Science EXCHANGE

Order experiments from the world's best labs

Elizabeth Iorns, Ph.D
Founder & CEO

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@elizabethiorns

Science EXCHANGE

TRENDS IN RESEARCH

A rapidly changing industry

Science EXCHANGE

Wednesday, May 29, 2013

The Crisis of Research Funding in the US

Unreliable research

Trouble at the lab

Scientists like to think of science as self-correcting. To an alarming degree, it is not

Oct 17th 2013, 15:02 | From the print edition

PHARMA & HEALTHCARE 4/19/2012 @ 4:05PM | 31,531 views

Culture as a Culprit of the Pharma R&D Crisis

Bad Statistics, and Bad Training, Are Sabotaging Drug Discovery

Stewart Lyman | 1/6/14

Science policy

High Cost and Pace Driving Collaborative Science

Science, once siloed and hyper-competitive, is becoming increasingly collaborative the face of the high cost of research and the need for speed in discovery.

CROs globally employ more personnel than pharma and biotech companies

San Diego's Mini-Cluster of Virtual Biotechs Without Labs on High Bluff Drive

SCIENCE 345 COMMENTS

Billionaires With Big Ideas Are Privatizing American Science

By WILLIAM J. BROAD MARCH 15, 2014

71% of senior industry executives say their companies will increase the use of CROs in the next three years

Major trends

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ONLINE

COLLABORATIVE

VERIFIED

Trends: Online

ONLINE

Science EXCHANGE

“Software is eating the world”

Marc Andreessen
(Founder, Andreessen Horowitz)

THE WALL STREET JOURNAL.

Software is eating the world

Science EXCHANGE

amazon.com® *eats* **BOOKSTORES**

UBER *eats* **TAXIS**

EVERYONE'S PRIVATE DRIVER™

NETFLIX *eats* **HOME MOVIES**

Online research tools

Science EXCHANGE

Reputation

ResearchGate
Scientific Network

academia.edu

MENDELEY

Fundraising

GRANT SCOOP
Helping Scientists Find Funding

experiment

Design

Riffyn

Purchasing

antibodies-online.com

QUARTZY

Publishing

PeerJ

PLOS ONE

Research 2.0

Collaborating

Science EXCHANGE

Peer review

PUBLONS [1]
EVALUATING ACADEMIC RESEARCH

Data storage

figshare

box

Protocols/ELN

protocols.io

labguru
do more science

OSF

Online: Implications

- Real-time
  - potential for ‘open lab book science’
- Access to all information
  - including raw and analyzed data

    enables re-analysis of data
  - full protocols and unique identification of research reagents

    enables replication of experiments
- Wisdom of the crowd
  - poor quality products and results will be rapidly identified and flagged by the research community

    e.g. Antibodypedia / Knoepfler Lab Stem Cell Blog

Trends: Collaborative

COLLABORATIVE

Trends: Collaborative

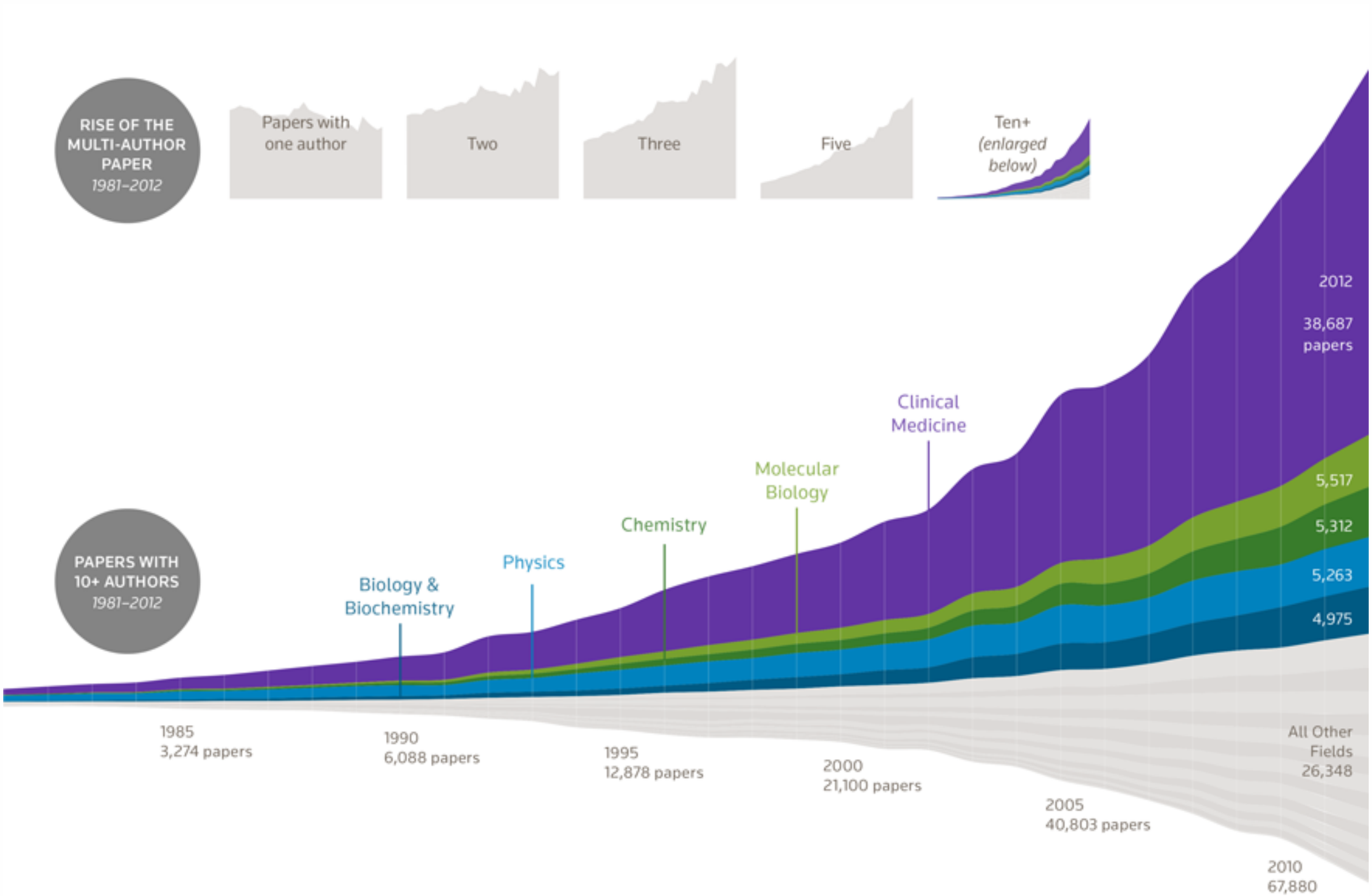
Science policy

High Cost and Pace Driving Collaborative Science

Science, once siloed and hyper-competitive, is becoming increasingly collaborative in the face of the high cost of research and the need for speed in discovery.

The Economist

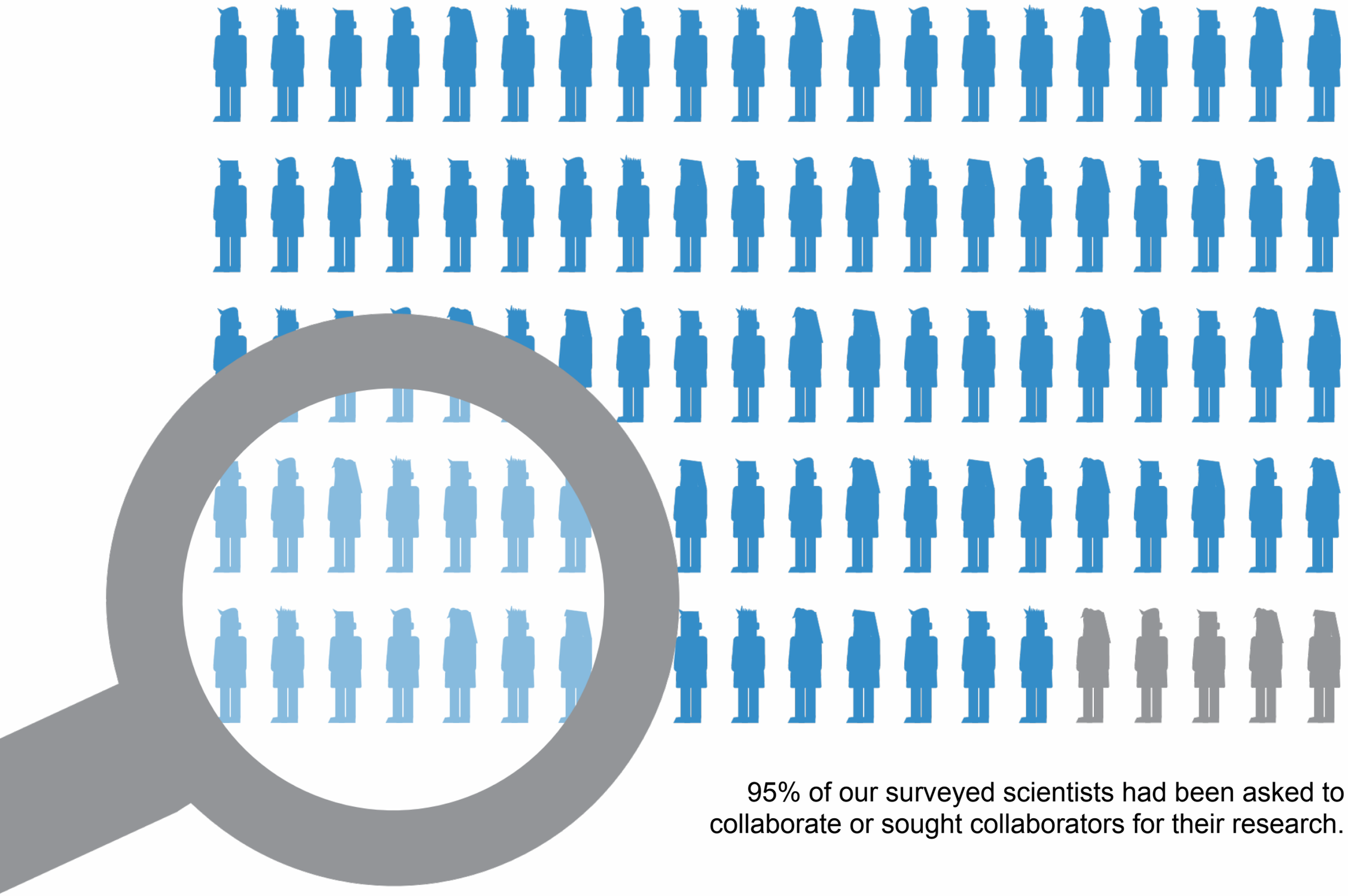
Collaboration is increasingly important



Source: http://ar.thomsonreuters.com/story3.html

Collaboration is increasingly important

Science EXCHANGE



95% of our surveyed scientists had been asked to collaborate or sought collaborators for their research.

