ascb
the american society for cell biology

How Can Scientists Enhance Rigor in Conducting Basic Research and Reporting Research Results?

A White Paper from the
American Society for Cell Biology

ASCB Data Reproducibility Task Force Recommendations

Executive Summary

In 2014, the American Society for Cell Biology (ASCB) convened a task force to examine the issue of reproducibility in life science research, with particular attention to basic research. The Task Force issued this white paper expressing 13 recommendations, which fall into two broad categories: engaging with existing efforts, and initiating new activities.

The difficulty in replicating research findings has been at the center of the attention in the specialized and lay press for a number of years and is more recently attracting the attention of the Administration and Congress. Various reports indicate the problem of data replication as cutting across all areas of research, although it has been studied mostly in the clinical and pre-clinical domains. The magnitude of the problem described in respectable published reports, is disturbing and could possibly undermine scientists' credibility.

Reports, particularly in the lay press, have discussed the inability to replicate results without specifying the areas of research. The ASCB has been troubled by these reports and the attention they have garnered, but most of all it is troubled by the problem itself. The leadership of the ASCB recognizes the need for an in-depth analysis of the problem, specifically tackled from the basic science and cell biology perspective, which has been overlooked in the various reports detailing the data reproducibility problem.

The Data Reproducibility Task Force was charged with "provid[ing] recommendations and propos[ing] eventual initiatives to enhance rigor in conducting experimental basic research. Particular attention should be paid to ASCB as a publisher and what actions the Society should take to improve transparency and accountability that ensure reproducibility of findings published in its scholarly journals."

The Task Force was led by Mark Winey, Ph.D., professor and chair of the Department of Molecular, Cellular, and Developmental Biology at the University of Colorado, Boulder. Other members of the Task Force were Stefano Bertuzzi, Ph.D., M.P.H., Carol Greider, Ph.D., Doug Koshland, Ph.D., Connie Lee, Ph.D., Paul Mungai, Ph.D., and Brian Nosek, Ph.D.

The Task Force met five times via conference call and covered a wide variety of issues. In addition to calls, the Task Force also surveyed the over 8,000 members of the ASCB on their experiences with data reproducibility.

We offer these recommendations to the ASCB and to other organizations and professional societies so that the conversation can continue over this important issue with science policy leaders at the national and local level.

<u>Engagement With Existing Efforts</u>

Training & Mentoring:

1. Support better training efforts as embodied in the NIGMS Training Modules to Enhance Data Reproducibility (RFA-GM-15-006), perhaps through train-the-trainer events.
2. Develop training modules on statistics or responsible conduct of research (RCR) topics through collaborations like the one with the Global Biological Standards Institute (GBSI). Even a simple reminder for trainees and PIs on the importance of examining original data (i.e., avoiding sensational oversimplified PowerPoint schematizations and cherry picking of results.)
3. Continue support of DORA and efforts to change the pressure as well as the culture forcing sensationalizing results in order to publish in a small set of "high profile" journals.

Publishing:

1. *Molecular Biology of the Cell* (MBoC), ASCB's scientific journal, should proactively engage in the emerging standards for publishing from NIH (http://www.nih.gov/about/reporting-preclinical-research.htm).
2. MBoC should consider the use of "Reviewer Checklists" to increase the quality and consistency of reviews.
3. MBoC should encourage authors to use open science archives or repositories to make primary data, materials, protocols, or code readily available.

Standards –

1. Represent the interests of the basic research community to NIH in the development of cell line authentication guidelines and similar NIH-led efforts.
2. Represent the interests of the membership the basic research community to other groups that seek develop standards such the Global Biological Standards Institute (GBSI) or carrying out replication efforts such as the Reproducibility Project: Cancer Biology.
3. Partner with other professional societies that are engaged in addressing replication issues.

