"Revisiting Rigor and Transparency in NIH Grant Applications:

It's one year later--what have we learned?"

April 10, 2017

Survey Drawing

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  - Learn how to teach others how to write successful proposals
  - Maximize your institution's mentoring capacity
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- For additional information, please contact Program Manager Kimberly Lawson at **rroc@nrmnet.net**.

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Applications due Monday April 17, 2017

"Revisiting Rigor and Transparency in NIH Grant Applications:

It's one year later--what have we learned?"

April 10, 2017

THE WALL STREET JOURNAL.

THE SATURDAY ESSAY

The Breakdown in Biomedical Research

Contaminated samples, faulty studies and inadequate training have created a crisis in laboratories and industry, slowing the quest for new treatments and cures

ILLUSTRATION: DOUG CHAYKA

By RICHARD HARRIS
Updated April 7, 2017 2:05 p.m. ET

Open Mike

Helping connect you with the NIH perspective, and helping connect us with yours

Posted on March 28, 2017 by Mike Lauer

Following Up On Interim Research Products

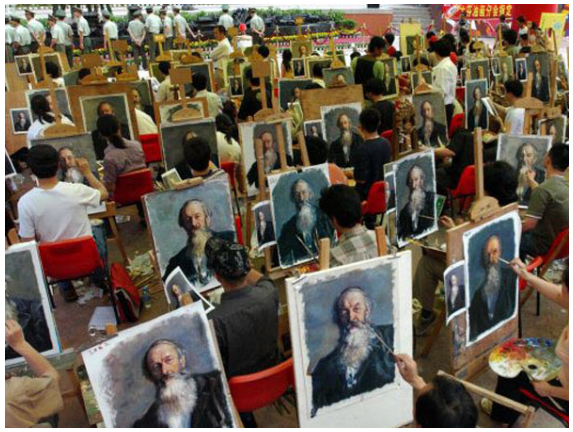
The role of preprints — complete and public draft manuscripts which have not gone through the formal peer review, editing, or journal publishing process – continues to be a hot topic in the biological and medical sciences. In January, three major biomedical research funders – HHMI, the MRC, and the Wellcome Trust, changed their policies to allow preprints to be cited in their progress reports and applications.

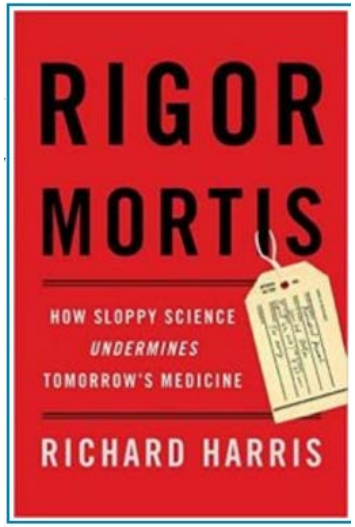
Dr. Michael Lauer is NIH's Deputy Director for Extramural Research, serving as the principal scientific leader and advisor to the NIH Director on the NIH extramural research program.

Arthur M. Sackler COLLOQUIA

March 8-10, 2017; Washington, D.C.

Reproducibility of Research: Issues and Proposed Remedies





Retraction Watch

Tracking retractions as a window into the scientific process

"Failure is an essential part of science:" …a new book on reproducibility

Today's K-Club Panelists

- **Janet Gross, PhD,** Grant Writing Consultant & Instructor in the MSCR program

- **Gary Miller, PhD,** Professor and Associate Dean for Research, Rollins School of Public Health, Department of Environmental Health

- **Russ Price, PhD,** Professor and Associate Vice Chair for Research, Department of Medicine

Spotlight on this issue

- 2012 Nature paper by C. Glenn Begley and Lee Ellis that is now famous for sounding the alarm about reproducibility in basic cancer research.

- Amgen tried to replicate 53 landmark studies in the basic science of cancer.

How many were they able to replicate?

6

The Reproducibility Challenge

- Noted by research community; in multiple publications
  - Across research areas
  - Especially in preclinical research

The Reproducibilit

Why animal research needs to improve

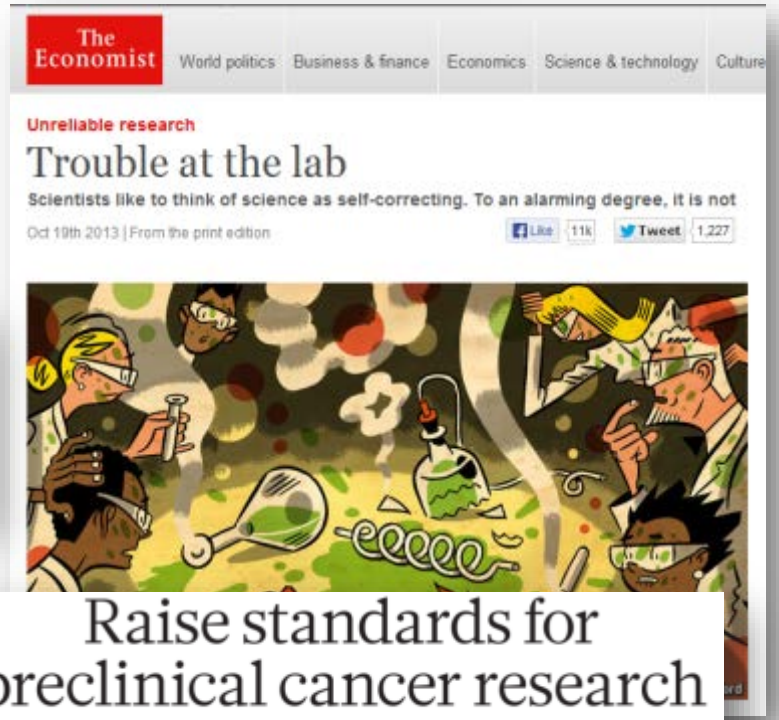
Many of the studies that use animals to model human diseases are too small and too prone to bias to be trusted, says **Malcolm Macleod**.

- Noted by research
  - **Beware the creeping cracks of bias**

    Evidence is mounting that research is riddled with systematic errors. Left unchecked, this could erode public trust, warns **Daniel Sarewitz**.
  - Across research areas
  - Especially i

Believe it or not: how much can we rely on published data on potential drug targets?