Why do scientists collaborate?

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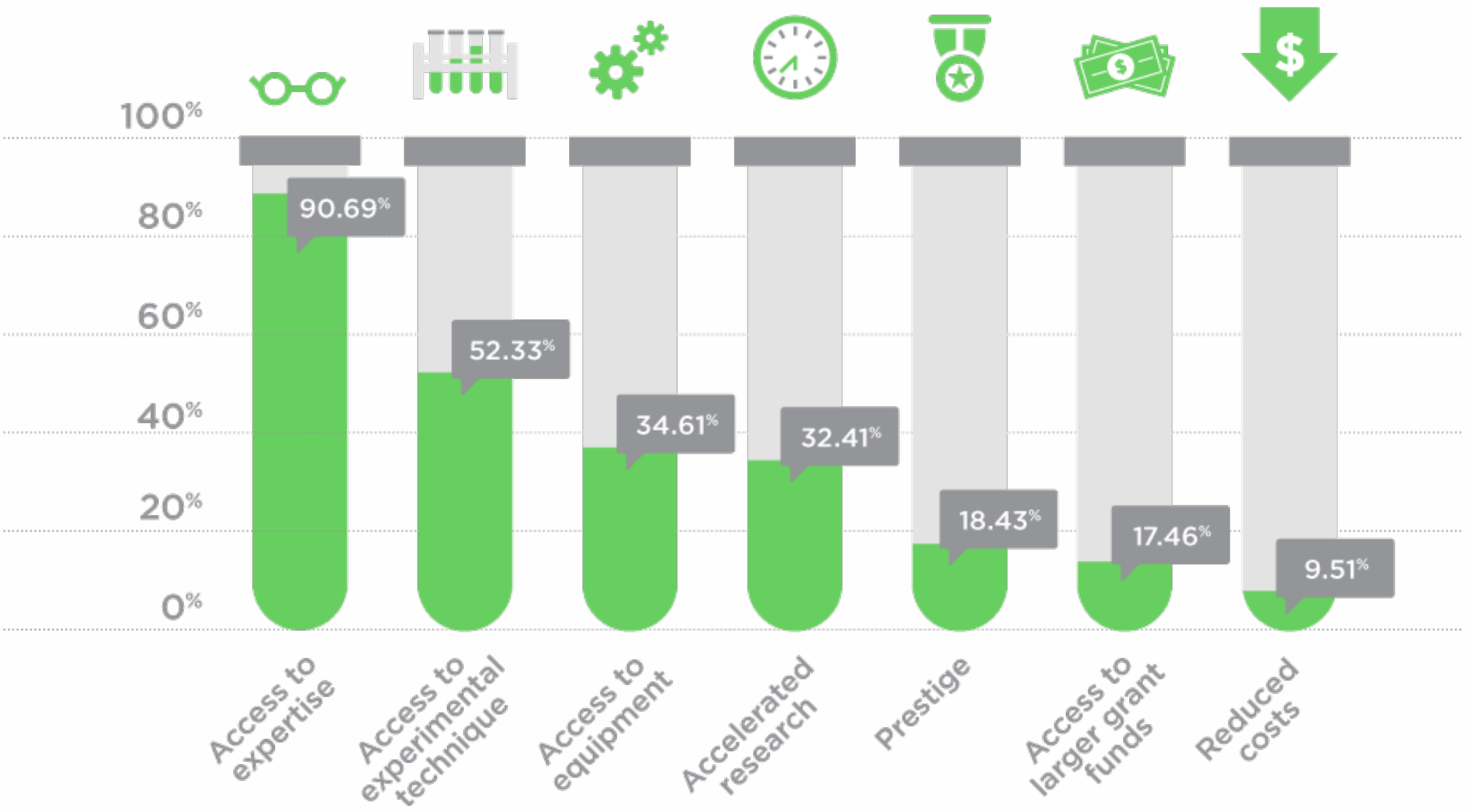

Why do scientists collaborate?

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To access specialized equipment and expertise

Why do scientists collaborate?

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Journal content

- Journal home
- Advance online publication
- Current issue
- Nature News
- Archive
- Supplements
- Web focuses

Letter

Nature **464**, 431-435 (18 March 2010) | doi:10.1038/nature08833; Received 29 September 2009; Accepted 18 January 2010; Published online 3 February 2010

RAF inhibitors prime wild-type RAF to activate the MAPK pathway and enhance growth

Georgia Hatzivassiliou[1], Kyung Song[1], Ivana Yen[1], Barbara J. Brandhuber[2], Daniel J. Anderson[1], Ryan Alvarado[1], Mary J. C. Ludlam[1], David Stokoe[1], Susan L. Gloor[2], Guy Vigers[2], Tony Morales[2], Ignacio Aliagas[1], Bonnie Liu[1], Steve Sideris[1], Klaus P. Hoeflich[1], Bijay S. Jaiswal[1], Somasekar Seshagiri[1], Hartmut Koeppen[1], Marcia Belvin[1], Lori S. Friedman[1] & Shiva Malek[1]

Author Contributions G.H. and S.M. designed the studies, interpreted the data and wrote the manuscript. K.S., I.Y., B.L., S.S. and D.S. conducted cellular experiments and dimerization assays. D.J.A., M.J.C.L. and R.A. conducted microscopy experiments. B.J.B., G.V., T.M. and I.A. conducted crystallography and provided structural input. S.L.G. conducted enzymology. K.P.H. and H.K. conducted *in vivo* experiments and immunohistochemistry. B.S.J. and S.S. generated inducible shRNA cell lines. M.B. and L.S.F. interpreted the data and wrote the manuscript.

How do scientists collaborate?

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Barter for potential future co-authorship

How do scientists collaborate?

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But bartering is:

- Inefficient

- time intensive to find and convince a professional colleague to help

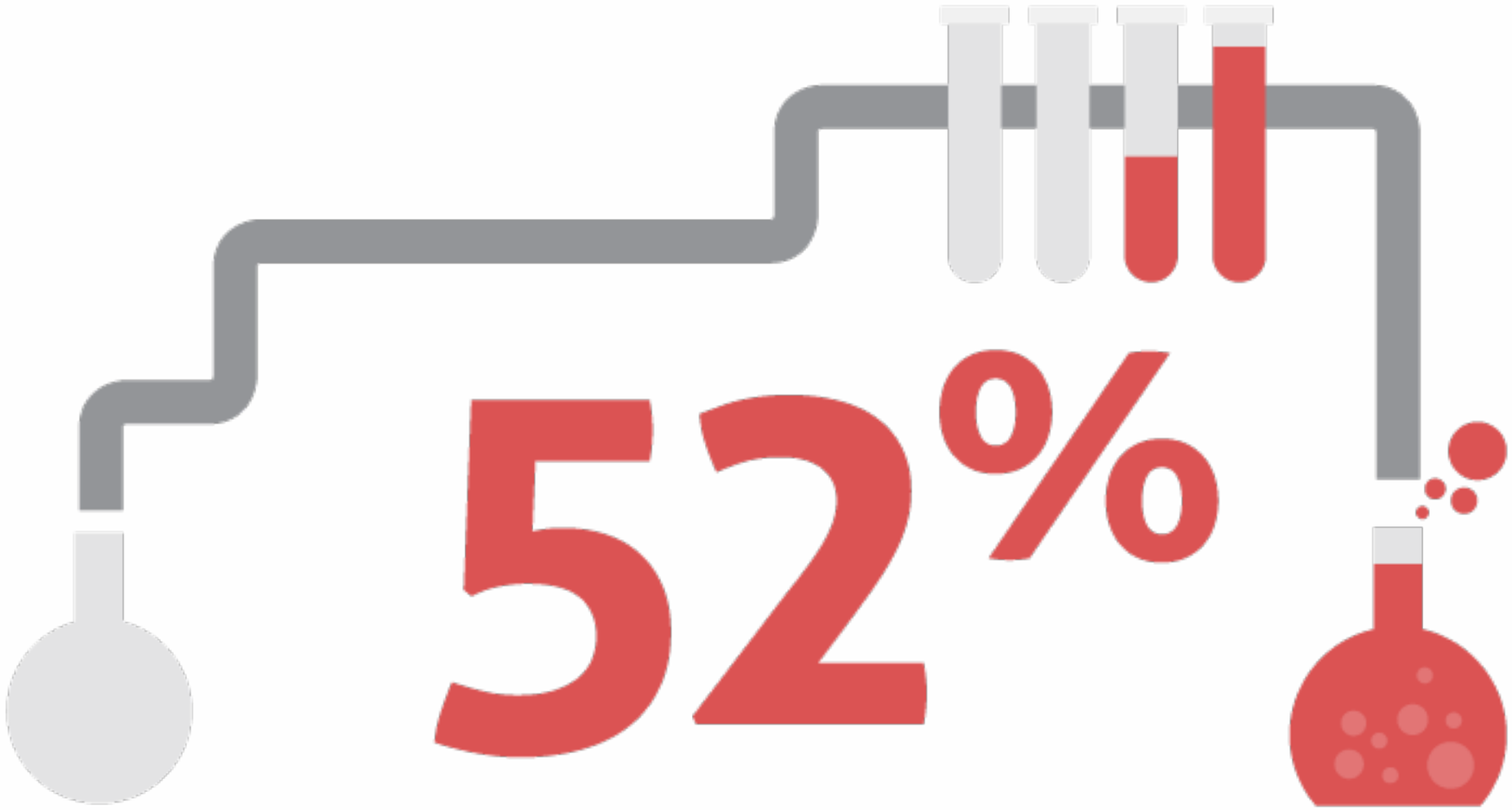
- Unscalable

- maintaining a professional network large enough to contain all expertise required