Initiate new activities

Community-based standards:

1. Educate the community about examples of community-based standards. For example, highlight in ASCB publications the experience of Daniel Klionsky (U. Michigan) on his successful community engagement to reach consensus on accepted assays within the autophagy community.
2. Actively promote community self-organization to identify and discuss standards by recruiting leadership and offering workshop time at ASCB Annual Meetings or in other ad hoc workshops.
3. Support the development and dissemination of community-based standards as articles in MBoC, supported with on-line forums. MBoC can offer a forum to allow scientific communities to reach consensus on standards in particularly sensitive and important assays or in areas where controversies have emerged due lack of reproducibility.
4. Connect these communities to external entities as listed above, such as NIH or GBSI, to represent the interests and expertise of the communities to policy makers and other interested groups.

"How Can Scientists Enhance Rigor in Conducting Basic Research and Reporting Research Results?"

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Background

An October 2013 cover of the "The Economist" cried out "How Science Goes Wrong!" [1]. This was one of several popular press articles which built on several scholarly articles concerning industry's inability to reproduce published academic life science research results. The growing awareness of the reproducibility issue has led to various efforts to identify and address practices that may contribute to the problem. NIH Director Francis Collins and the NIH Deputy Director Lawerence Tabak outlined NIH efforts in a *Nature* editorial [2].

While there are some questions about the lack of reproducibility analyses [3] there is a general agreement that indeed there are problems to address. The American Society for Cell Biology (ASCB), whose membership is overwhelming comprised of working life scientists, convened a task force to examine the reproducibility issue in the area of basic science and to offer recommendations to the Society on which it could act in support of the membership[1]. In this white paper, the Reproducibility Task Force offers a perspective from the membership and offers recommendations for action[2].

The first issue, avoided by most authors on this subject, is to define reproducibility. "Lack of reproducibility" is often used as a "catch all" statement, but the ASCB Task Force felt it needed to adopt some nuanced but important differentiations, given the complexity of the scientific method. In discussions of the definition of reproducibility, we came to adopt a multi-tier definition of reproducibility [see 4]:

- *Analytic replication* – Attempts to reproduce the results from the same original data via reanalysis.

- *Direct replication* — Attempts to reproduce the same results using the same conditions, materials, and methods as the original experiment.

- *Systematic replication* — Aims at obtaining the same finding of a given publication, but under different conditions, for example in a different cell line, mouse strain, etc.

- *Conceptual replication* — Aims to demonstrate the validity of a concept or a finding using a different paradigm. For example, topographical connection mapping in the brain can be different in different organisms, involve slightly different nuclei and molecules, but the circuitry, the effectors and the effects can still be the same. Validating the understanding

[1] See the Appendices for the ASCB Charge to the Reproducibility Task Force.
[2] See the Appendices for the membership of the Reproducibility Task Force.

of effectors and effects across organisms is the role of conceptual replication.

The Task Force focused on "direct replication" for which there is an expectation that a result should be reproducible using the same conditions, reagents, and methods. Many of the issues of analytic replication are addressed with the same recommendations for improving direct replication – sharing of research materials and data. Also, failures in systematic and conceptual replication were judged more difficult to tie to issues with the conduct of research as opposed to the complexity of living organisms revealing divergent outcomes. Similarly, failure in systemic or conceptual replication may actually be an advance brought on by a new technological approach that reveals shortcomings in previous experimental work. Identifying shortcomings is part of the normal, and highly successful, self-corrective nature of research[3].

Findings

The Task Force does not believe that reproducibility issues are driven by misconduct and fraud, as pointed out by Collins and Tabak [2] and in our charge (see Appendix). Nonetheless, as working scientists, we all have personal experience with reproducibility challenges as pointed out by Bissell [3]. Challenges can include the incomplete or misspecification of methods, lack of availability of reagents or other materials, lack of tacit knowledge and particular expertise, and the occurrence of false positive results in original demonstrations or false negative results in replication attempts. Most challenges can be resolved with openness in supplying both reagents and expertise. Through these experiences, we identified various factors that contribute to poor reproducibility.