Florian Prinz, Thomas Schlange and Khusru Asadullah



False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant

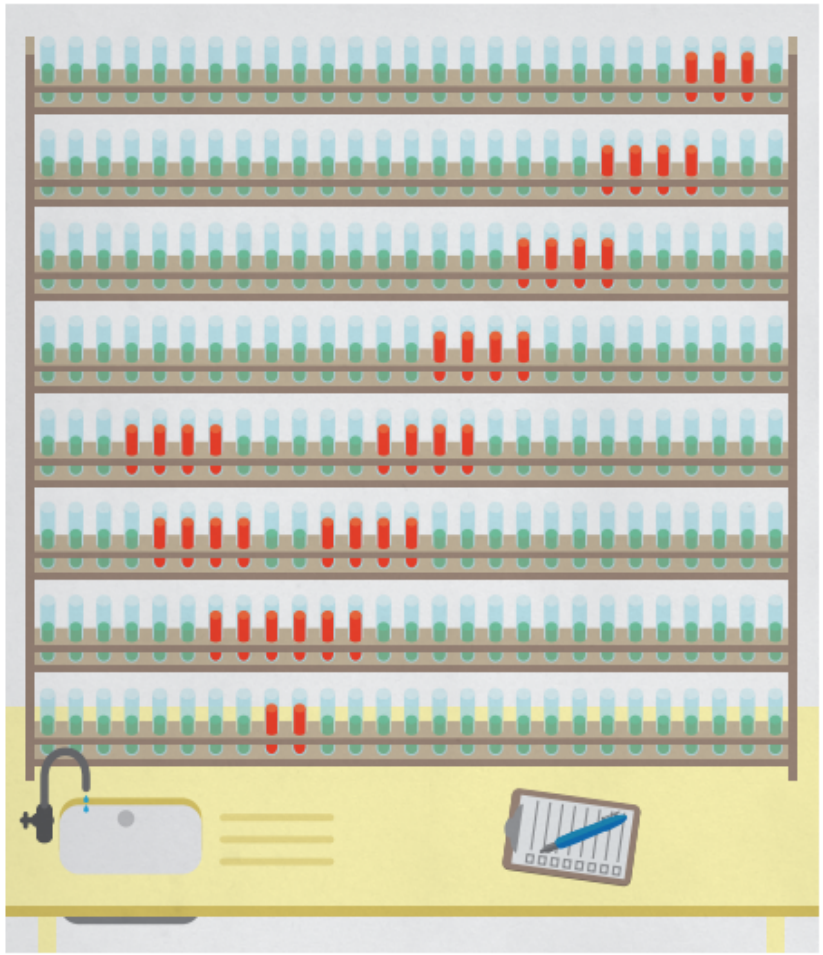
Raise standards for preclinical cancer research

C. Glenn Begley and **Lee M. Ellis** propose how methods, publications and incentives must change if patients are to benefit.

Drug targets slip-sliding away

The starting point for many drug discovery programs is a published report on a new drug target. Assessing the reliability of such papers requires a nuanced view of the process of scientific discovery and publication.

Reforming Science: Methodological and Cultural Reforms



CHRIS RYAN/NATURE

NIH plans to enhance reproducibility

Francis S. Collins and **Lawrence A. Tabak** discuss initiatives that the US National Institutes of Health is exploring to restore the self-correcting nature of preclinical research.

A growing chorus of concern, from scientists and laypeople, contends that the complex system for ensuring

shorter term, however, the checks and balances that once ensured scientific fidelity have been hobbled. This has compromised

outnumbered by the hundreds of thousands published each year in good faith.

Instead, a complex array of other factors seems to have contributed to the lack of reproducibility. Factors include poor training of researchers in experimental design; increased emphasis on making provocative statements rather than presenting technical details; and publications that do not report basic elements of experimental design[4]. Crucial experimental design elements that are all too frequently ignored include blinding, randomization, replication, sample-size calculation and the effect of sex differences. And some scientists reputedly use a 'secret sauce' to make their experiments work — and withhold details from publication or describe them only vaguely to retain a competitive edge[5]. What hope is there that other scientists will be able to build on such work to further biomedical progress?

Exacerbating this situation are the policies and attitudes of funding agencies, academic centres and scientific publishers. Funding agencies often uncritically encourage the overvaluation of research published in high-profile journals. Some academic centres also provide incentives for publications in such journals, including promotion and tenure, and in extreme circumstances, cash rewards[6].

Then there is the problem of what is not published. There are few venues for researchers to publish negative data or papers that point out scientific flaws in previously published work. Further compounding the problem is the difficulty of accessing unpublished data — and the failure of funding agencies to establish or enforce policies that insist on data access.

PRECLINICAL PROBLEMS

Reproducibility is potentially a problem in all scientific disciplines. However, human clinical trials seem to be less at risk because they are already governed by various regulations that stipulate rigorous design and independent oversight — including randomization, blinding, power estimates, pre-registration of outcome measures in standardized, public databases such as ClinicalTrials.gov and oversight by institutional review boards and data safety monitoring boards. Furthermore, the clinical trials community has taken important steps towards adopting standard reporting elements[7].

Nomenclature

Enhancing reproducibility through rigor and transparency

Rigor + Transparency = Reproducibility

Rigor and Transparency in Research

To support the **highest quality science, public accountability, and social responsibility in the conduct of science,** NIH's Rigor and Transparency efforts are intended to clarify expectations and highlight attention to four areas that may need more explicit attention by applicants and reviewers:

- Scientific premise
- Scientific rigor
- Consideration of relevant biological variables, such as sex
- Authentication of key biological and/or chemical resources

NIH's Philosophical Message

- Raise awareness and begin culture shifts in the scientific community
- Demonstrate to our public stakeholders that NIH is seriously considering their concerns
- Ensure that NIH is investing in the best science and minimizing unnecessary burden

NIH's Practical Message

- Clarify NIH's long-standing expectations regarding rigor and transparency and how they would like to see this described in applications
- Prompt applicants to consider issues that they may have previously down-played or ignored, which may have a detrimental effect on the quality of the science they produce
- Improve the way that applicants describe their work; provide sufficient information for reviewers

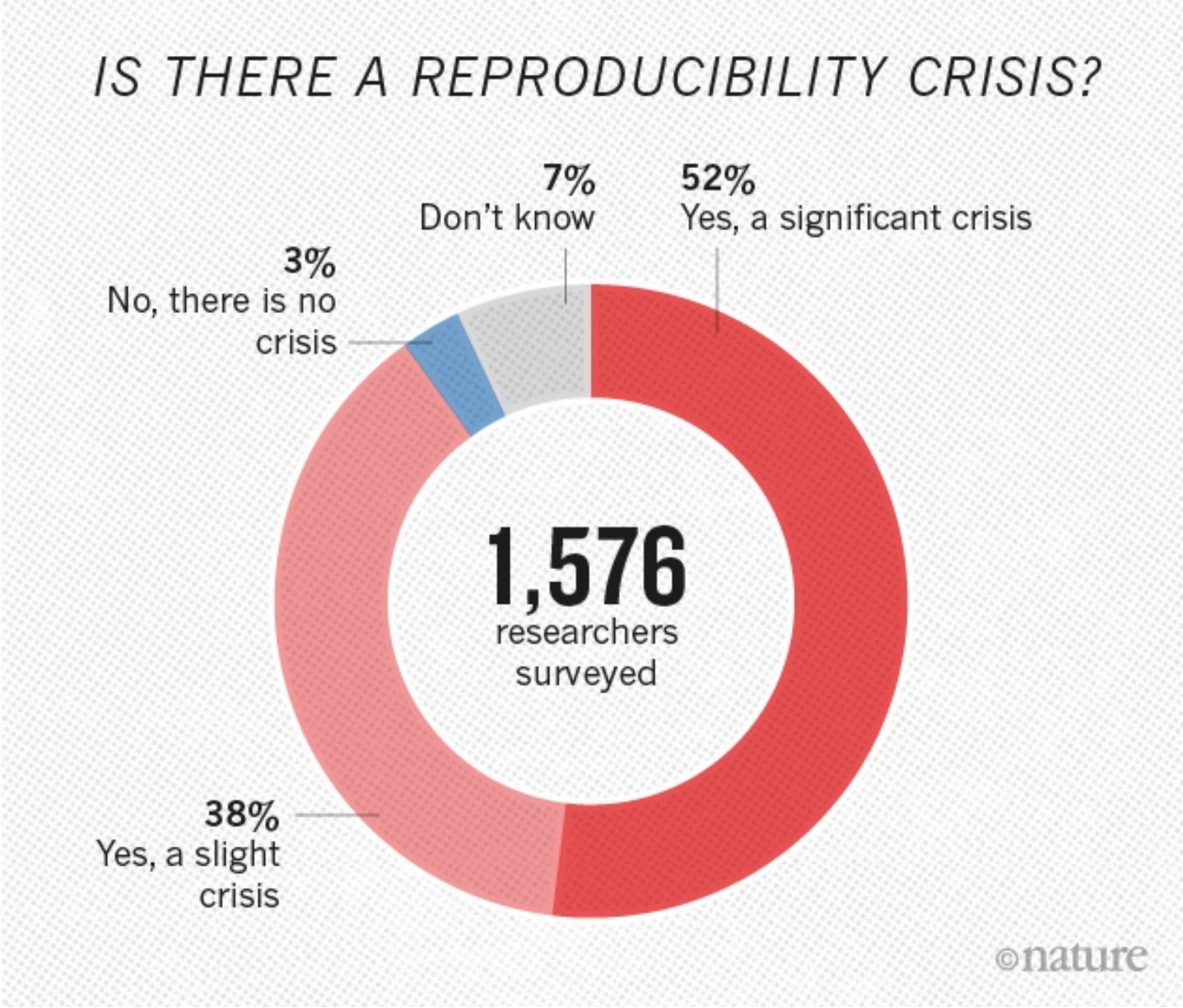
What Do Scientists Say?

