
disciplinary boundaries. This
does not necessarily reflect our
experience in practice as a
funder, which is that most
reviewers are very receptive and
wish to enable such research.

**A FINAL WORD**

It is our strong belief that
peer review remains critical to
the process of science. Whilst it
is by no means a perfect
system, the decisions we make
in science have major
implications and need to be
based on the judgement of
experts. There is simply no
viable alternative.

Should we actively embrace
innovation to address the
challenges and burdens
associated with peer review? Of
course we should. Is peer
review broken? Emphatically not.
PEER REVIEW – IS IT WORKING?

PEER REVIEW AND THE PUBLIC INTEREST

Peer review is not just the esoteric concern of scientific researchers. It is a system of independent scientific scrutiny that helps to safeguard the public interest in sound science, and as such we should pay it a lot of attention.

Sense About Science is a UK based charity to help people make sense of science and evidence. We work with over 5000 scientists and hundreds of organisations from science and civil society to respond to questions about scientific issues and to chase up misleading claims.

Our trust was born in 2002, one of many responses to the troubled relationships between science and society, troubles which had been elaborated in the House of Lords Science and Technology Committee’s report of 2000.

It was a baptism of fire. The newspaper front pages raged with headlines and horror stories about cloning, stem cell research, genetic modification, mobile phone radiation, the Measles Mumps and Rubella vaccine and nuclear waste disposal. Many stories were being generated by claims, often apparently conflicting, about what was shown by scientific research. Contradictory accounts of evidence were not just the product of the news media. They often arose in statements from advocacy groups, policy makers, advertisers and from the rapidly multiplying public relations activities of institutions.

Peer review seemed to be a well kept secret of the research community. In no other area of life do people systematically volunteer their life’s work to be critically evaluated by others in their field. Can you imagine a Government Minister’s press releases being submitted for approval to MPs before publication?

Our Working Group on Peer Review, established in 2004 and chaired by Professor Sir Brian Heap FRS, concluded that it was a process little understood by many who interacted with the findings of research. For them, and the public at large, insights into how research had been evaluated were valuable. The Working Group resolved that greater effort was needed by research institutions, journals, publishers and others to share the workings of these processes.

However, many in the scientific community were sceptical about the public’s interest in peer review. This might in part have been the result of defensiveness about those times when the system broke down – incidents which accounted for what little publicity there was about the peer review process at that time. Concerns about bias, frustrating experiences, bad behaviour by reviewers or authors, eclipsed consideration of a system that delivered 1.3 million papers a year and that was used to select research for funding and to develop critical evaluation post-publication. There were also reservations about putting information about the system into the hands of the public, for fear that it would be misunderstood. For example, “it’s peer reviewed’ might be taken to mean ‘it’s true’.

When we published the resulting public guide to peer
review, I Don't Know What to Believe, I am afraid that we took these comments rather too much on board. The guide explains how research findings are reviewed for validity, significance and originality. It also gives a brief summary of how editors select reviewers and discusses the importance of ensuring that papers refer to previous work and provide information so that others in the field can see how the research was conducted. We printed just 10,000 copies.

It was to our surprise that the publication of the guide immediately generated public discussion, ranging from national radio and papers to the specialist publications serving voluntary bodies and public information services. Peer review seemed to be newsworthy. The guide began flying out of the door and the electronic link to it appeared across the Web.

Here we are today, some 500,000 copies and 10 reprints later, looking at a much improved situation. The guide is used by many people and organisations who respond to the public’s questions about research claims, such as patient helpline operators who handle calls about the validity of stories in the news about the causes of Alzheimer’s disease, for example. Our peer review work is now backed by library services, publishers and editors. Information about whether findings have been peer reviewed is sought by journalists, and details of the scientific publication are regularly included in institutions’ press releases and in news reports, though it has to be said, not yet regularly enough.

In policy too the picture is better. Back in the early 2000s, there had been a rapid growth in Government’s use of consultations, especially on contentious policy issues. This appeared to have been accompanied by a rather literal weighing of research claims in Whitehall. So we saw situations where two consultation submissions giving opposite views about research were counted thus: one for, one against. Never mind that one might summarise and evaluate the entire peer-reviewed, published body of research and the other be based on the press release of an unpublished survey by a campaign group.

Now there is a greater awareness of the need to ask questions about the status of research being fed into policy making. Information about peer review is included in training for senior civil servants. Revised guidelines about the significance and originality. It also gives a brief summary of how editors select reviewers and discusses the importance of ensuring that papers refer to previous work and provide information so that others in the field can see how the research was conducted. We printed just 10,000 copies.