To determine whether our experiences were more widely held, the Task Force distributed a brief survey to the Society membership. The survey consisted of four basic components. First, it addressed whether the issue is real — had ASCB members encountered difficulties in reproducing a single published result? Second, in the case of having had a reproducibility issue, the survey aimed at shedding light on how issue was resolved. Third, the survey asked about what factors members perceive as contributing to difficulty in reproducing results; and finally, there was a mechanism for respondents to provide additional feedback that produced 282 comments.

The survey was distributed to over 8,000 members of the ASCB and we received 869 responses; a 10.8% response rate. The response rate is lower than what is considered acceptable for statistically valid results; therefore, the possibility of a surveillance bias introduced into this study is a real possibility. **For this reason, the Task Force strongly encourages the survey results to be considered as qualitative and not quantitative**.

The survey tool, a breakdown of the responds and the written comments, can be found in Appendix. The written comments were informally coded for tabulation of the different contents of the comments. The largest respondent class identified themselves as "PI/Faculty" (63%). With the

[3] Note that, in reality, direct, systematic, and conceptual replication exists on a continuum because no experiment is ever exactly the same as a prior experiment. As such, a direct replication is "the attempt to duplicate the conditions and procedure that existing theory and evidence anticipate as necessary for obtaining the effect." (Nosek & Lakens, 2014, Registered reports: A method to increase the credibility of published results. *Social Psychology, 45*, 137-141; see also Schmidt, 2009 [4] for a conceptual review of replication).

caution of using numbers generated by an instrument which may suffer from selection bias, it is interesting to note that the general finding is that the majority of respondents (72%) reported having trouble reproducing at least one published result, and a third reported being informed that another group was unable to repeat at least one of their results.

In answering questions about a specific instance of difficulty in reproducing a result, the most common resolution was via amicable communication between the involved laboratories (60%). Only 18% of cases were unresolved despite attempts to reconcile outcomes, but we do not know if all of these cases involved direct replication. Twenty two percent of cases were deemed insignificant and not resolved. Interestingly, 25% of the failed replication instances were resolved by an alternate approach or new technology, not by direct replication. The Task Force sees the high level of resolution of reproducibility issues as the appropriate behavior of the scientific community and as demonstrating the self-corrective nature of science. The respondents also take reproducibility seriously with 54% reporting that the resolution required significant or "huge" levels of effort.

Nonetheless, there is a perception that some reproducibility problems arise from poor practices. There was a wide collection of known experiences and perceived poor practices thought to contribute to reproducibility issues. These poor practices can be organized into two broad categories under the headings "The Culture of Science" and "The Practice of Science." As discussed in more detail below, the Task Force finds merit in these concerns and has developed recommendations to address the issues.

The Culture of Science

The majority of respondents indicated that the incentive system that greatly values publishing research papers in "high profile" journals is leading to a culture of poor standards and "cherry picking" results to make a great story. This was the top response on a question in the survey asking about factors contributing to reproducibility issues and lead the comments, appearing in ~20% of the open-ended responses. Publication in these top tier journals can be rewarded with grants, job offers and promotions. Respondents also reported that there are few disincentives to "getting it wrong." Fraud aside, where the punishment can be disbarment from receiving research grants and termination of a position, there are no regularly applied sanctions for getting it wrong except the possibility of a tarnished reputation. In these times of tight research funding, the pressure to publish what is perceived to be "high impact" work is acute and may be compromising quality. The opinion is shared by Bruce Alberts and colleagues as voiced in their important essay in the *Proceedings of the National Academy of Sciences* [5].

The Practice of Science

The second area of greatest concern among the survey respondents were publishing practices, focusing on truncated methods sections. Many respondents commented that it was challenging, if not impossible, to repeat published work by solely using the methods and list of reagents that accompany a paper. Incomplete or truncated methods sections were chosen as a top factor by 45% of respondents when asked about contributing factors to reproducibility problems. The issue tied the high-impact publication comments by appearing in 20% of the comments. Furthermore, it was suggested that reviewing has become rushed and cursory leading to reduced review quality.