- Poor incentives

- may not incentivize best experts to conduct experiments

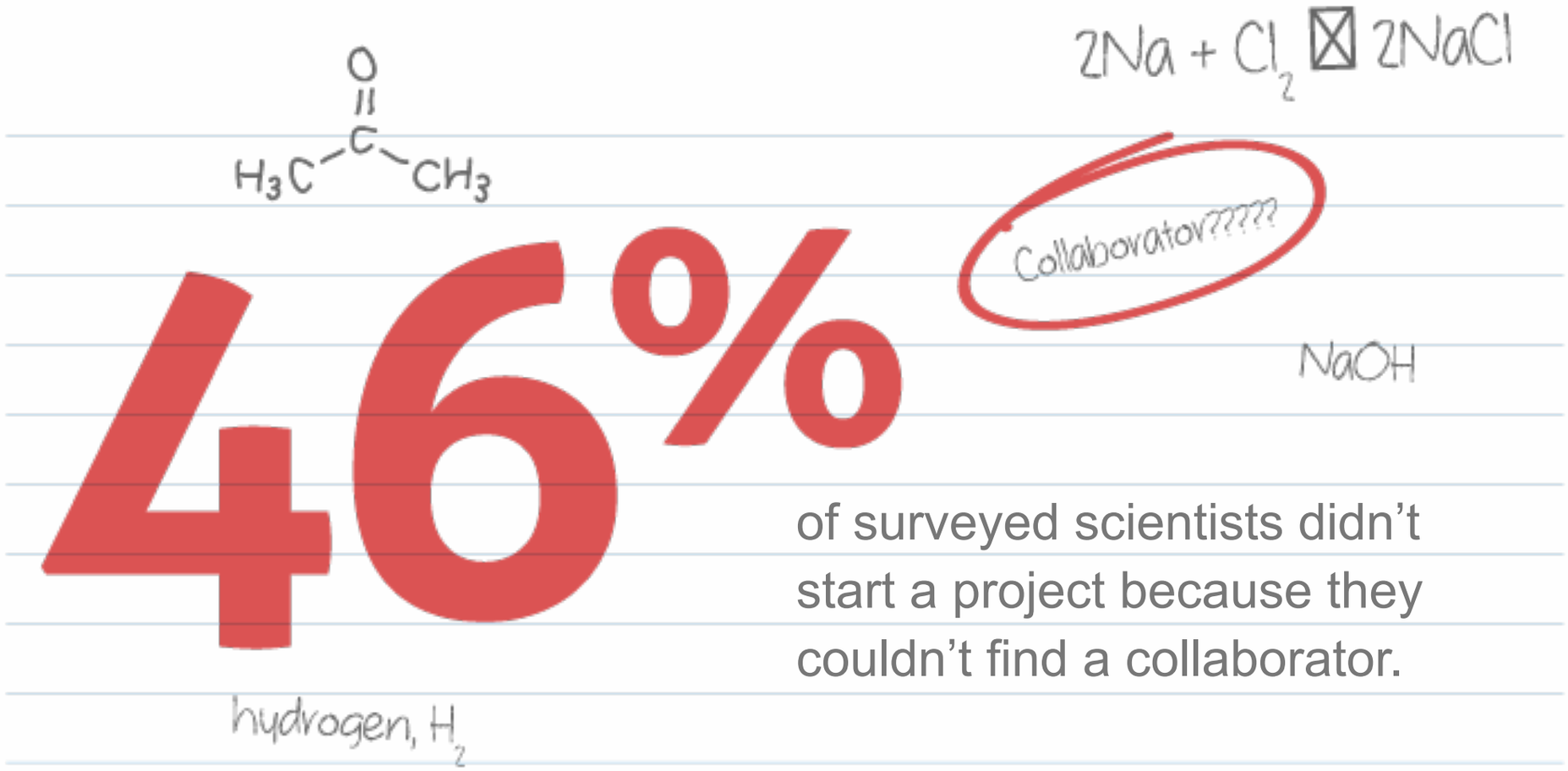
Collaboration has poor incentives



of surveyed scientists have felt that collaboration was one-sided.

Source: Science Exchange Collaboration Survey 2014

Collaboration has poor incentives

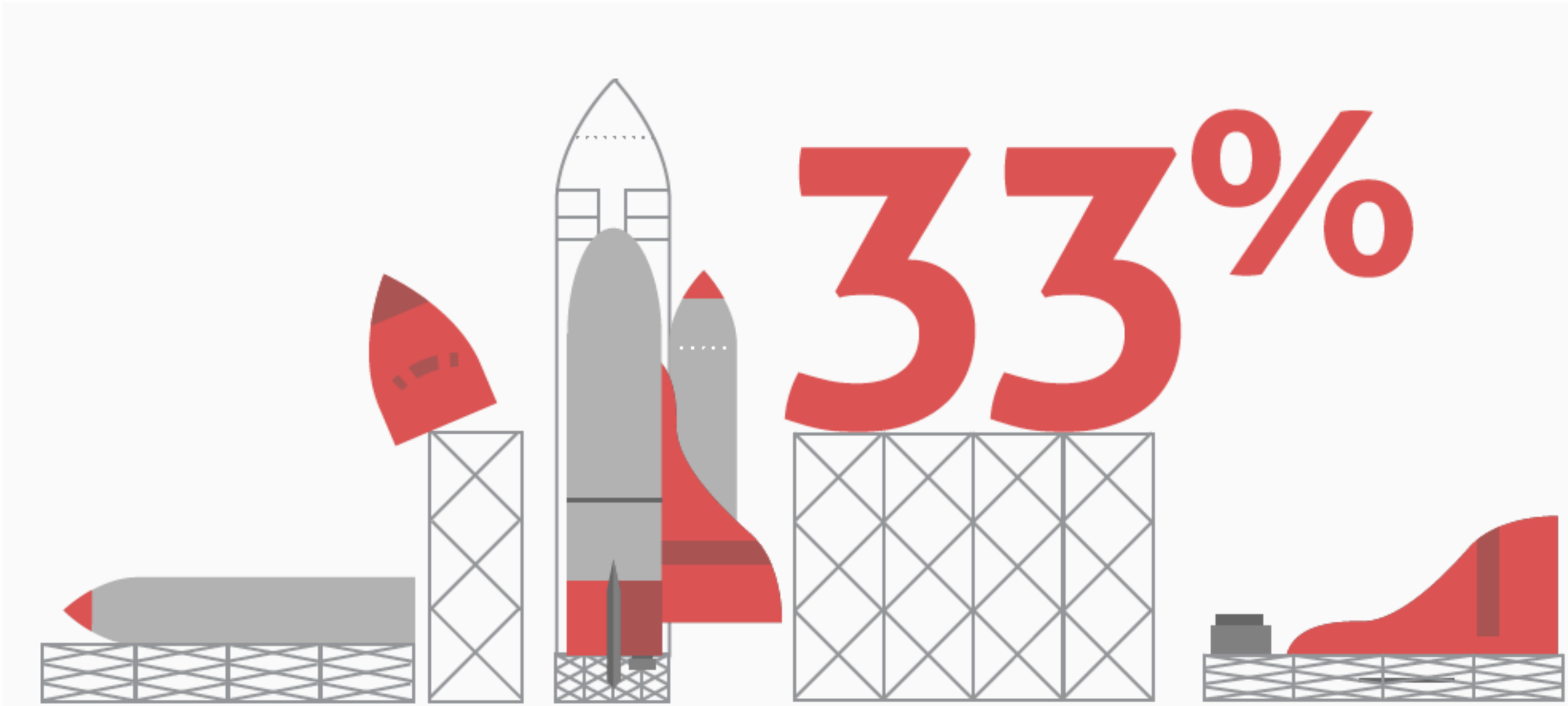


46%

of surveyed scientists didn't start a project because they couldn't find a collaborator.