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...Something must select what we pay attention to from the sea of research out there...
paper ranked much higher (90% and 85%) than gaining personal recognition or enhancing one’s career (34% and 46%). Sir Mark Walport has discussed the question of paying reviewers. We should tread very carefully here, where there is a risk of undermining these values by putting a price on them.

I want to tackle a few things that people often conclude when we discuss the challenges of peer review. Some argue that we need alternatives to peer review. But why should we leap from individual failures in the system to dismiss the bigger principles at stake? We don’t do that in other systems which fall short of their principles. Lawyers will regale you about court delays and inadmissible evidence. But we don’t say we need an alternative to justice. We ask how the system can deliver it better.

Let’s be clear too about the ‘alternatives’. There is just one. Something must select what we pay attention to from the sea of research out there. If it is not a system that aims for independence and objectivity, then it will be researchers with the clubbiest contacts and institutions with well-funded public relations. You can dress this up in talk of online technologies and social media networks, but it remains what it was in the time of the Medicis – patronage.

Peer review is more than just having to settle for ‘the best we’ve got’. It is the best. It might struggle with the weaknesses of human judgement, but that is because it has all the strengths of human judgement. It’s a flexible system, which can reflect movement within a field in a way that no tick-box approval system can. It has the ability to spot something good and bring it to the attention of researchers and research users more quickly. If it falls short, it is because our aspirations to objectivity are high. For the public and for the research community, we should keep them that way and improve the system.

PEER REVIEW – IS IT WORKING?

PEER REVIEW IN A CHANGING AND DISRUPTED PUBLISHING LANDSCAPE

Peers review is often the subject of intense debate, and never more so than now when we are at a critical juncture in scholarly publishing. A number of interconnected areas, including peer review, are impacting on one another and will affect how research output is going to be communicated, accessed and evaluated in the future. The time is ripe for innovation and it is likely that new models and new players will enter the area.

Peer review in journal scholarly publishing (known as ‘editorial’ peer review, to distinguish it from funding review) is, quite simply, “the process by which research output is subjected to scrutiny and critical assessment by individuals who are experts in those areas”1. It traditionally takes place before publication, i.e. a ‘filter, then publish’ approach, but there have been suggestions that everything should be published and only then evaluated, in ‘publish, then filter’. Many, however, are concerned that this approach would not only release incorrect material, which in some disciplines could be harmful or misleading, but readers, particularly non-specialists, would find it difficult to know what to trust. Indeed, one of the conclusions of the 2011 House of Commons Science and Technology Committee inquiry into peer review was that “Peer review in scholarly publishing, in one form or another, is crucial to the reputation and reliability of scientific research”2.

It is important to stress that quality of peer review is independent of journal business model. It does not matter whether it is subscription based, open access with author-side payment, or has a hybrid arrangement with elements of both. Sweeping statements shouldn’t be made by any group to denigrate another (as has sometimes happened against open-access journals); there are good and bad examples of peer review in all the models. Criticisms of peer review itself have, however, been around for a very long time – that it is slow, expensive, unreliable, idiosyncratic, conservative, and open to abuse and bias. These are certainly potential problem areas, ones that most researchers have experienced in their careers. Peer review isn’t
infallible. It can and does go wrong, just as any other human activity. The peer-review process looks deceptively simple, for example when described in a flow chart. In reality it’s complex and sophisticated, and at its best and in the right hands a powerful tool. The role of the Editor is absolutely critical. A common misconception is that it is reviewers who ‘accept’ or ‘reject’ manuscripts. They don’t. They assess, advise and make recommendations, and it is Editors who makes the decision whether or not to publish. Good and skilful Editors are ones who exercise sound and fair critical judgement, acting as more than just vote counter, deciding whether reviewers’ criticisms and requests are justified, whether additional work is or is not needed. They help create and maintain a sound scholarly reviewing system.

The primary role of communicating scientific discovery to one of demonstrating academic activity. This is even more applicable today, with greatly increased submissions to journals making publication highly competitive. Competition is also becoming keener because of the increasing numbers (and quality) of submissions from newly emerging scientific nations such as China and India. Editorial and reviewing loads are becoming heavier, and this has led to speculation that “the peer review system is breaking down and will soon be in crisis”.

There is currently some geographical imbalance in submission and reviewing activity which may be partly responsible for this, with researchers in the USA, for example, carrying a higher load. The situation is now often referred to as the largest journal in the world. In terms of annual output it is: in 2011 it published about 14,000 articles, representing about 1.5% of the total world scientific output. The journal is a true ‘game changer’, partly because it has proved itself to have a sustainable business model. Indeed, many publishers have rushed to launch similar repository-type or ‘mega’ journals. With this model, researchers no longer have to go from journal to journal to get research published, thus avoiding delays in getting sound work out and available to others to use and build on and allowing them to concentrate on their research rather than chasing publication. Many, understandably, like this, and PLoS ONE’s respectable Impact Factor (4.411) has led to a steep rise in submissions.