NATURE

25 May 2016

1,500 scientists lift the lid on reproducibility

Survey sheds light on the ‘crisis’ rocking research


IS THERE A REPRODUCIBILITY CRISIS?
7%
Don't know
52%
Yes, a significant crisis
3%
No, there is no crisis
1,576
researchers surveyed
38%
Yes, a slight crisis
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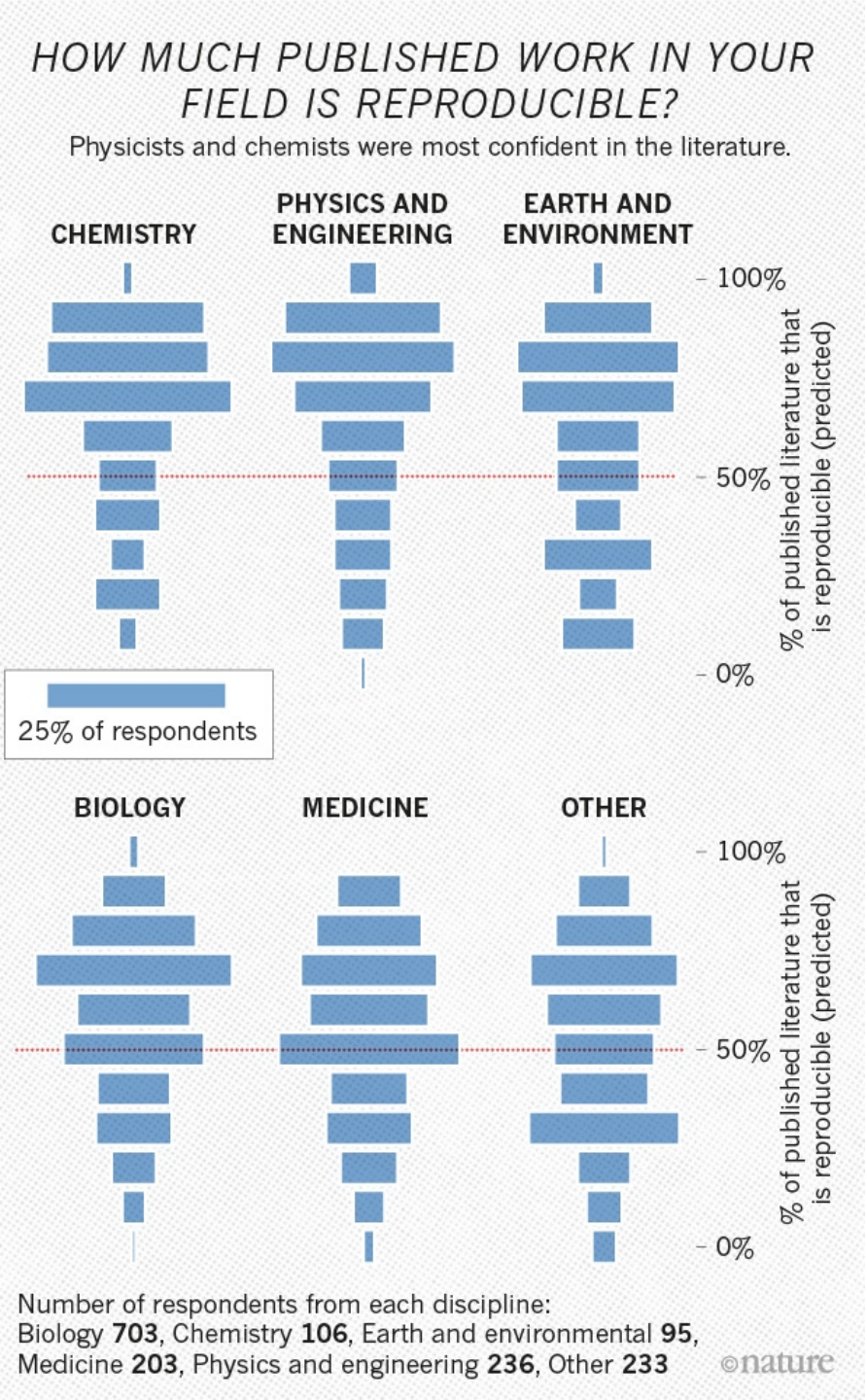
HOW MUCH PUBLISHED WORK IN YOUR FIELD IS REPRODUCIBLE?
Physicists and chemists were most confident in the literature.
CHEMISTRY
PHYSICS AND ENGINEERING
EARTH AND ENVIRONMENT
100%
50%
0%
% of published literature that is reproducible (predicted)
25% of respondents
BIOLOGY
MEDICINE
OTHER
100%
50%
0%
% of published literature that is reproducible (predicted)
Number of respondents from each discipline:
Biology 703, Chemistry 106, Earth and environmental 95,
Medicine 203, Physics and engineering 236, Other 233
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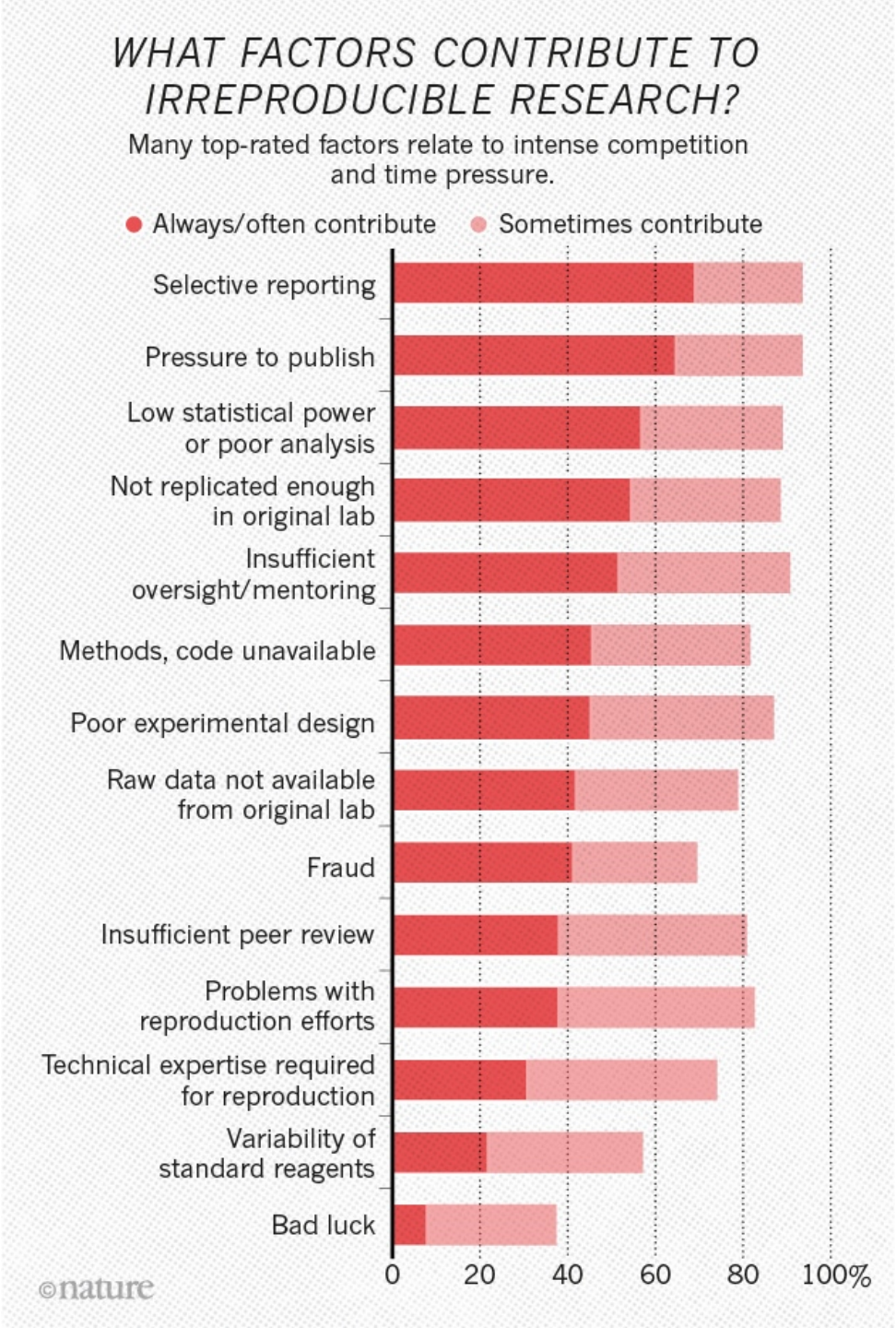
WHAT FACTORS CONTRIBUTE TO IRREPRODUCIBLE RESEARCH?
Many top-rated factors relate to intense competition and time pressure.
Always/often contribute