Source: Science Exchange Collaboration Survey 2014

Collaboration has poor incentives



Source: Science Exchange Collaboration Survey 2014

Marketplace for collaboration

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Demand Side

NASA

MERCK

OncoSynergy

PerlsteinLab

SANOFI

Yale UNIVERSITY

STANFORD SCHOOL OF MEDICINE
Stanford University Medical Center

NIH National Institute on Drug Abuse
The Science of Drug Abuse & Addiction

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IP agreements; Shipping;
Communication; Data transfer;
Customer support; Payment

Supply Side

NYU

UC DAVIS
UNIVERSITY OF CALIFORNIA

INDIANA UNIVERSITY

OREGON HEALTH & SCIENCE UNIVERSITY

ASU ARIZONA STATE UNIVERSITY

HARVARD MEDICAL SCHOOL

UF UNIVERSITY of FLORIDA

CASE WESTERN RESERVE UNIVERSITY

UMASS LOWELL

JOHNS HOPKINS UNIVERSITY

Researchers

Academics; Government;
Biotech & industry; Citizen scientists

Labs

CROs; Core Facilities;
individual scientists

Solution

Science EXCHANGE

REVEAL BIOSCIENCES

NORTHWESTERN UNIVERSITY

NEW YORK UNIVERSITY

INDIANA UNIVERSITY

SUNY The State University of New York

THE UNIVERSITY OF TOLEDO 1872

UCDAVIS UNIVERSITY OF CALIFORNIA

UNIVERSITY OF MARYLAND

Simplifies collaboration to ordering an experiment from the world's best labs

UNIVERSITY

EST. 1826 UNIVERSITY

WAYNE STATE UNIVERSITY

BOSTON UNIVERSITY

UNIVERSITY OF Nebraska Medical Center

UCLA

UF UNIVERSITY of FLORIDA

IDAHO STATE UNIVERSITY

VirginiaTech

PENNSTATE

Consequences of greater collaboration

Science EXCHANGE

Speed

Distributed research
Collaborating with experts enables distributed research

Cost

Access the most cost effective expert
No investment in training/infrastructure required

Control

Maintain ownership
IP and confidentiality protected

Quality

Specialists for specialized research
Network of verified specialist labs ensures quality

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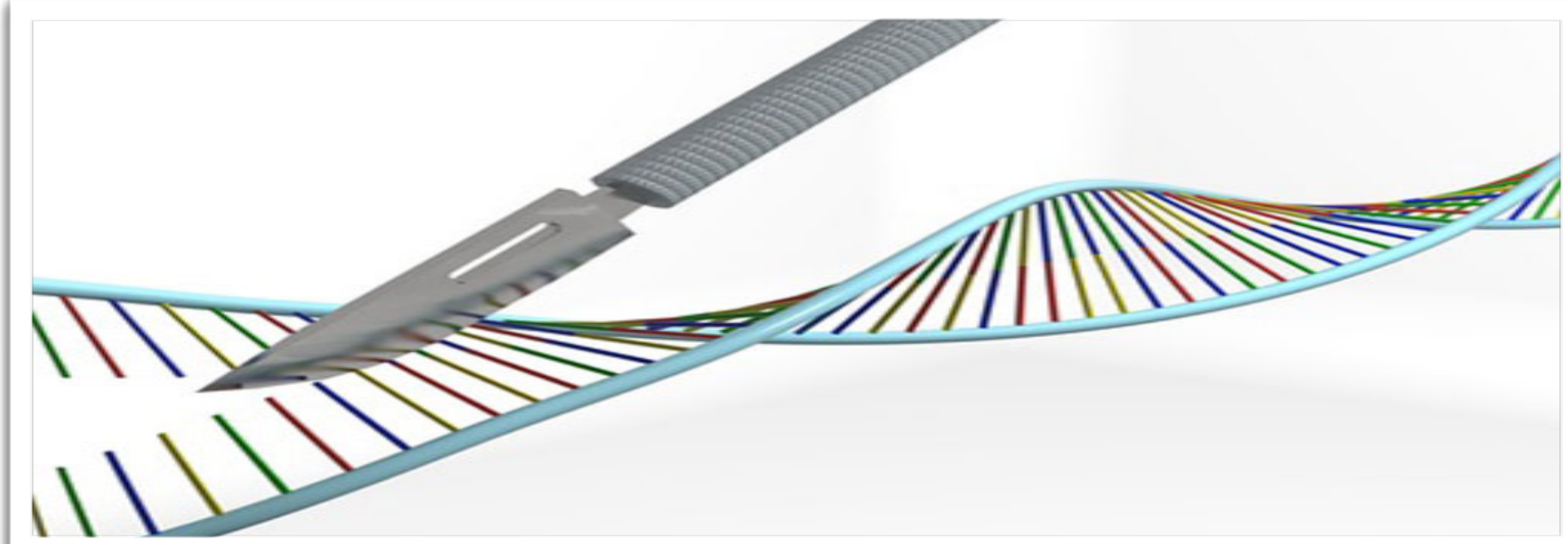
Science EXCHANGE

Platforms like Science Exchange provide one point of contact for a vast network of contract labs allowing research to be distributed and parallelized

Speed

Greater use of experts also enables more rapid adoption of new technologies (e.g. Illumina HiSeq X Ten and CRISPR now widely available)



Consequences of greater collaboration

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Cost

Specialists can be more cost effective than in-house

In House Methods

Doing experiments in house can be costly and time consuming. The cost of reagents have been obtained from major reagent suppliers. Labor costs have been ascertained by the university standard

Reagents

Reagent	Cost (per sample)
RNeasy Maxi Kit	$27.00
2-Mercaptoethanol	$0.19
Ethanol	$12.86
RNase free tips	$10.20
RNase free eppendorf	$0.10

Total cost of reagents for 1 sample = $50.35

Labor

Cost of Post Doc's Labor for 1 hour = $21.00

Total cost: + $71.35

Science Exchange

Science Exchange allows you to browse and post projects in over 2000 categories for free. The labs listed are the world's best and are commited to providing expertise in knowledge and techniques.

Browse

Browse over 40 labs for RNA Extraction services

Order

Save your time and money by ordering from one of the world's best labs!

Total cost: + $10.00

Save **86%** on RNA Extraction by using Science Exchange

Consequences of greater collaboration

Science EXCHANGE

Speed

Distributed research
Collaborating with experts enables distributed research

Cost

Access the most cost effective expert
No investment in training/infrastructure required

Control

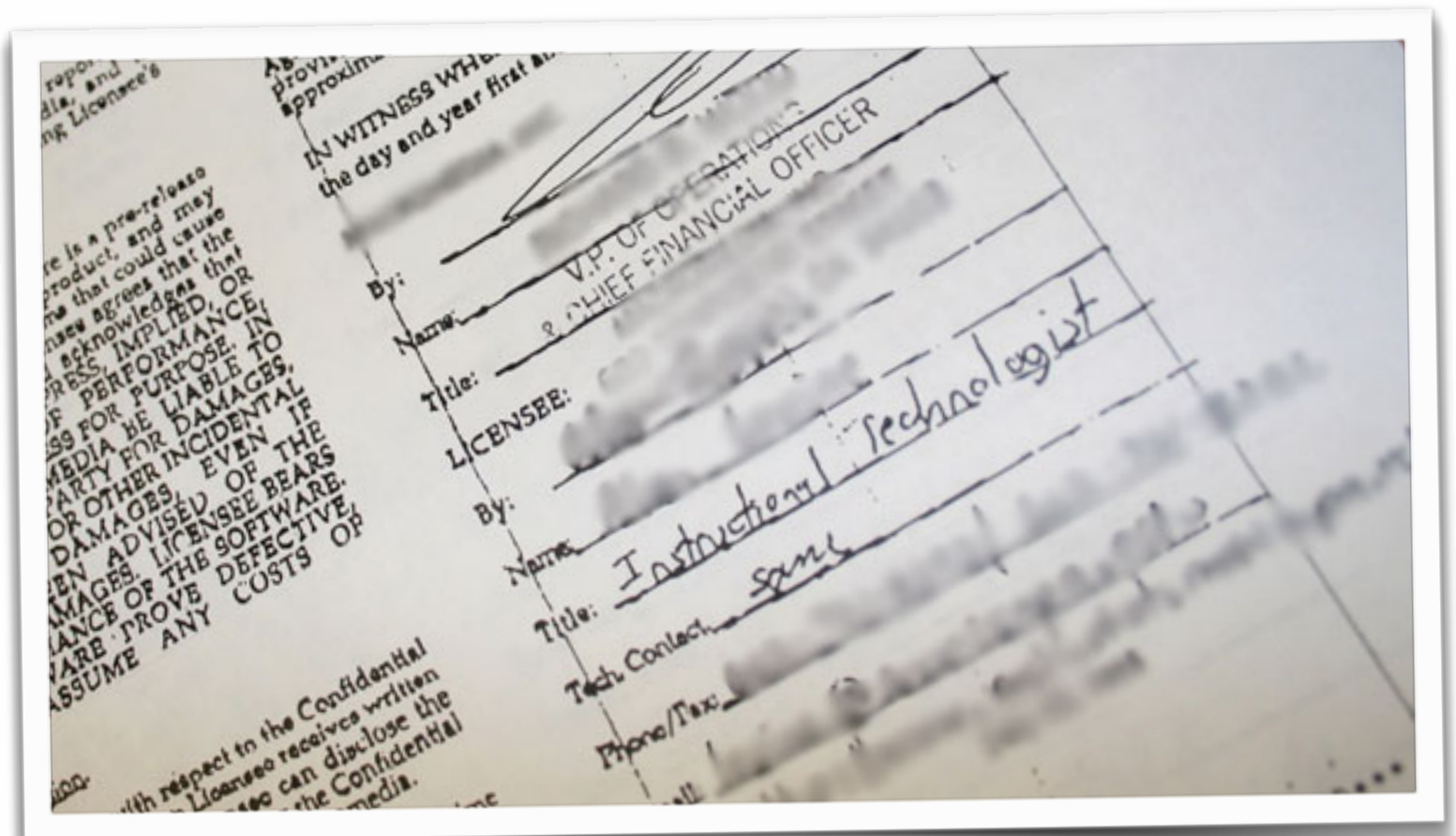
Maintain ownership
IP and confidentiality protected

