research rigor & reproducibility | R3 and me

a toolkit for rigorous and reproducible research

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what do we mean by research rigor and reproducibility?

Rigor is the strict application of the scientific method to ensure unbiased and well-controlled experimental design, methodology, analysis, interpretation and reporting of results.

National Institutes of Health, 2018

Reproducibility or computational reproducibility – obtaining consistent computational results using the same input data, computational steps, methods, code, and conditions of analysis

Replicability – obtaining consistent results across studies aimed at answering the same scientific question, each of which has obtained its own data

National Academies of Sciences, Engineering, and Medicine 2019

have you **failed to reproduce** an experiment (your own, someone else's)?

what **factors** contribute to irreproducible research?

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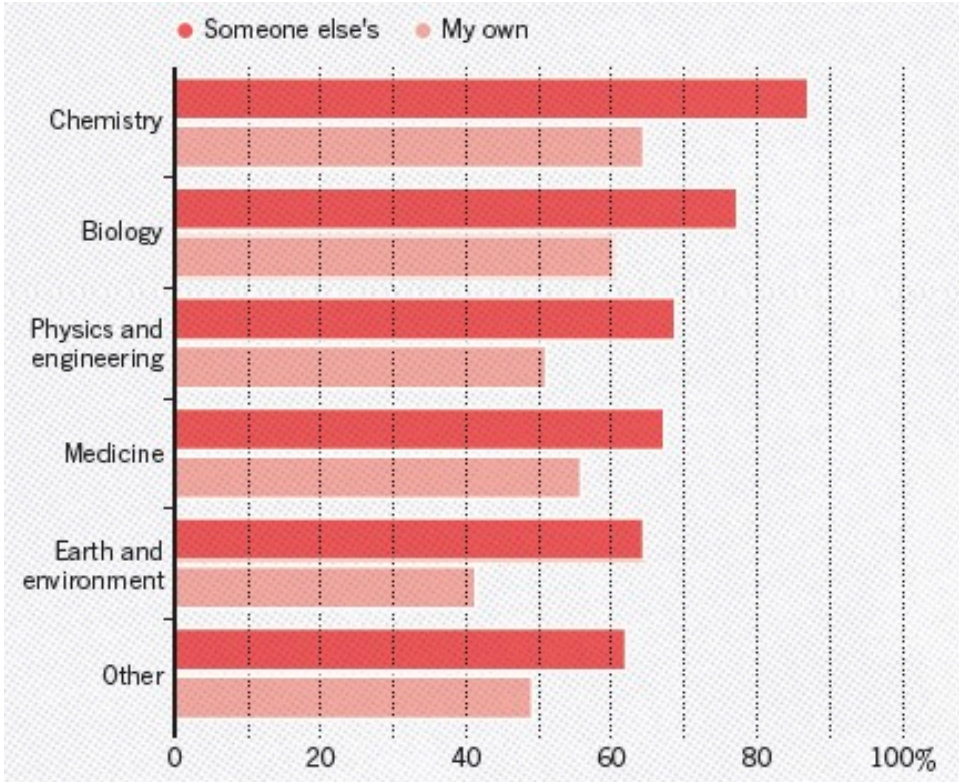