Respondents suggested that, as a consequence, poor quality, potentially irreproducible, results are making their way into the literature. The Task Force agrees with these findings.

Respondents also expressed concern with the execution and interpretation of experiments. These concerns included inappropriate statistical analyses and poorly powered studies that clearly contributed to the collection of irreproducible pre-clinical studies that have raised concerns. Also common were concerns about the expertise of the replication team (40% of respondents) and about the materials used in experiments (38% of respondents). The concerns about materials included poor quality, unvalidated reagents and issues with cell line contamination or misidentification. Confidence in cell line authenticity is critical for the reproducibility of research results. The Task Force supports NIH's efforts to develop strong guidelines [6] regarding cell line authentication. The Task Force recommends that the ASCB represent the interests of the membership to NIH while developing guidelines to ensure the recognition of that compiling will have time and financial implications for investigators[4].

Overall, the Task Force finds that there are opportunities to enhance rigor in scientists daily practices and opportunities to better function as a community, which more openly discusses and shares problems in reproducing results and finds consensus on how to address particularly thorny issues.

Current Activities to Address Reproducibility & Recommendations

The Task Force recognizes that we ignore these reproducibility issues at our own peril. The citizens of the United States have provided many years of significant support for basic life sciences research and they have the right to expect scientific results that can be reproduced and built upon to create a better understanding of biological processes and disease states, as well as producing approaches to prevention and treatment. As such, while the ASCB membership raised concerns about reproducibility, many of which are shared by the Task Force, we are encouraged that there are already numerous efforts to address reproducibility. The Task Force explored these efforts and we promote some of them in our recommendation.

It is important that science is an open process in which replication is encouraged, and in which problems are identified and addressed. The scientific process needs to be understood by policy makers and by the public. The Task Force expects the ASCB advocacy effort in partnership with the Coalition for Life Sciences and other professional societies to be leading outreach efforts to educate policy makers and science policy leaders about the nature of research and the efforts to make research work even more effective.

Culture of Science

The “culture of science” issues around coveted publications are difficult to address and may require significant realignment of university and institute hiring and promotion criteria, along with changes in funding agency selection criteria. There is a concern among many young scientists

[4] This has occurred as seen in the “Perspectives” in *Science* by Jon Lorsch (Director, NIGMS), Francis Collins (Director, NIH) and Jennifer Lippincott-Schwartz (ASCB President)(Ref. 15)

about the incentive structure inherent in the current system of job placement and promotion. Nonetheless, these topics are being discussed [5]. Furthermore the ASCB already leads the way with its of the *San Francisco Declaration on Research Assessment* (DORA, http://www.ascb.org/dora/). At the 2012 Annual Meeting, the ASCB convened an international group of scholarly journal editors and publishers to address the need to improve the methods by which stakeholders evaluate scientific research output. Their discussions led to the DORA Declaration. The recommendations highlight the need to move away from impact factors and where work is published, and moving towards evaluating the merits of the published work. DORA has over 12,300 individual co-signers and over 570 organizations that have signed, and its broad adoption would be a welcome change in scientific culture..

Education about the culture of science – such as the values of the profession – should arise during training and results from good mentoring. To this end, both NIH and NSF have had requirements for Responsible Conduct of Research (RCR) training. The National Institute of General Medical Sciences has gone further and launched a call for proposals under the title "Training Modules to Enhance Data Reproducibility" (http://grants.nih.gov/grants/guide/rfa-files/RFA-GM-15-006.html#sthash.Xn8yTUjS.dpuf). As mentioned above, there is scrutiny of training in statistics that may be addressed with new training modules.

Recommendations:

1. Support better training efforts as embodied in the NIGMS Training Modules to Enhance Data Reproducibility (RFA-GM-15-006), perhaps through train-the-trainer events.
2. Develop training modules on statistics or responsible conduct of research (RCR) topics through collaborations like the one with the Global Biological Standards Institute (GBSI). Reminders for trainees and PIs to stress the importance of examining original data (i.e., avoiding the PowerPoint schematization and cherry picking of results)should be encouraged.
3. Continuation of the goals of the DORA Initiative and efforts to change the "hyper-competitive" culture forcing sensationalizing results in order to publish in a small set of "high profile" journals.