Quality

Specialists for specialized research
Network of verified specialist labs ensures quality

Control

IP and confidentiality agreements with expert labs protects research



Consequences of greater collaboration

Science EXCHANGE

Speed

Distributed research
Collaborating with experts enables distributed research

Cost

Access the most cost effective expert
No investment in training/infrastructure required

Control

Maintain ownership
IP and confidentiality protected

Quality

Specialists for specialized research
Network of verified specialist labs ensures quality

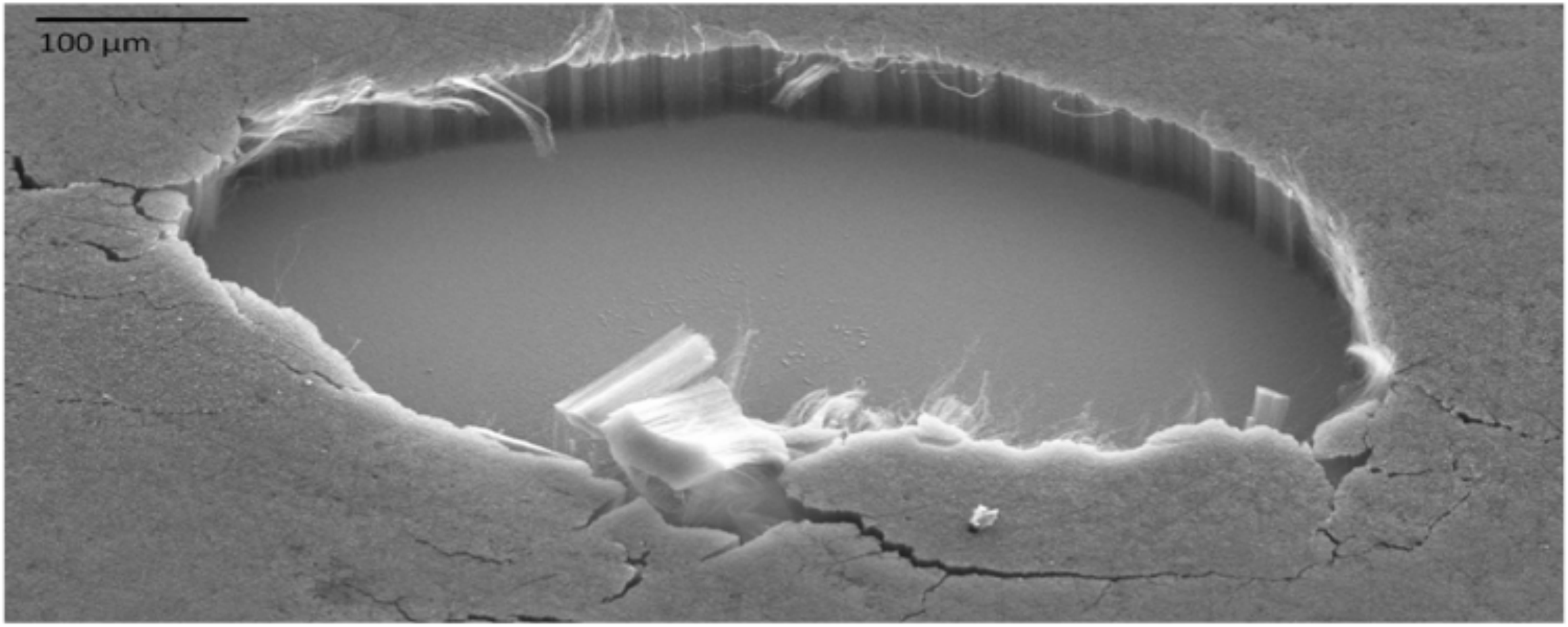
Quality

Science EXCHANGE

Using expert verified labs ensures high quality research

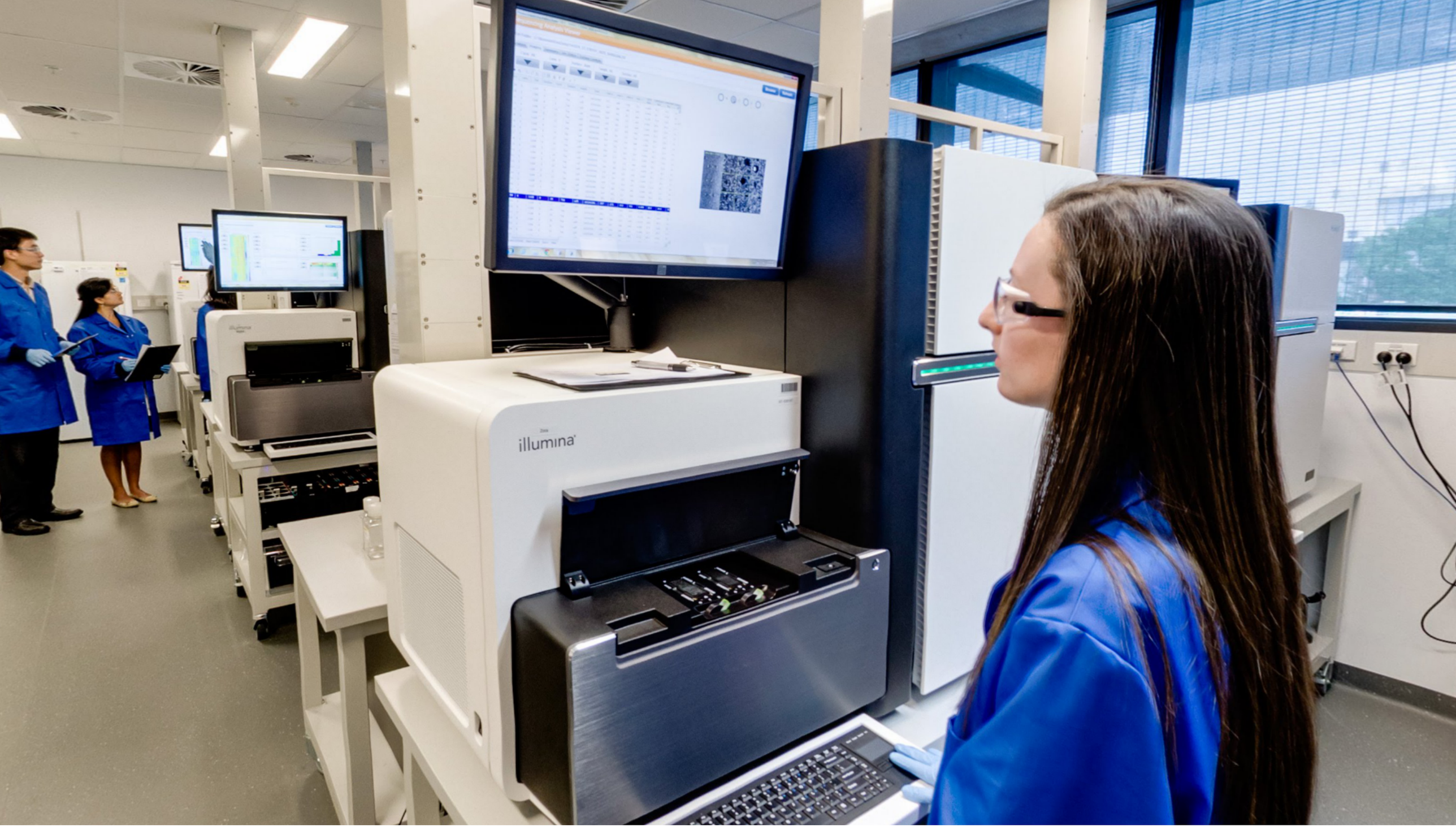
Australian National Fabrication Facility

Services offered:
Chemical vapor deposition (CVD), Electron beam lithography (EBL), Focused ion beam tomography (FIB), Flip-chip bonding, Inductively coupled plasma etching, Digital Holographic microscopy and 80 others



2011-2013: NASA (unsuccessfully) attempts to increase the blackness of their nanotubes in order to improve the robustness and application of nanotube technology (at a cost of several million dollars).

2013: Through a collaboration formed via Science Exchange, NASA was able to produce carbon nanotube forests – the blackest materials ever measured. Project cost $3,000 and took 3 months.



Kinghorn Centre for Clinical Genomics

Services offered:
Illumina next generation sequencing, Whole genome sequencing, Bioinformatics

WIRED

Jan 15th: “Illumina’s HiSeq X Ten Sequencing System will prove affordable for only a few. The system...costs a whopping $10 million.”

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Feb 8th: HiSeq X Ten at Kinghorn Center for Clinical Genomics listed on Science Exchange and available to any researcher in the world

Sanford Burnham Medical Research Institute

Services offered:
Viral research BSL4; in vitro and in vivo experimentation; lentiviral, retroviral and adenoviral viral vector production

Can We Defeat EBOLA with an Experimental CANCER Drug?

Dr. W. Shawn Carbonell | Dr. Elizabeth Iorns
OncoSynergy, Inc.

Open Access

$5,031
Pledged

100%	$5,000	0
Funded	Goal	Days

Success! This project was funded on 21 September 2014

OncoSynergy

Aug 22nd: OncoSynergy discovers cancer drug (OS2966) targets the same pathway used by the ebola virus to infect cells. Starts crowdfunding project.

Science EXCHANGE

Oct 10th: Work starts with a BSL4 certified lab at Sanford Burnham Medical Institute to test whether OS2966 can be used as a treatment for ebola. Initial results show OS2966 is a potent inhibitor of ebola entry.