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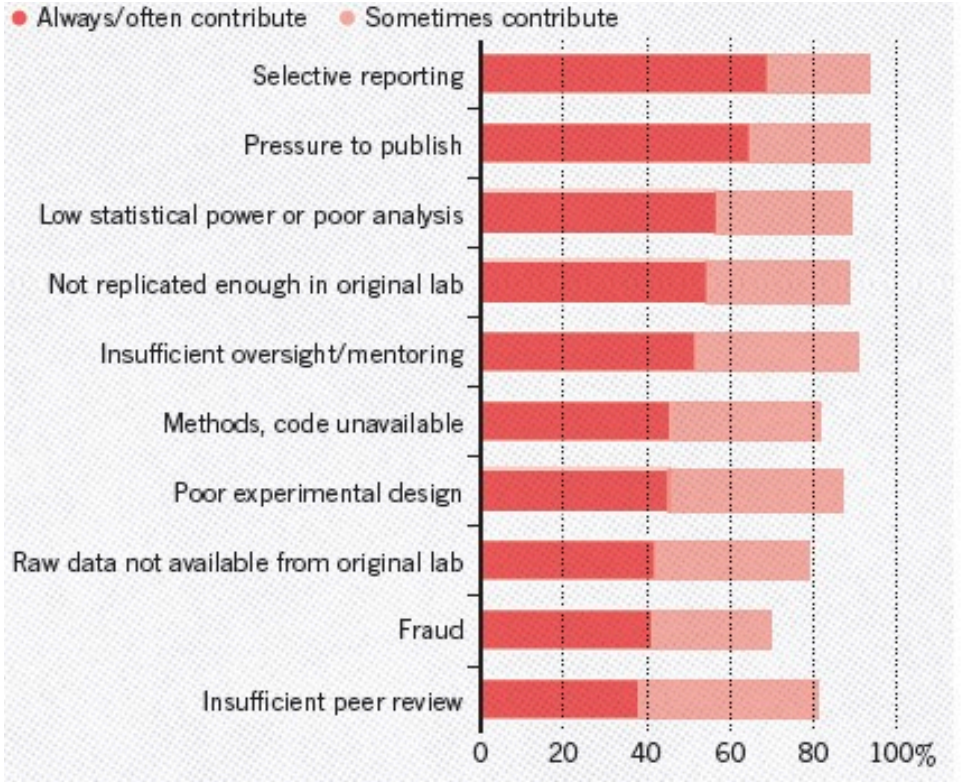


Is there a Reproducibility Crisis, *Nature 2016*

“fixing problems with cell lines”

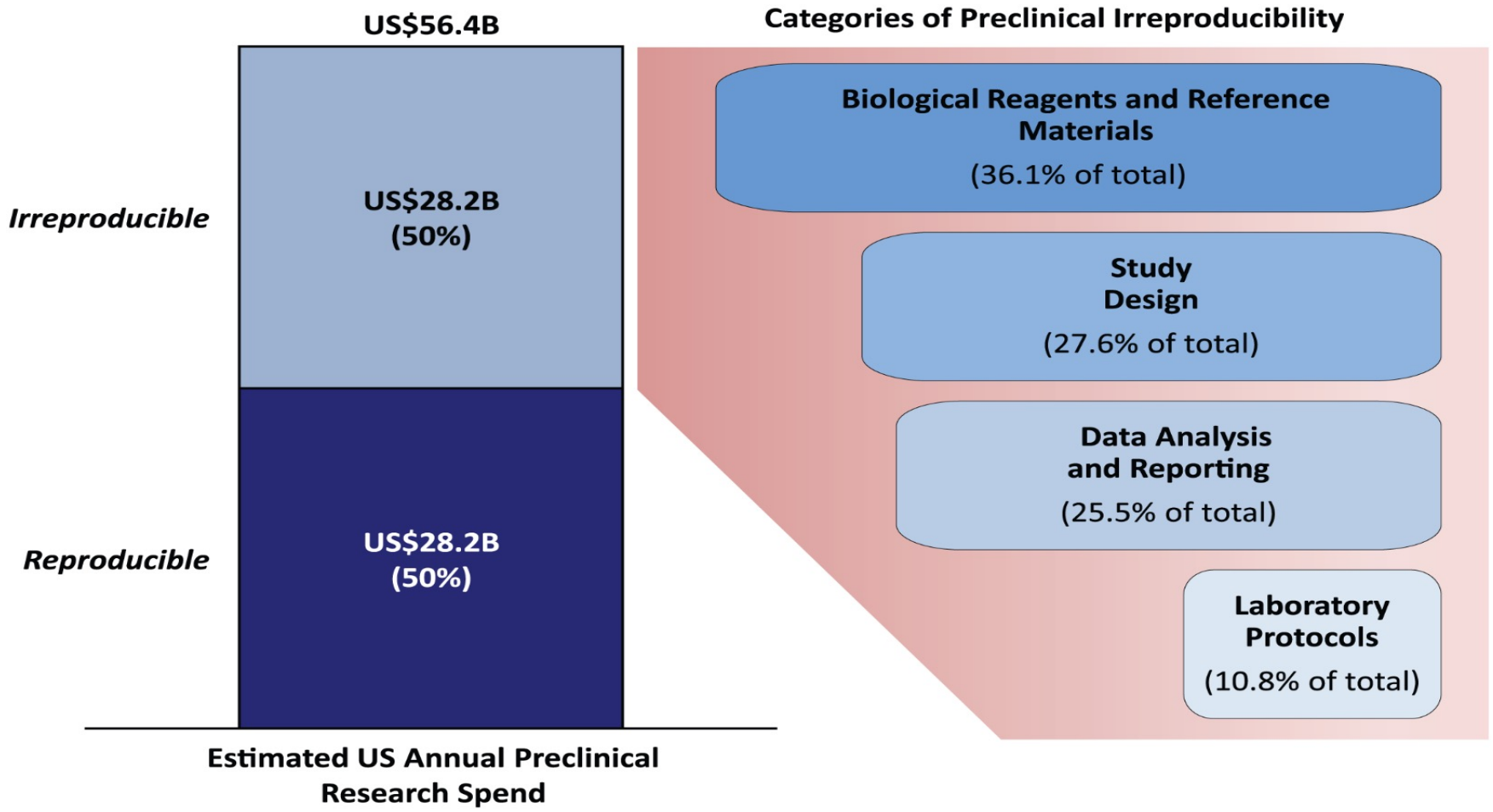
- Since the 1960s, more than 400 widely used cell lines worldwide have been shown to have been misidentified