Practice of Science

Some of the "practice of science" issues are more readily addressed. The publishing community has taken up the issue under the leadership of the NIH and the American Association for the Advancement of Science (AAAS). A workshop held in June 2014 produced at set of guidelines posted by NIH (http://www.nih.gov/about/reporting-preclinical-research.htm). These guidelines are gaining acceptance [7], and the Task Force urges the Society's journal, *Molecular Biology of the Cell* (MBoC) to follow the recommendations it has not already implemented. Still innovations are possible, such as the journal *Autophagy* that now requires catalog numbers for reagents [8]. Among the guidelines and various issues discussed in editorials, the Task Force was particularly interested in assisting reviewers by providing a checklist to aid in the production of a thorough review. The Task Force is supportive of asking *MBoC* to help authors find appropriate repositories for their primary data such as Dryad (http://datadryad.org) or the Open Science Framework (http://osf.io/) and linking to library of repositories such as Databib (http://databib.org).

Recommendations:

1. *Molecular Biology of the Cell* (MBoC) should proactively engage in the emerging standards for publishing from NIH (http://www.nih.gov/about/reporting-preclinical-research.htm).
2. MBoC should consider using a "Reviewer Checklist" to increase the quality and consistency of reviews.
3. MBoC should encourage authors to use open science archives or repositories to make primary data, materials, protocols, or code readily available.

Community-Based Standards

Finally, many of the concerns voiced about experimental work could be addressed, in part, by developing community-based standards. While has been a recognized shortcoming in many areas of life science research, both private and federal efforts have emerged to produce standards. NIH is considering new approaches for cell line authentication [6] and NIGMS has issued an RFA concerning training modules in statistics. In the December 19, 2014 issue of Science, NIGMS Director Jon Lorsch, NIH Director Francis Collins and 2014 ASCB President Jennifer Lippincott-Schwartz called for "A multipronged strategy that combines additional research, alteration of practices, improved training, and investment in the development of new technologies will be necessary." The three also highlighted the work being done by the ASCB, the Global Biological Standards Institute, and the U.S. National Institute of Standards and Technology in developing standards and suggested best practices.

A notable private effort to set standards comes from the Global Institute for Biological Standards (GBSI, http://www.gbsi.org). They state their mission as "enhancing the quality of biomedical research by advocating best practices and standards to accelerate the translation of research breakthroughs into life-saving therapies." A related, but distinct approach from the Science Exchange (http://validation.scienceexchange.com/#/about) is the Reproducibility Initiative and in cooperation with the Center for Open Science (http://centerforopenscience.org), the Reproducibility Project: Cancer Biology (https://osf.io/e81xl/) [9]. These projects set out to examine the replicability of previous studies. However, Science Exchange and the Center for Open Science are both interested in best practices and standards, and their replication efforts are, in part, an effort to discover strengths and weaknesses in reported studies that can inform the development of standards. The ASCB has begun to engage with some of the groups to support their efforts, supply expertise, and to represent the interests of the ASCB membership.

Recommendations:

1. Represent the interests of the ASCB membership to NIH in the development of cell line authentication guidelines and similar NIH-led efforts.
2. Represent the interests of the membership to other groups that seek to develop standards such the Global Biological Standards Institute (GBSI) or to carry out replication efforts such as the Reproducibility Project: Cancer Biology.
3. Partner with other professional societies that are engaged addressing reproducibility issues.

Additional Steps

The Task Force sees an opportunity for the ASCB to foster the growth of community-based standards. There are fine examples of community-driven standards for research. While some of

the efforts mentioned above talk about community-based standards, mechanisms to develop such standards are lacking. At one level, there are research efforts with a specific standards question in mind, such as identifying noise in protein mass spectrometry under the name the “Crapome” [10]. Larger community-based efforts are possible as demonstrated by several model organism communities, which have proven effective in dealing with nomenclature issues and genome annotation, among other issues.