Collaborative: Implications

- Improvement of data quality through use of experts
- Need for tools to facilitate collaboration, workflow provenance, data integrity and sharing between collaborators
- Researchers will develop professional brands around technical expertise

Trends: Verified

VERIFIED

Trends: Verified

VERIFIED

“One of the most important principles of the scientific method is reproducibility, the ability to replicate an experimental result.”

The scientific method

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Scientific method

From Wikipedia, the free encyclopedia

"Scientific study" redirects here. For observational studies, see observational study.

The **neutrality of this article is disputed**. Relevant discussion may be found on the talk page. Please do not remove this message until the dispute is resolved. *(January 2013)*

The **scientific method** is a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge.[1] To be termed scientific, a method of inquiry must be based on empirical and measurable evidence subject to specific principles of reasoning.[2] The *Oxford English Dictionary* defines the scientific method as: "a method or procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses."[3]

The chief characteristic which distinguishes the scientific method from other methods of acquiring knowledge is that scientists seek to let reality speak for itself,[*discuss*] supporting a theory when a theory's predictions are confirmed and challenging a theory when its predictions prove false. Although procedures vary from one field of inquiry to another, identifiable features distinguish scientific inquiry from other methods of obtaining knowledge. Scientific researchers propose hypotheses as explanations of phenomena, and design studies to test these hypotheses via predictions which can be derived from them. These steps must be repeatable, to g[uider experimenter. Theories that encompass wider domains of inquiry may bind many indepen[dently derive]. Theories, in turn, may help form new hypotheses or place groups of hypothe[ses into context.

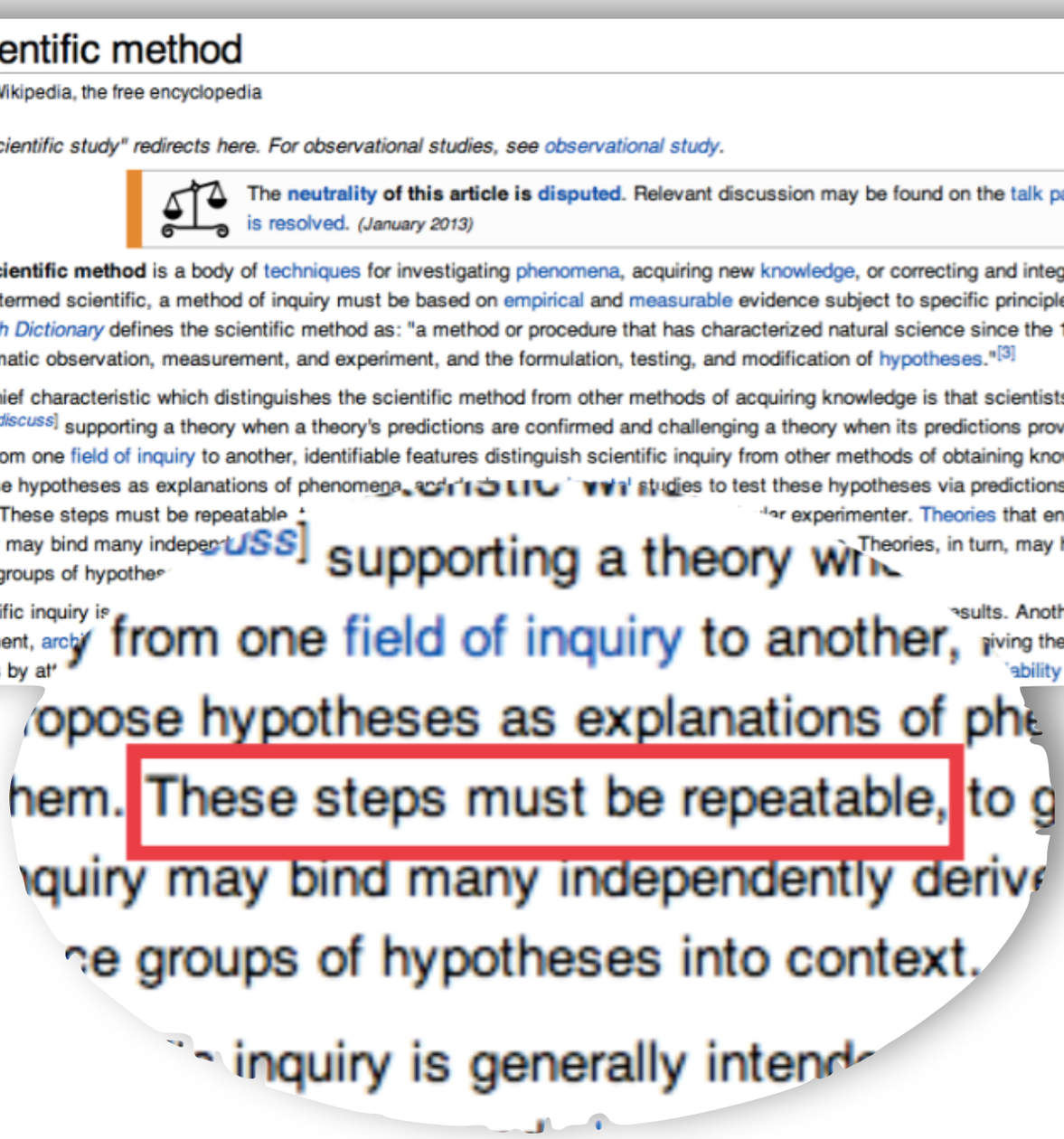
Scientific inquiry is[generally intend]ed to be as objective as possible, to reduce biased interpretations of the results. Another basic expectation is to document, archi[ve all data and methods] giving them the opportunity to verify results by at[tempting to recreate the] ability of these data to be established (when data is sampled or compared to chance).

Part of a series on **Science**

- Formal sciences [show]
- Physical sciences [show]
- Life sciences [show]
- Social sciences [show]
- Applied sciences [show]
- Interdisciplinarity [show]
- Philosophy and history of science [show]

Outline · Portal · Category

v · t · e



Reproducibility

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Reproducibility

From Wikipedia, the free encyclopedia

Reproducibility is the ability of an entire experiment or study to be reproduced, either by the researcher or by someone else working independently. It is one of the main principles of the scientific method. The result values are said to be *commensurate* if they are obtained (in distinct experimental trials) according to the same reproducible experimental description and procedure.

Reproducibility is determined from controlled interlaboratory test programs.[3][4]

Reproducibility

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Are published results reproducible?

Reproducibility

Science EXCHANGE

Are published results reproducible?

Unreliable research

Trouble at the lab

Scientists like to think of science as self-correcting. To an alarming degree, it is not

Oct 17th 2013, 15:02 | From the print edition

Reproducibility problems

RESEARCH ARTICLE

VIEWS | ACADEMIC BOOKMARKS | SI

A Survey on Data Reproducibility in Cancer Research Provides Insights into Our Limited Ability to Translate Findings from the Laboratory to the Clinic

Aaron Mobley, Suzanne K. Linder, Russell Braeuer, Lee M. Ellis, Leonard Zwelling

Methods and Findings

To examine a microcosm of the academic experience with data reproducibility, we surveyed the faculty and trainees at MD Anderson Cancer Center using an anonymous computerized questionnaire; we sought to ascertain the frequency and potential causes of non-reproducible data. We found that ~50% of respondents had experienced at least one episode of the inability to reproduce published data; many who pursued this issue with the original authors were never able to identify the reason for the lack of reproducibility; some were even met with a less than "collegial" interaction.

http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0063221

Reproducibility problems

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ALSTDI
ALS Therapy Development Institute

Re-tested 70+ drugs from 221 independent studies[1]

➜ 0 reproduced

➜ Minocycline: effective in four separate ALS mouse studies worsened symptoms in a clinical trial of more than 400 patients[2]

National Institute of Neurological Disorders and Stroke
National Institutes of Health

Sponsored replication of 12 spinal cord injury studies

➜ 2/12 fully reproduced[3]

BAYER Bayer

Conducted in-house target validation studies

➜ 14/67 reproduced[4]

AMGEN®

Attempted to reproduce 53 “landmark” oncology publications

➜ 6/53 reproduced[5]

1. Scott et al. Amyotroph Lateral Scler. 9, 4-15 (2008).
2. Gordon et al. Lancet Neurol. 6, 1045–1053 (2007).
3. Stuart et al. Experimental Neurology 233, 597–605 (2012).
4. Prinz et al. Nat Rev Drug Discov. 10, 712 (2011).
5. Begley and Ellis. Nature. 483, 531-3 (2012).

Reproducibility problems

Science EXCHANGE

Are published results reproducible?

Not always

Reproducibility problems

Science EXCHANGE

But doesn’t the literature correct itself?

Reproducibility problems

Science EXCHANGE

But doesn’t the literature correct itself?

Not often

Self correction

Retraction?

- Only 0.2% of the literature (vs 70%+ irreproducibility)

Negative findings?

- Less than 30% of researchers who could not reproduce published findings published their failure[1]
- Only 14% of the literature reports any negative results[2]

Additional publications?

"We didn't see that a target is more likely to be validated if it was reported in ten publications or in two publications"[3]

Example: Retraction of PLOS[4] and Science[5] papers by Pamela Ronald at UC Davis

- Self retraction due to reagent error
- Results had been 'confirmed' independently by three other groups[6-8]

1. Mobley et al. PLOS ONE. 8, e63221 (2013)
2. Fanelli. Scientometrics. 90, 891 (2012)
3. Prinz et al. Nat Rev Drug Discov. 10, 712 (2011)
4. Han et al. PLOS ONE. 6, e29192 (2011)
5. Lee et al. Science. 326, 850 (2009)
6. McCarthy et al. J Bacteriology. 193, 6375 (2011)
7. Shuguo et al. Appl Biochem Biotechnol. 166, 1368 (2012)
8. Qian et al. J Proteome Res. 12, 3327 (2013)

Citations

What about citations?