- A 2011 study of 122 different head and neck cancer cell lines revealed that 37 (30%) were misidentified

- Studies using just two misidentified cell lines were included in 3 grants funded by the NIH, two clinical trials, 11 patents, and >100 papers

Lorsch et al., *Science 2014*

"the economics of reproducibility"



Freedman et al., *PLoS Biology 2015*

how do we correct this?

what does your research practice entail to ensure rigor & reproducibility?

how do we correct this?

spectrum of skills needed to develop in order to become great scientists

adapted from Catalyzing the Modernization of Graduate Education
Gammie, Lorsch, Singh | NIGMS Feedback Loop Blog | 2015

how do we correct this?

spectrum of skills needed to develop in order to become great scientists

TECHNICAL SKILLS

methods & technology

quantitative & computational

OPERATIONAL SKILLS

acquiring information, experimental design & data interpretation

PROFESSIONAL SKILLS

management & leadership

communication & teamwork

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how do we correct this?

spectrum of skills needed to develop in order to become great scientists

TECHNICAL SKILLS

- Research lab
- Visit HMS core facilities

- Build your quantitative & computational skills
- Finding the right analysis methods
- Cleaning your data

OPERATIONAL SKILLS

- How to critically evaluate foundational research underlying a project?
- How to be rigorous about experimental design and data interpretation?
- How to keep your records, share your data and materials, and be transparent in reporting?
- Consideration of relevant biological variables such as sex
- Authentication of key biological and/or chemical resources