Sometimes contribute
Selective reporting
Pressure to publish
Low statistical power or poor analysis
Not replicated enough in original lab
Insufficient oversight/mentoring
Methods, code unavailable
Poor experimental design
Raw data not available from original lab
Fraud
Insufficient peer review
Problems with reproduction efforts
Technical expertise required for reproduction
Variability of standard reagents
Bad luck
0
20
40
60
80
100%
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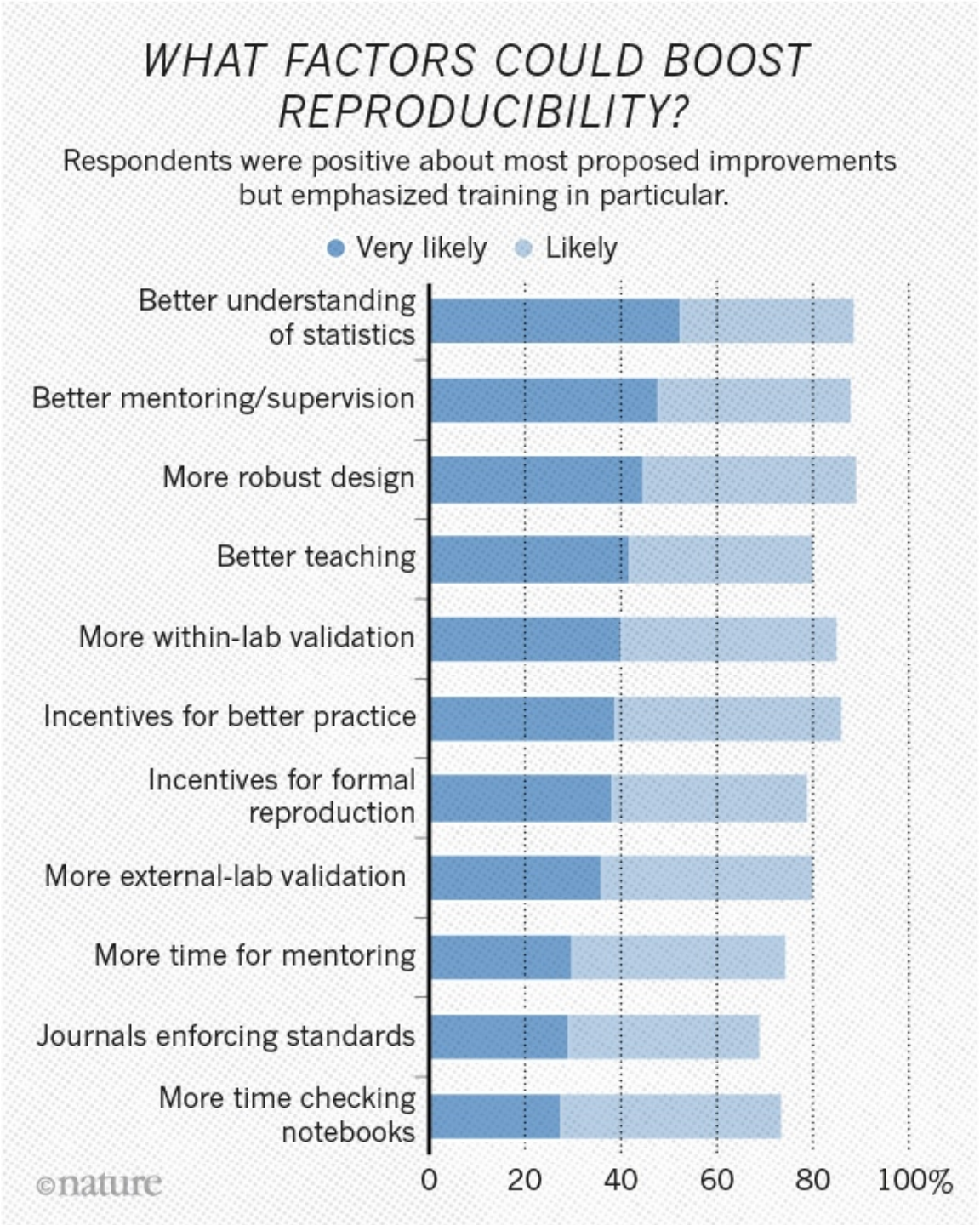
WHAT FACTORS COULD BOOST REPRODUCIBILITY?
Respondents were positive about most proposed improvements but emphasized training in particular.
Very likely
Likely
Better understanding of statistics
Better mentoring/supervision
More robust design
Better teaching
More within-lab validation
Incentives for better practice
Incentives for formal reproduction
More external-lab validation
More time for mentoring
Journals enforcing standards
More time checking notebooks
0
20
40
60
80
100%
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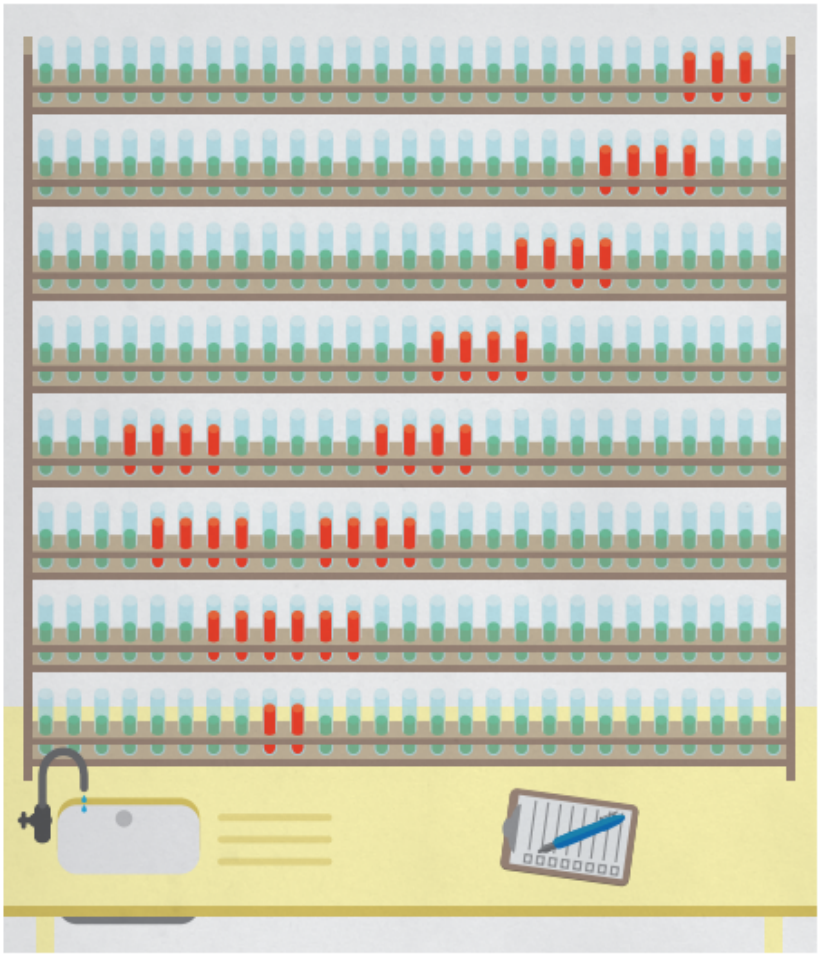