None of the replication studies reported have found any correlation with citations (or journal impact factor):

- NINDS - No significant difference[1]
- Bayer - No significant difference[2]
- Amgen - *"We saw no significant difference in citation rates between papers that were reproducible versus non-reproducible"*[3]

1. Stuart et al. Experimental Neurology 233, 597–605 (2012).
2. Prinz et al. Nat Rev Drug Discov. 10, 712 (2011).
3. Begley and Ellis. Nature. 483, 531-3 (2012).

Reproducibility problems

Many published results may be irreproducible and we do not have a mechanism to identify reproducible results

Reproducibility problems

"As a funding agency, the NIH is deeply concerned about this problem."

Francis S. Collins (Director, NIH)
Lawrence A. Tabak (Deputy Director, NIH)

nature

Reproducibility solution

Science EXCHANGE

nature
International weekly journal of science

NATURE | COLUMN: WORLD VIEW

عربي

Jocelyn Filley

If a job is worth doing, it is worth doing twice

Researchers and funding agencies need to put a premium on ensuring that results are reproducible, argues Jonathan F. Russell.

03 April 2013

Reproducibility solution

Science EXCHANGE

Verify key results by independent replication

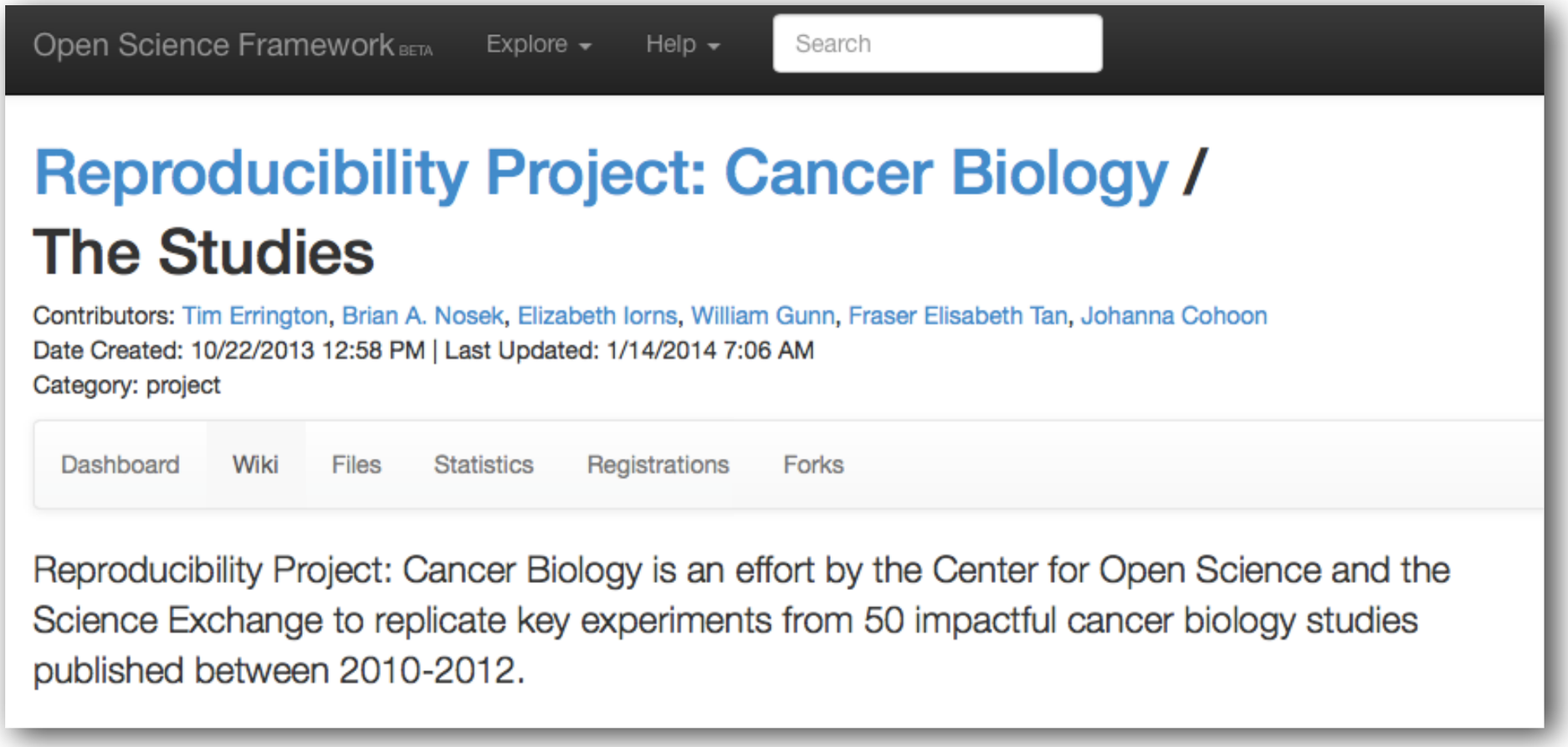
RP: Cancer Biology

Reproducibility Project: Cancer Biology

RP: Cancer Biology

Project 1. Reproducibility Project: Cancer Biology

Independently replicating key experimental results from the top 50 cancer biology studies from 2010-2012



Learn more at cos.io/cancerbiology

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Goals:

- Show direct replication is possible in a cost-effective and scalable manner
- Demonstrate replication studies provide an approach to identify reproducible results
- Generate an open dataset of high value replicated studies
- Identify best practices that maximize reproducibility

Track progress at cos.io/cancerbiology

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Selection:

- 50 studies from 2010, 2011, 2012
- most cited for cancer biology related terms in WoS and Scopus
- retrieved Mendeley readers and altmetric.com data & ranked by combined score
- excluded reviews, clinical trials, case studies, sequencing papers

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Replication:

- Identify key experiments
    - no initial exploratory work ensures timeliness and cost effectiveness
- Conduct a direct replication (using the same materials and methods as closely as possible, including any additional controls as necessary)
- Obtain input from the original author on proposed replication protocols
- Pre-register and peer review protocols and analysis plans
- Use power calculations to ensure replication sample size is sufficient to detect the reported effect with at least 80% power
- Use expert, independent labs with extensive expertise in the techniques being replicated
- Publish all protocols, results, and data in the Open Science Framework for review by any interested party

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Status:

- Replication experiments are currently underway for 9 studies
- Registered reports are currently being peer reviewed for 12 studies
- Awaiting information from authors and/or labs for remaining studies

RP: Cancer Biology

http://elifesciences.org/collections/reproducibility-project-cancer-biology

The Reproducibility Project: Cancer Biology is a collaboration between the Center for Open Science and Science Exchange to independently replicate selected results from 50 papers in cancer biology. For each paper a Registered Report detailing the proposed experimental designs and protocols for the replications is peer reviewed and published prior to data collection. The results of these experiments will be published in a Replication Study. The project will provide evidence about reproducibility in cancer biology, and an opportunity to identify factors that influence reproducibility more generally.

Articles

HUMAN BIOLOGY AND MEDICINE

Discovery and Preclinical Validation of Drug Indications Using Compendia of Public Gene Expression Data

ORIGINAL ARTICLE

M Sirota, JT Dudley, J Kim, AP Chiang, AA Morgan, A Sweet-Cordero, J Sage, AJ Butte