Specific to the task of developing standards, the Task Force was impressed with the efforts of Prof. Dan Klionsky (University of Michigan) whom it interviewed. Dr. Klionsky while at a Keystone autophagy conference some years ago, realized that there was a problem with which cellular events were considered autophagic and with the standard of proof to claim autophagy. Dr. Klionsky organized the community to write two papers of standards for the field [11,12]. These papers have large numbers of authors essentially serving a co-signers to community agreed upon standards for their field. The papers are highly cited as representing the current standards in the field and Dr. Klionsky reports that reviewers cite these papers when a manuscript does not meet the standards. Also, authors cite the papers in defense of their work when reviews challenge certain claims or ask for additional work. No member of the Task Force works in the field of autophagy to give us first-hand knowledge of the use of these standards and how they are applied to ensure quality data without infringing on the interpretation of results. Nonetheless, these efforts appear to have produced a widely accepted set of community-based standards.

Dr. Klionsky, in his role as editor of the journal *Autophagy*, has further enhanced these community-based efforts. The journal hosts a web-based forum for community dialog about various issues, such as the reagents used for specific assays. Finally, Dr. Klionsky reports these community-building efforts have led to new, productive collaborations [13] and to similar efforts in related communities. The Task Force finds this model of community-driven standards appealing because it is driven by the input and consensus of the scientists doing the work. Furthermore, such communities are readily apparent within the membership of the ASCB and the Society should work to identify and support communities in their efforts to derive standards for their field.

Recommendations:

1. Educate the membership about examples of community-based standards, including the experience of Daniel Klionsky (U. Michigan) on his successful community engagement to reach consensus on accepted assays within the autophagy community.
2. Actively promote community self-organization to identify and discuss standards by recruiting leadership and offering workshop time at the annual ASCB meeting or in other ad hoc workshops.
3. Support the development and dissemination of community-based standards as articles in MBoC, supported with on-line forums. MBoC can serve as a forum for scientific communities to reach consensus on standards in particularly sensitive and important assays or in areas where controversies have emerged due lack of reproducibility
4. Connect these communities to external entities as listed above, such as NIH or GBSI, to represent the interests and expertise of the communities to policy makers and other interested groups.

The members of the Task Force are pleased to have had the opportunity to prepare this white paper for the ASCB and are gratified to know that the Society plans to take action on this timely issue. In fact, the Society is already committed to a number of recommended activities. We present an ambitious list of recommendations for the consideration ASCB Council, and look forward the Society's success in these endeavors.

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APPENDENCIES:

1. Task Force Charge Letter

2. Task Force Membership

3. The Member Survey

4. The Member Survey Results with all written comments

Appendix 1: The Task Force Charge –

DATA REPRODUCIBILITY TASK FORCE
COMMITTEE CHARGE

The difficulty in replicating research findings has been at the center of the attention in the specialized and lay press, and also in Congress and the Administration. Various reports indicate the problem of data replication as across-cutting in all areas of research, although it has been studied mostly at the clinical and pre-clinical research level. The magnitude of the problem described in respectable published reports, is disturbing and could possibly undermine scientists' credibility.

Several determinants have been found to be likely contributors to this problem, including, but not limited to:

- a hyper-competitive culture which tends to overemphasize findings, omitting methodological details;
- difficulties in reporting negative results that insert in the published literature a strong selection bias for positive results, which may have been achieved by chance only;
- journal publishing models that do not provide enough space for the Methods sections of articles;
- poor statistical training and experimental design.

The American Society for Cell Biology (ASCB) is troubled by these findings and recognizes the need for an in-depth analysis of the problem, specifically tackled from the basic science and cell biology perspective, which has been overlooked in the various reports detailing the data reproducibility problem.