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sauce' to make
and withhold d
describe them o
petitive edge[5]. W
scientists will be
to further biome

Exacerbating
and attitudes of
centres and sci
ing agencies of
the overvaluatio
high-profile jou
tres also provide
in such journals
tenure, and in e
rewards[6].

Then there i
not published.
researchers to
papers that poin
viously published work. Further compounding the problem is the difficulty of accessing unpublished data — and the failure of funding agencies to establish or enforce policies that insist on data access.

> *"Efforts by the NIH alone will not be sufficient to effect real change in this unhealthy environment."*

PRECLINICAL PROBLEMS

Reproducibility is potentially a problem in all scientific disciplines. However, human clinical trials seem to be less at risk because they are already governed by various regulations that stipulate rigorous design and independent oversight — including randomization, blinding, power estimates, pre-registration of outcome measures in standardized, public databases such as ClinicalTrials.gov and oversight by institutional review boards and data safety monitoring boards. Furthermore, the clinical trials community has taken important steps towards adopting standard reporting elements[7].

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Posted on **March 28, 2017** by **Mike Lauer**

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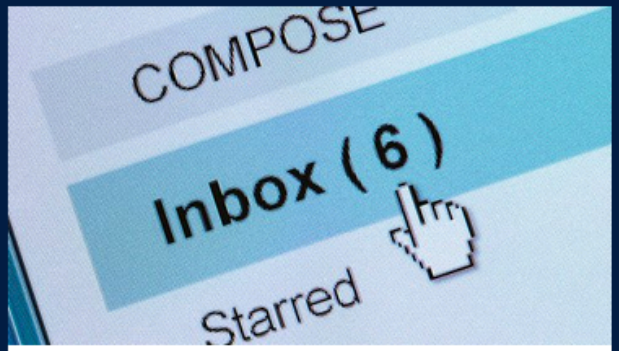
Dr. Michael Lauer is NIH's Deputy Director for Extramural Research, serving as the principal scientific leader and advisor to the NIH Director on the NIH extramural research program.

Addressing Rigor & Transparency – Outside of NIH requirements

- Use of preprints
- Use of data repositories, providing a venue for deposition of large data sets, code, and even methods



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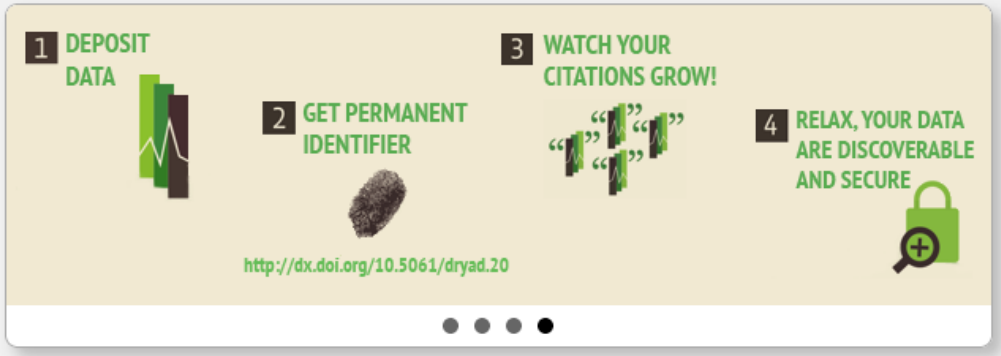

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Pekcan-Hekim Z, Hellén N, Härkönen L, Nilsson PA, Nurminen L, Horppila J (2016) Data from: Bridge under troubled water: turbulence and niche partitioning in fish foraging. *Ecology and Evolution* http://dx.doi.org/10.5061/dryad.3q7c9

Lehnert S, Devlin R, Pitcher T, Semeniuk C, Heath D (2016) Data from: Redder isn't always better: cost of carotenoids in Chinook salmon eggs. *Behavioral Ecology* http://dx.doi.org/10.5061/dryad.2bp67