The second seismic event began on 16 December 2011. On that day, the Research Works Act (RWA) bill (HR 3699) was introduced into the US House of Representatives, and within 3 months most of the world’s journals were following suit.

A common misconception is that it is reviewers who ‘accept’ or ‘reject’ manuscripts. They don’t. . .

. . . and underlying these worries was yet another: that scientific articles have been hijacked away from their primary role of communicating scientific discovery to one of demonstrating academic activity. . .

. . . about 1.5 million articles are published globally in around 26,000 peer-reviewed journals each year . . .
Representatives. The RWA would, if passed, effectively reverse the NIH (National Institutes of Health) Public Access Policy of 2008, which requires NIH-funded researchers to deposit all final peer-reviewed manuscripts resulting from that funding in PubMed Central (NIH’s National Library of Medicine free archive of biomedical and life sciences journal literature) and to be publicly accessible no later than 12 months after publication. It would also prohibit any further open-access mandates for federally funded research.

Support of the bill by the Association of American Publishers (although a number of member publishers dissociated themselves from this) and the actions of certain publishers acted as a trigger, releasing latent unrest amongst the academic community. An acrimonious battle has since broken out and is being played out in the blogosphere. There has been a ‘call to arms’, which is having a direct effect on peer review – researchers are being asked to refuse to review, submit and carry out editorial duties for certain commercial publishers as a protest against support of the RWA and other measures to restrict free exchange of information, the prices of journal subscriptions, the level of some publisher profits, and reluctance to move to open access as the basis of research publishing. For example, The Cost of Knowledge web site http://thecostofknowledge.com was started at the end of January (originally for mathematicians, but it now encompasses various sciences, medicine and social sciences) and at the beginning of March has nearly 8000 signatures. Template letters for review refusal are circulating on the internet, along with negative, sometimes vicious, comments about publishers. A major problem seems to be a lack of understanding and engagement by the two sides. Publishers cannot afford to ignore what is being said. All partners in the funding and communication of science need to get together to find ways to move forward for the benefit of science. On 27 February, the controversial RWA was very suddenly abandoned. The unrest in the research community, however, continues.

Peer review doesn’t stop at publication. Many feel that this is actually when real peer review starts, as researchers begin to scrutinise, repeat and build on published work and the self-correcting nature of science starts. Post-publication review and evaluation can take a number of forms and the internet and technological advances have brought increasing opportunities for experimentation and innovation. There are a number of challenges, including how to get people to participate (the level of engagement is in many cases very low), how to aggregate opinions, evaluations, blog posts and other contributions in a meaningful way, and knowing who to trust. A number of projects are already under way, but there is again plenty of space for innovators to create new services. With the increasing number of journals adopting the PLoS ONE model, there is a real need for evaluation, sorting and analysis of all the work being published. The blogosphere and Twitterverse are becoming increasingly important in this respect, especially as adoption of social tools by researchers grows, allowing scientific interaction outside of journal articles. They also provide the means to alert communities rapidly about problems with published work, for example as happened with a paper published in the journal Science in December 2010. When researchers reported that they’d found a bacterium that could grow on arsenic and incorporate arsenate in place of phosphate into its DNA, experts in the field started to post criticisms of the methodology and interpretation online within a day or two. The story came to be known by its Twitter hashtag, #arseniclife. The online community knew about the problems with the paper straight after publication, readers of the journal article wouldn’t have known about them until a number of commentaries on the article appeared 6 months after its publication.

So, is peer review working? Yes, but it’s facing many challenges. As the publishing landscape evolves, so will the diversity of peer-review models. It’s possible that new organisations will be set up to offer peer-review services. A recent example is Peerage of Science (http://www.peerageofscience.org/), a Finnish company founded, owned and governed by scientists. There is the potential for considerable disruption in the scholarly publishing sector. To maintain a central position, publishers will need both to convince researchers of the value they bring and to innovate in ways that will help them be more productive, providing the tools they need to do this. Research funder-publisher partnerships will also be critical, and publishers need to be prepared for funders to require the work they fund to be publicly available. Publishers have to ask themselves the brutal questions: Can researchers survive without publishers? Can publishers survive without researchers?

Can researchers survive without publishers? Can publishers survive without researchers? . . .