To achieve this goal, ASCB establishes a *Data Reproducibility Task Force* which, after reviewing and summarizing findings in the literature, will examine eventual evidence for data replication and experimental reproducibility in cell biology and basic science, in general. Clinical and pre-clinical research reproducibility should not be considered the main focus of this committee's work. Also, fraud, misconduct, fabrication and plagiarism are not within the scope of the Task Force charge. The ASCB Task Force will follow closely and interact with the Advisory Council to the NIH Director, which is analyzing the problem of data replication and is planning for NIH-wide actions.

ASCB expects that the Task Force will provide recommendations and propose eventual initiatives to enhance rigor in conducting experimental basic research. Particular attention should be paid to ASCB as a publisher and what actions the Society should take to improve transparency and accountability that ensure reproducibility of findings published in its scholarly journals.

Appendix 2: The Task Force Membership –

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Appendix 3: ASCB Member Survey –

Q1: What best describes your position? (Choose one):

- Graduate Student
- Postdoctoral Fellow
- Faculty member/PI
- Scientist in industry/Biotechnology
- Government Scientist
- Other (please specify)

Q2: Which model systems do you use? (Choose all the apply):

- Virus & host cells
- Bacteria
- Yeast/Fungi
- Other microbial eukaryotes
- C. elegans
- Drosophila
- Xenopus
- Mice/Rats
- Plants
- Tissue culture cells
- Other

Q3: Have you ever been unable to replicate a published experimental result?

- Yes
- No

Q4: Has another laboratory ever told you that they have had trouble replicating one of your published experimental results?

- Yes
- No

Q5: Thinking of the instance that led to you answer "yes" above, how was the issue resolved?

- Resolved myself with additional trials
- Resolved amicably by consulting with the other lab
- Resolved upon contentious consultation with the other lab
- Resolution occurred, but not via reproduction. A better technology or different approach was used to resolve the issue.
- Unresolved

Q6: If unresolved, why not?

- Unresolved despite amicable consultation with the other lab
- Unresolved in the face of contentious consultation with the other lab
- Unresolved because the issue was deemed not important enough to pursue

Q7: If the discrepancy is resolved, what were the key issues in resolving the issue? (Choose all the apply)

- The original result was a false positive
- Lack of appropriate expertise or rigor
- Incomplete specification of original protocol could not accurately guide the replication attempt
- Failure to follow the original protocol
- Differences in Biological strains/Genetic background
- RNAi complications
- Reagents (including antibodies, sera, plasmids, etc.)
- Detection method (e.g. sensitivity of different instruments, cameras or assays)
- Lack of rigorous statistical analysis
- Low powered replication methods
- Random error

Q8: If the discrepancy is resolved, how much time and effort did it take to resolve the issue.

- Huge amount of time
- Significant amount of time
- Some time
- Very little time
- No time at all

Q9: What factors do you believe contribute to poor reproducibility?

Possible Answers:

- Strongly Disagree
- Disagree
- Neither Agree or Disagree
- Agree
- Strongly Agree

Possible Factors:

- Poor laboratory record keeping
- Lack of resources to appropriately executive the experiments
- Pressure to publish in a high profile journal
- Poor methodological training
- Poor statistical knowledge

Q10: Based on your knowledge of failures to replicate published results, rate the extent to which each of the following plays a role in the failure to replicate:

Possible Answers:

- Strongly Disagree
- Disagree
- Neither Agree or Disagree

- Agree
- Strongly Agree

Possible Factors:

- The original result was a false positive
- Lack of appropriate expertise or rigor among the team making the original observation
- Lack of appropriate expertise or rigor among the replication team
- Incomplete specification of original protocol could not accurately guide the replication attempt
- Failure to follow the original protocol
- Differences in Biological strains/Genetic background
- RNAi complications
- Reagents (including antibodies, sera, plasmids, etc.)
- Detection method (e.g. sensitivity of different instruments, cameras or assays)
- Lack of rigorous statistical analysis
- Low powered replication methods
- Random error

Q11: Comments on your perspective concerning reproducibility are welcome.