Douhard M, Pigeon G, Festa-Bianchet M, Coltmann DW, Guillemette S, Pelletier F (2016) Data from: Environmental and evolutionary effects on horn growth of male bighorn sheep. *Oikos* http://dx.doi.org/10.5061/dryad.m5648

Staats E, Agosta S, Vonesh J (2016) Data from: Predator diversity reduces habitat colonization by mosquitoes and midges. *Biology Letters* http://dx.doi.org/10.5061/dryad.2f452

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EDITORIAL

Preprints in Toxicology

Gary W. Miller[1,*,†]

Richard Sever
@cshperspectives

Following

Medawar on scooping: an “endearing trait of a young research[er] is the illusion everyone else is eager to do his research before he can"

Richard Sever @cshperspectives
Toxicologists embrace bioRxiv academic.oup.com/toxsci/article…

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3 20 25

Use of Preprints is catching on

- Reporting Preprints and Other Interim Research Products
- https://grants.nih.gov/grants/guide/notice-files/NOT-OD-17-050.html
- Newly NIH issued statement endorses use including citation within biosketch and grant applications

Four Key Areas

1) **Scientific Premise** for the proposed research

2) **Rigorous Experimental Design** for robust and unbiased results

3) Consideration of **Relevant Biological Variables**

Addressed within Research Strategy

4) **Authentication** of key biological and/or chemical resources

Addressed as separate attachment

Rigor and Transparency in Research
Reviewer Guidance

To support the **highest quality science, public accountability, and social responsibility in the conduct of science,** NIH's Rigor and Transparency efforts are intended to clarify expectations and highlight attention to four areas that may need more explicit attention by applicants and reviewers:

- Scientific premise
- Scientific rigor
- Consideration of relevant biological variables, such as sex
- Authentication of key biological and/or chemical resources

Role of reviewers: Assess the scientific merit of each application according to the review criteria, which include consideration of scientific premise, rigor, and consideration of relevant biological variables, and the adequacy of the authentication of key biological and/or chemical resources as an administrative issue. Evaluations should be based on current best practices in the field.

Reviewing Rigor and Transparency of Research: RPG Applications

	Applies to which applications?	Where will I find it in the application?	Where do I include it in my critique?	Addition to review criteria	Affect overall impact score?
Scientific Premise	All	Research Strategy (Significance)	Significance	Is there a strong scientific premise for the project?	Yes
Scientific Rigor	All	Research Strategy (Approach)	Approach	Are there strategies to ensure a robust and unbiased approach?	Yes
Consideration of Relevant Biological Variables, Such as Sex	Projects with vertebrate animals and/or human subjects	Research Strategy (Approach)	Approach	Are adequate plans to address relevant biological variables, such as sex, included for studies in vertebrate animals or human subjects?	Yes
Authentication of Key Biological and/or Chemical Resources	Project involvin biological and chemical resou				No

For K applications, these three are scored under the "Research Plan" criterion

The Four Focus Areas – one by one

1) Scientific Premise
2) Scientific Rigor
3) Consideration of Relevant Biological Variables

4) Authentication of Biological/Chemical Resources

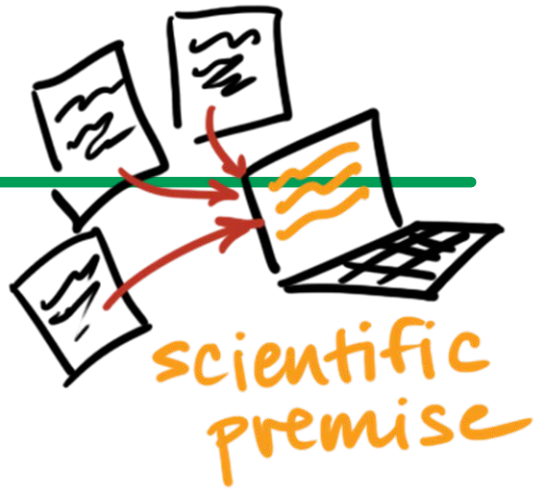
Scientific Premise
Application Instructions

- Explain the importance of the problem or critical barrier to progress in the field that the proposed project addresses.
- *Describe the scientific premise for the proposed project, including consideration of the strengths and weaknesses of published research or preliminary data crucial to the support of your application.*
- Explain how the proposed project will improve scientific knowledge, technical capability, and/or clinical practice in one or more broad fields.
- Describe how the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field will be changed if the proposed aims are achieved.

Black text – current instructions

Red, italics text – "new" instructions

Scientific Premise

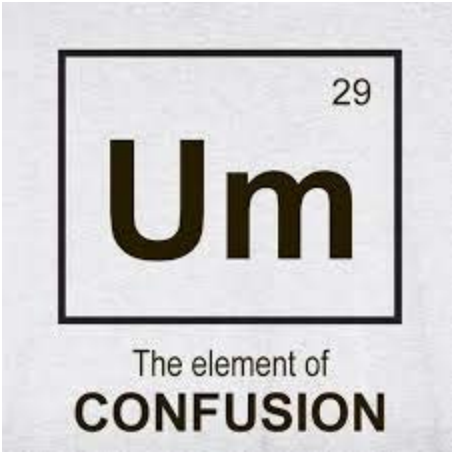


- All research builds upon prior research, whether observations, preliminary data, or published literature. The scientific premise for an application is **the research that is used to form the basis for the proposed research question.**
- Scientific premise includes a retrospective consideration of the foundation for the application
- The applicant should evaluate the strengths and weakness of the foundational research *including the rigor, relevant variables, and authentication of resources of said work*
- ***The background***

https://grants.nih.gov/reproducibility/faqs.htm#II

Premise vs Significance

- **Scientific premise** includes a *retrospective consideration* of the foundation for the application. It concerns the quality and strength of the research used to form the basis for the proposed research question.
- **Significance** is a *prospective analysis* should the aims be achieved.



Scientific Premise: How Reviewers are Instructed

Is there a strong scientific premise for the project?

Scientific Premise: The key data introduced by the applicant to justify the project.

- The applicant should supply a sufficient evaluation of the strengths and weaknesses of the data or other justification used to support the application, and should describe how the proposed research will address any weaknesses or gaps.
- Extending the existing review criteria to include a retrospective assessment of the foundation for the project, scientific premise will be addressed in peer review:
  - As a **Significance criterion** for **research grant applications**
  - As a **Research Plan criterion** for **mentored CDA's**.
- Reviewers should factor a weak premise or the failure to address scientific premise adequately, into the criterion score and overall impact score.

Scientific Premise: Questions for the Panel

- What have you observed in review/in practice? Are there approaches to addressing premise that work great or clearly miss the mark?
- Do reviewers all agree on what this means and how best to address it?
- What are some good ways to evaluate the strengths and weakness of the foundational research *including the rigor, relevant variables, and authentication of resources of said work* especially in cases when they are not your own work?
- Do you have to worry about offending others in the field (who may be reviewing your application)?
- What do you think of efforts to formalize replication attempts? (i.e. Reproducibility Initiative where life scientists can pay to have their work validated by an independent lab)
- Should publishing negative results become a priority?