PROFESSIONAL SKILLS

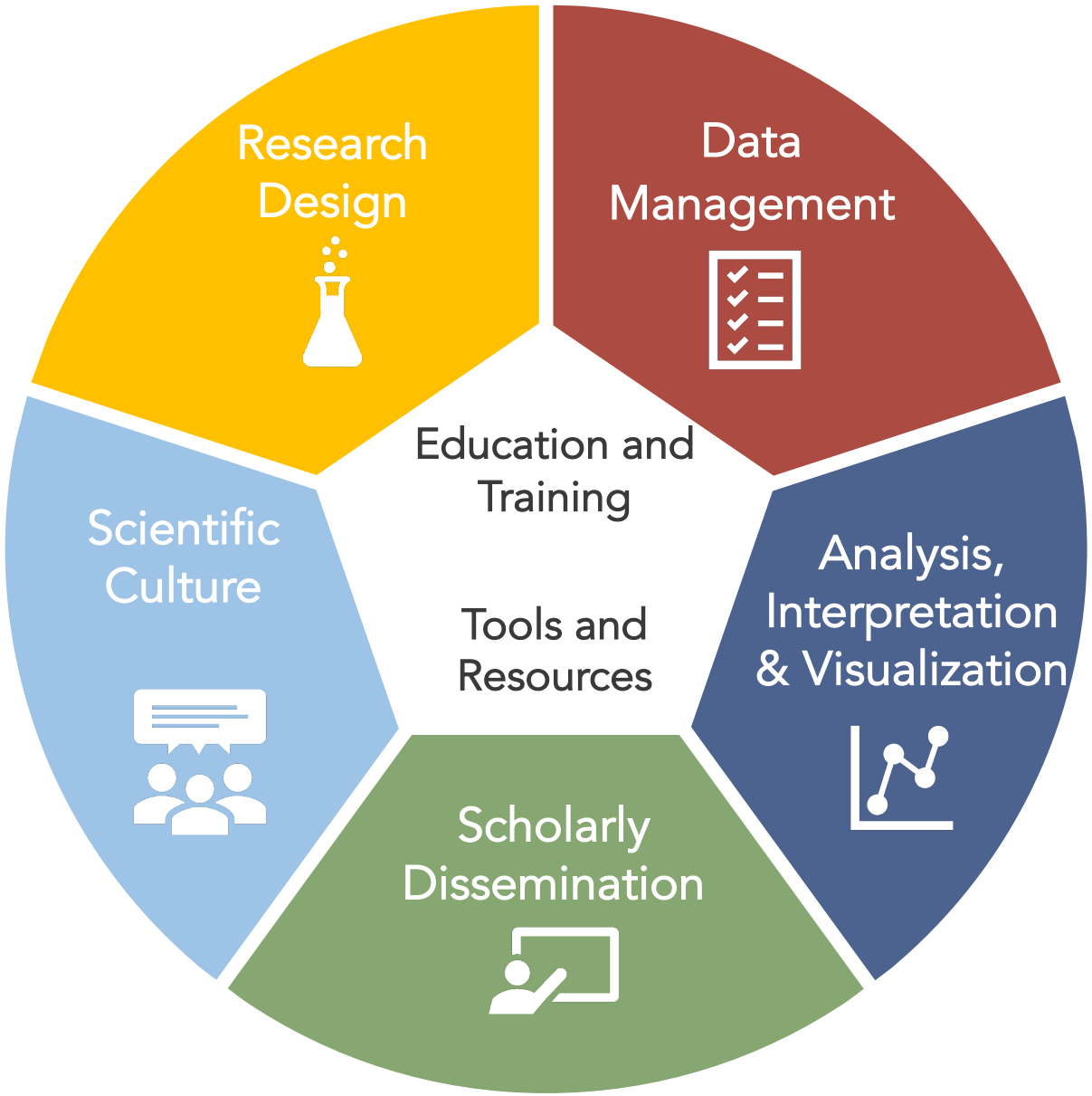
- How to be an effective science communicator?
- How to be a teacher?
- How to be a mentor?

- How to manage your projects?
- How to manage time?
- How to build your leadership skills?