The Four Focus Areas – one by one

1) Scientific Premise
2) Scientific Rigor
3) Consideration of Relevant Biological Variables

4) Authentication of Biological/Chemical Resources

Scientific Rigor
Application Instructions

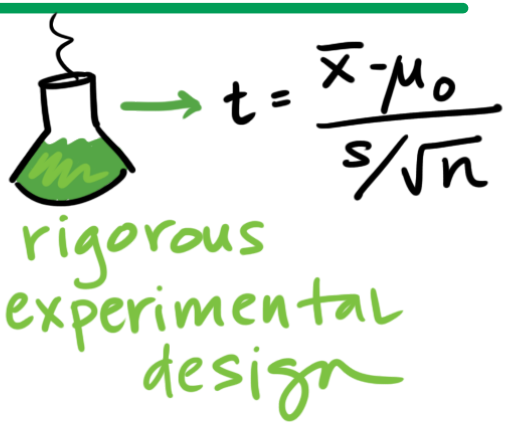
- Describe the overall strategy, methodology, and analyses to be used to accomplish the specific aims of the project. *Describe the experimental design and methods proposed and how they will achieve robust and unbiased results.* Unless addressed separately in the Resource Sharing Plan attachment below, include how the data will be collected, analyzed, and interpreted.
- Discuss potential problems, alternative strategies, and benchmarks for success anticipated to achieve the aims.
- If the project is in the early stages of development, describe any strategy to establish feasibility, and address the management of any high risk aspects of the proposed work.

Black text – current instructions

Red, italics text – "new" instructions

Scientific Rigor

- The **strict application of the scientific method** to ensure robust and unbiased experimental design, methodology, analysis, interpretation and reporting of results



- Describe the experimental design and methods proposed and how they will achieve robust and unbiased results
- Robust and unbiased results are obtained using methods designed to avoid bias and these results can be reproduced under well-controlled and reported experimental conditions
- This includes **transparency of experimental details** to allow reproducibility

https://grants.nih.gov/reproducibility/faqs.htm#III

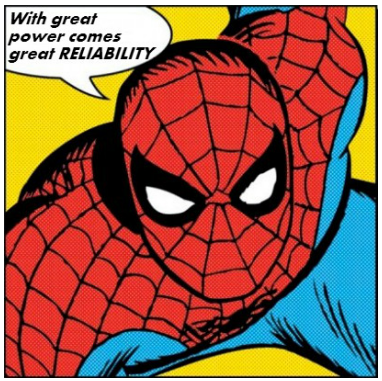
Scientific Rigor -
How Reviewers are Instructed

- *Have the investigators/presented strategies to ensure a robust and unbiased approach, as appropriate for the work proposed?*

Scientific Rigor: Engaging Statistical Expertise

Common statistical pitfalls that researchers should avoid

- Not addressing statistical power
- P-hacking, HARKing, fishing expeditions
- Using poorly defined/unvalidated outcome measures



Scientific Rigor: Innovative/exploratory research

Does this requirement jeopardize innovative/exploratory research?

Mitigate through:

- Show a strong scientific premise
- Identification/acknowledgement of the unknown factors
- Incorporate strategies to reduce bias
- Well-designed methods

Scientific Rigor: Questions for the Panel

- Have you changed your own approach to grant writing/designing experiments?
- Have you noticed that grant review processes have changed in response to this newly worded review criteria?
- Are there generalizable approaches that address this in a comprehensive manner?
- What are some common statistical pitfalls that researchers should avoid?
- Have you seen if this does/doesn't jeopardize exploratory research proposals?

The Four Focus Areas – one by one

1) Scientific Premise
2) Scientific Rigor
3) Consideration of Relevant Biological Variables

4) Authentication of Biological/Chemical Resources

Relevant Biological Variables
Application Instructions

Listed in the Research Strategy Section under Approach

- *Explain how relevant biological variables, such as sex, are factored into research designs and analyses for studies in vertebrate animals and humans.*
  - *For example, strong justification from the scientific literature, preliminary data, or other relevant considerations, must be provided for applications proposing to study only one sex.*
  - *Please refer to NOT-OD-15-002 for further consideration of NIH expectations about sex as a biological variable.*

Consideration of Relevant Biological Variables, Such as Sex

- Biological variables, such as sex, age, weight, and underlying health conditions, are often critical factors affecting health or disease

- NIH expects that sex as a biological variable will be factored into research designs, analyses, and reporting in vertebrate animal and human studies
- Strong justification from the scientific literature, preliminary data or other relevant considerations must be provided for applications proposing to study only one sex

https://grants.nih.gov/reproducibility/faqs.htm#IV

The Four C's of Studying Sex to Strengthen Science

1. **Consider** - Design studies that take sex into account, or explain why it isn't incorporated
2. **Collect** - Tabulate sex-based data
3. **Characterize** - Analyze sex-based data
4. **Communicate** - Report (via progress reports) and publish sex-based data

Strong justification from the scientific literature, preliminary data, or other relevant considerations must be provided for applications proposing to study only one sex.

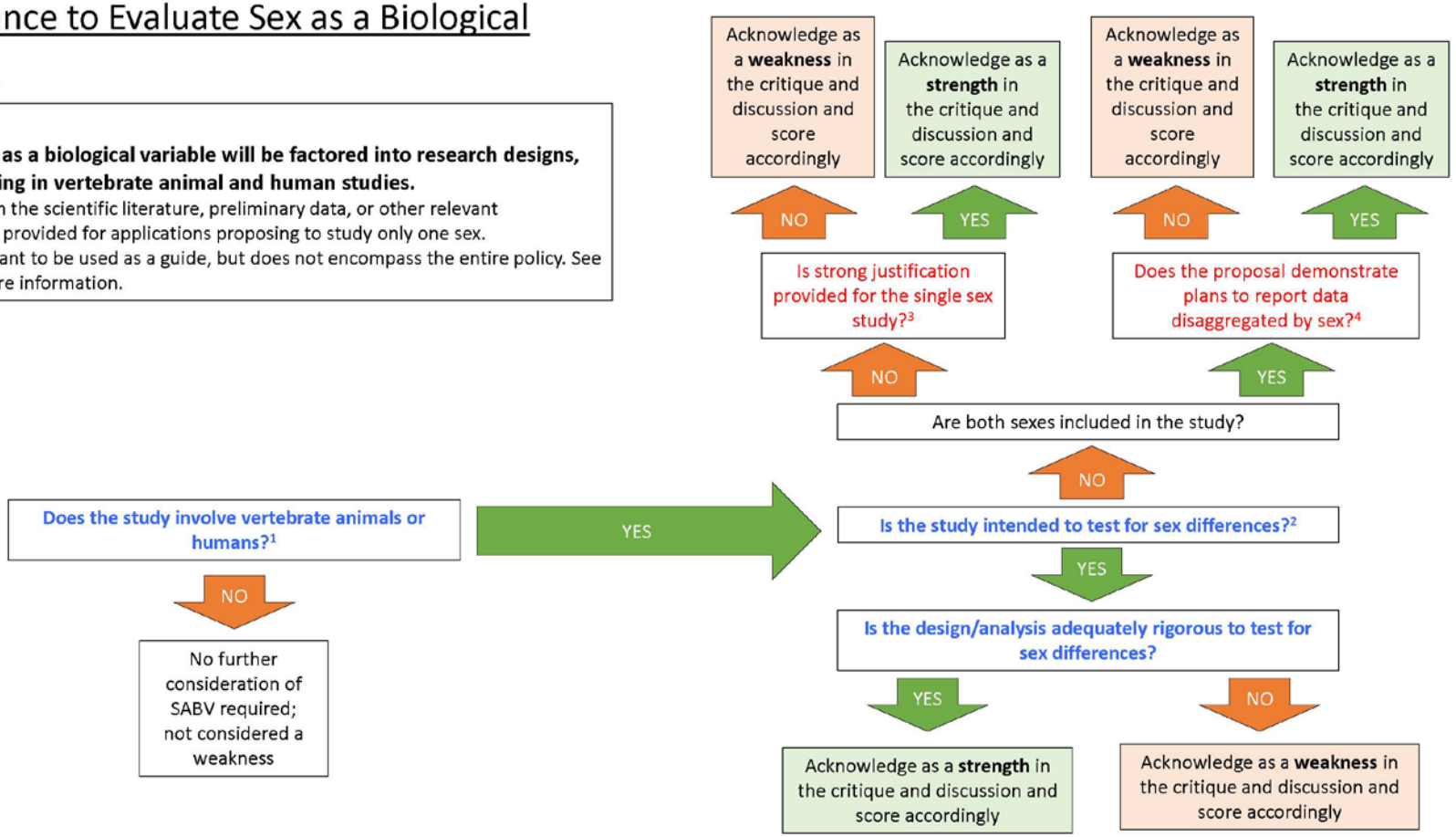
Relevant Biological Variables
How Reviewers are Instructed

- *Have the investigators presented adequate plans to address relevant biological variables, such as sex, for studies in vertebrate animals or human subjects?*

Reviewer Guidance to Evaluate Sex as a Biological Variable (SABV)

Main points

- **NIH expects that sex as a biological variable will be factored into research designs, analyses, and reporting in vertebrate animal and human studies.**
- Strong justification from the scientific literature, preliminary data, or other relevant considerations must be provided for applications proposing to study only one sex.
- This decision tree is meant to be used as a guide, but does not encompass the entire policy. See NOT-OD-15-102 for more information.



Notes

[1] See FAQs on inclusion, primary cells and tissues, and established cell lines.

[2] See FAQs on considering sex as a biological variable and use of males and females in basic research.

[3] See FAQ on justification of single sex studies.

[4] Based on the research question and availability of relevant data, statistically powered comparisons between the sexes may not be required. Analyzing and publishing sex-based data, even in the absence of powered sex differences analyses, would permit the consideration of the influence of sex in the interpretation of study results and the appropriate generalization of research findings.

Consideration of Relevant Biological Variables: Questions for the Panel

- How can this be handled in a cost effective manner?
- Will this require more foundational work and preliminary data in proposals?
- Can you provide examples of what is considered "strong justification" for including just one sex?
- How do you address this when using cell lines?
- How is this discussed during the review session?

The Four Focus Areas – one by one

1) Scientific Premise
2) Scientific Rigor
3) Consideration of Relevant Biological Variables

4) Authentication of Biological/Chemical Resources

Authentication of Key Resources
Application Instructions – own attachment

Briefly describe methods to ensure the identity and validity of key biological and/or chemical resources used in the proposed studies.

- *Key biological and/or chemical resources may or may not be generated with NIH funds and:*
  - *1) may differ from laboratory to laboratory or over time;*
  - *2) may have qualities and/or qualifications that could influence the research data; and*
  - *3) are integral to the proposed research. These include, but are not limited to, cell lines, specialty chemicals, antibodies, and other biologics.*
- *Standard laboratory reagents that are not expected to vary do not need to be included in the plan. Examples are buffers and other common biologicals or chemicals.*
- *Reviewers will assess the information provided in this Section. Any reviewer questions associated with key biological and/or chemical resource authentication will need to be addressed prior to award.*

Authentication of Key Biological and/or Chemical Resources

- The quality of the resources used to conduct research is critical to the ability to reproduce the results. Key biological and/or chemical resources should be regularly authenticated to ensure their identity and validity for use in the proposed studies.

- Key biological and/or chemical resources are those that: 1) may differ from laboratory to laboratory or over time; 2) may have qualities and/or qualifications that could influence the research data; and 3) are integral to the proposed research and may or may not be generated with NIH funds. **These include, but are not limited to, cell lines, specialty chemicals, antibodies and other biologics.**

https://grants.nih.gov/reproducibility/faqs.htm#V

Authentication of Key Resources How Reviewers are Instructed

- *For projects involving key biological and/or chemical resources, reviewers will comment on the brief plans proposed for identifying and ensuring the validity of those resources.*

(Not part of the impact score)

Authentication of Key Biological and/or Chemical Resources:

Questions for the Panel

- Does this apply to clinical research and/or clinical trials?
- What should be included/excluded?
- What can labs do to make this a part of their laboratory culture?
- Is this discussed during the review session?
- Can you provide any examples of where you thought this was done really well?


A. BACALL
"There's a flaw in your experimental design.
All the mice are scorpios."

Examples of Authentication of Key Resources documents

Authentication of Key Resources Example

We understand the importance of authenticating resources used in this project, as part of our overall laboratory quality assurance (QA) program. The intent of our QA program is to ensure reproducibility of our results, so that our findings can make a real and continued impact in the field. Part of our QA program includes requiring a minimum of three replicates for all submitted/published experiments, and validation of all key results by an independent, blinded laboratory member. Another important aspect of QA is the documentation of the quality and activity of all key reagents developed in our research program. Here we detail our current procedures for key reagents.

Authentication of Key Resources Example

Standard laboratory reagents. We purchase high quality chemicals from Sigma, Fisher, VWR, and other very established biological/chemical suppliers. For these, we rely upon the analysis conducted by the manufacturer and supplier.

Authentication of Key Resources Example

Purchased/acquired antibodies. We purchase from multiple vendors, and rely on published reports plus documentation from the vendor to ensure specificity initially. However, for key experiments we validate specificity using knockdown/knockout cell lines as controls and validated preparations of antigen to evaluate specificity. We generally acquire more than one antibody for each antigen as further means of establishing the correct reactivity.

Authentication of Key Resources Example

We will deposit our published reagents, including DNA constructs, cell lines, and other unique reagents to the NIH AIDS Research and Reference Reagent Program to share with other researchers and to facilitate similar research in the field.

Authentication of Key Resources Example

We will provide appropriate training for new members in our lab to understand the importance of authentication of key biological and chemical resources and practice above procedures during research.

Authentication of Key Resources Example

We will publish detailed information of materials and methods used in the studies to ensure reproducibility of assays by other researchers.

Additional links

Examples for satisfying Rigor Requirement:

- http://www.ninds.nih.gov/funding/transparency_in_reporting_guidance.pdf
- http://www.nimh.nih.gov/research-priorities/policies/enhancing-the-reliability-of-nimh-supported-research-through-rigorous-study-design-and-reporting.shtml
- https://www.drugabuse.gov/offices/office-nida-director-od/office-translational-initiatives-program-innovations-otipi/nih-initiative-enhancing-research-reproducibility-transparency

Resources including examples of Rigor used in real, awarded applications:

- http://grants.nih.gov/reproducibility/index.htm