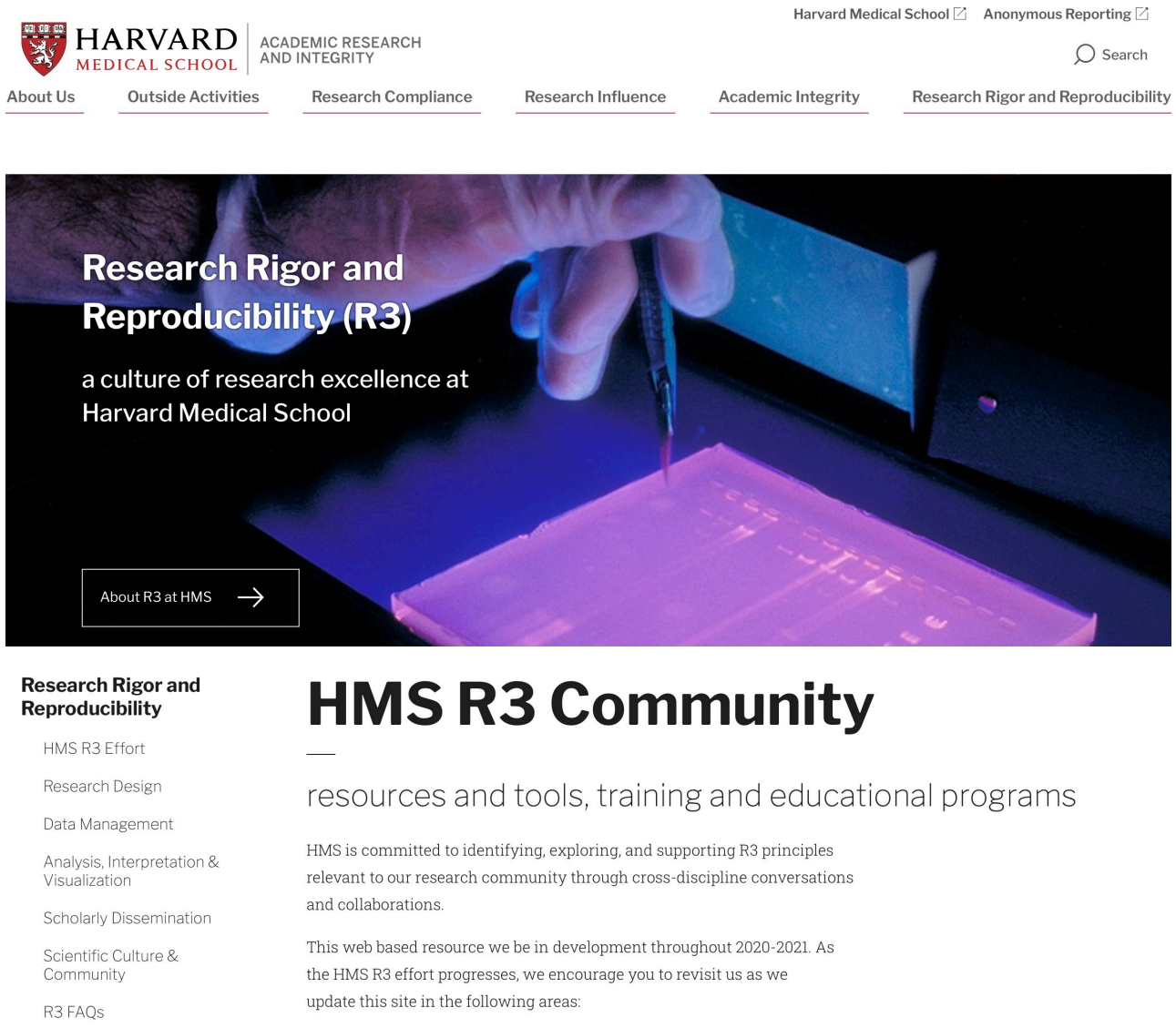
R3 effort at HMS

mission statement

Advances in modern biomedical research require the continuous development of and support for a culture that advances research rigor and reproducibility (R3). HMS is committed to **identifying, exploring, and supporting R3 principles relevant to our research community** through cross-discipline conversations and collaborations. The HMS R3 Committee will be responsible for identifying opportunities to further support R3, with **focus on organizational development, training and educational programs, and resources and tools** for our students, trainees, faculty, and staff to support the continued advancement of research excellence at HMS.



how does this benefit you



https://ari.hms.harvard.edu/hms-r3-community

R3 online portal | resource collection

Research Design →

Laying the groundwork for effective research endeavors

Data Management →

Foundations of sustainable research

Analysis Interpretation & Visualization →

Integrating research data and experimental results

Scholarly Dissemination →

Sharing your work with the research community

Scientific Culture & Community →

Recognizing and cultivating R3 efforts in our community

Frequently Asked Questions (FAQs) →

How can R3 can make a difference in your research efforts?