Science Translational Medicine 2011;3:96ra77
10.1126/scitranslmed.3001318

REGISTERED REPORT

May 5, 2015

Irawati Kandela, Ioannis Zervantonakis, Reproducibility Project: Cancer Biology

eLife 2015;4:e06847
10.7554/eLife.06847

HUMAN BIOLOGY AND MEDICINE | MICROBIOLOGY AND INFECTIOUS DISEASE

Intestinal inflammation targets cancer-inducing activity of the

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

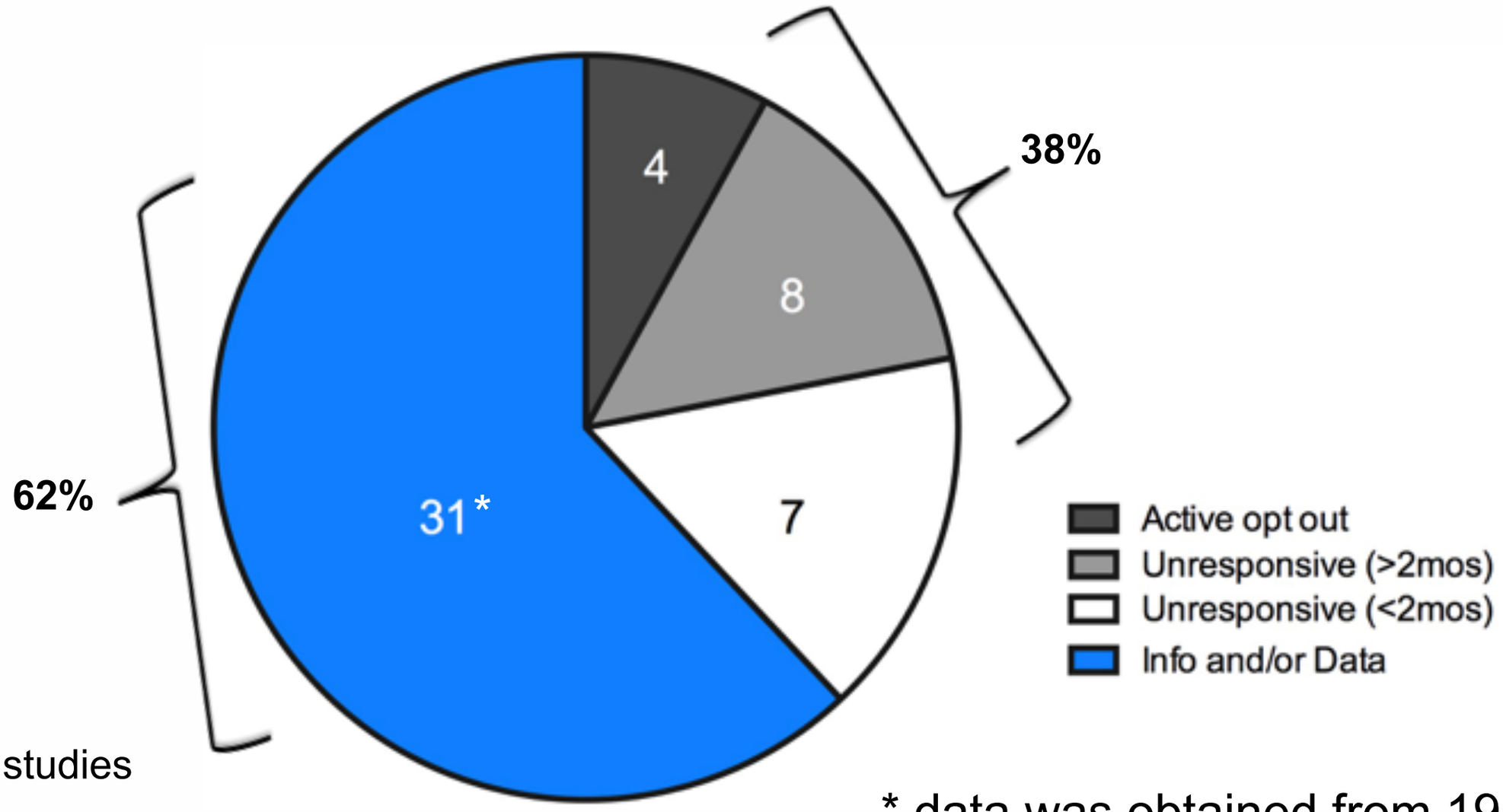
Key learnings to date:

- Publications have insufficient documentation to enable replication or follow on studies
  - all studies required additional information from original authors
  - frequently the only author with the required knowledge is the first author and they are often not able to be contacted
- Reagents are often not uniquely identified, not available or cannot be easily shared due to bureaucratic MTA requirements
  - need for centralized repositories and deposition requirements for research materials
- Raw data is infrequently stored or available
  - need for data repositories linked to published figures
- Replications are cost effective

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Author responsiveness:

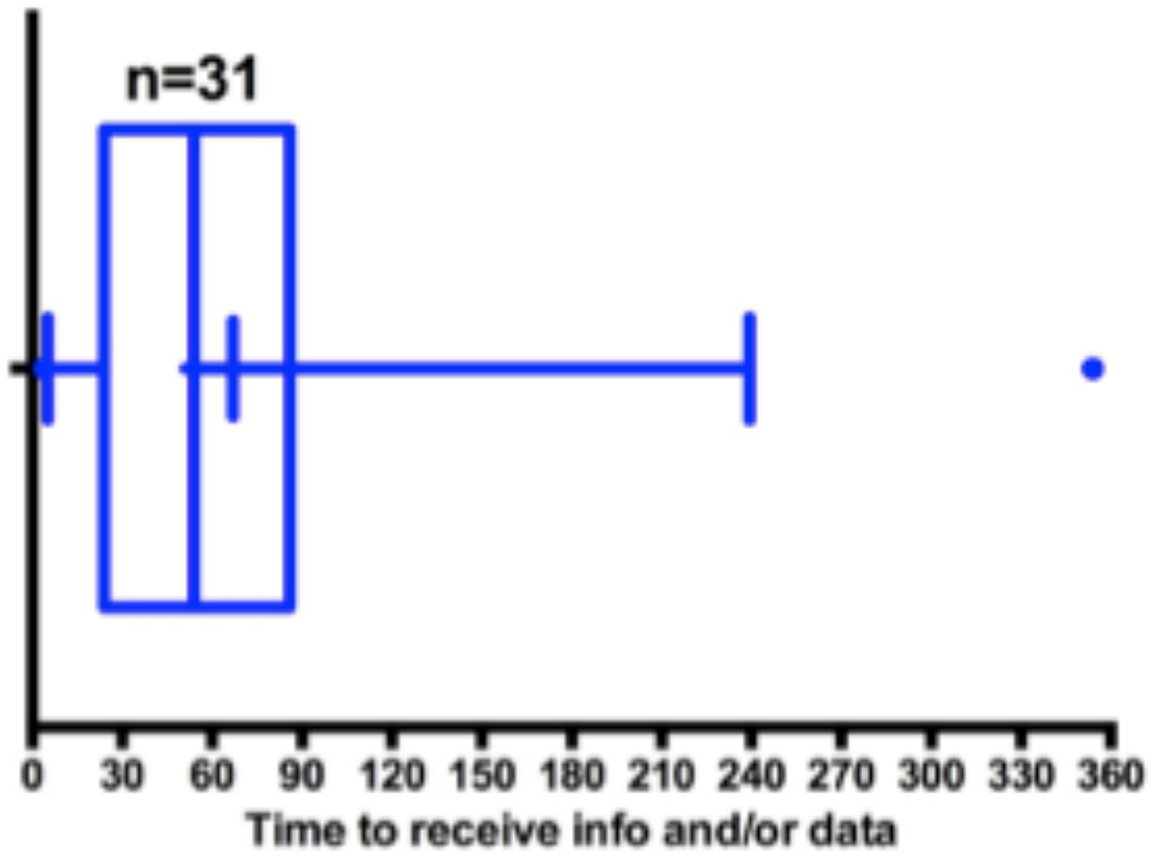


n = 50 studies

* data was obtained from 19 studies

Project 1. Cancer Biology Reproducibility Project

Author responsiveness:

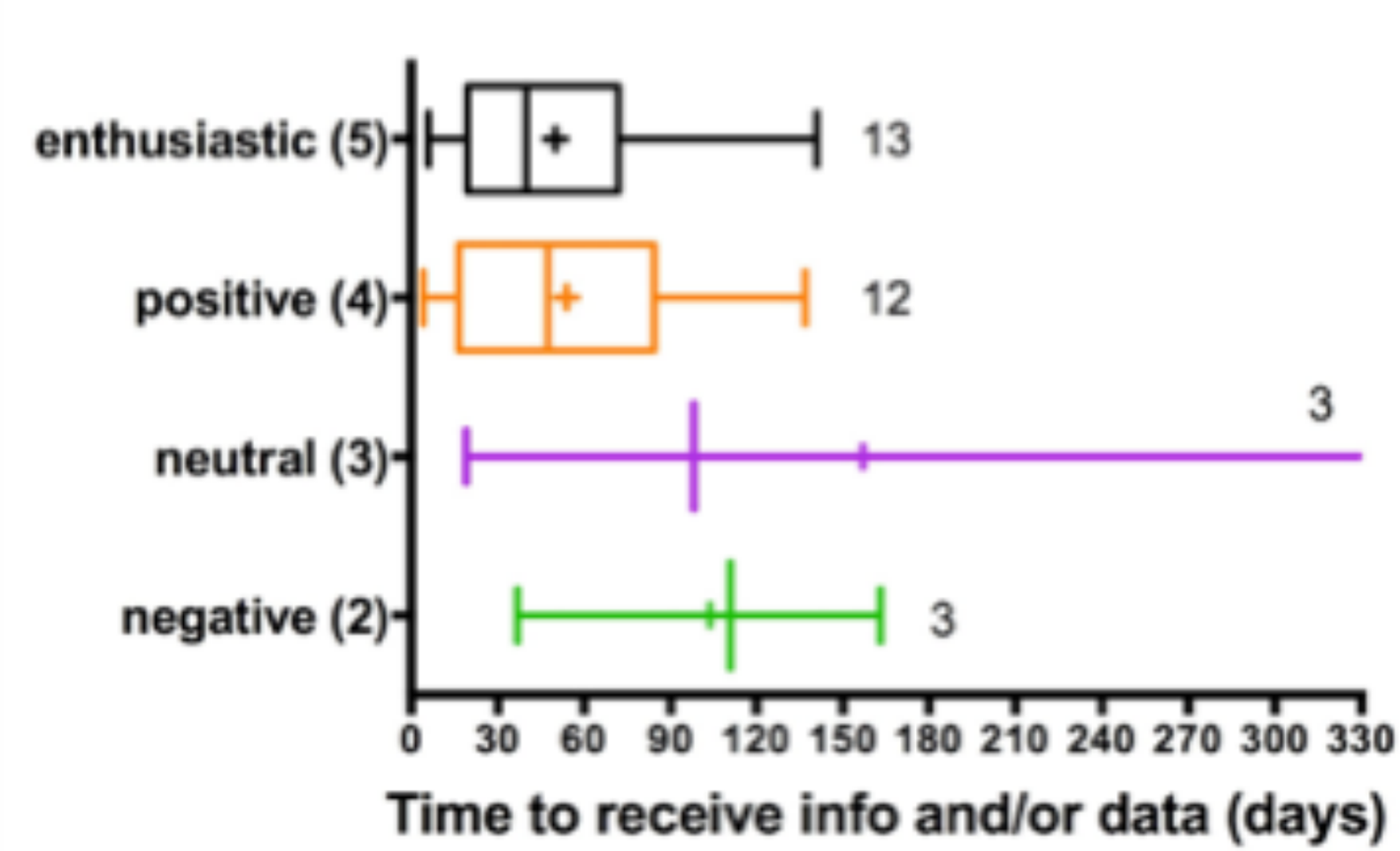


Mean = 67 days, max 354 days

RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

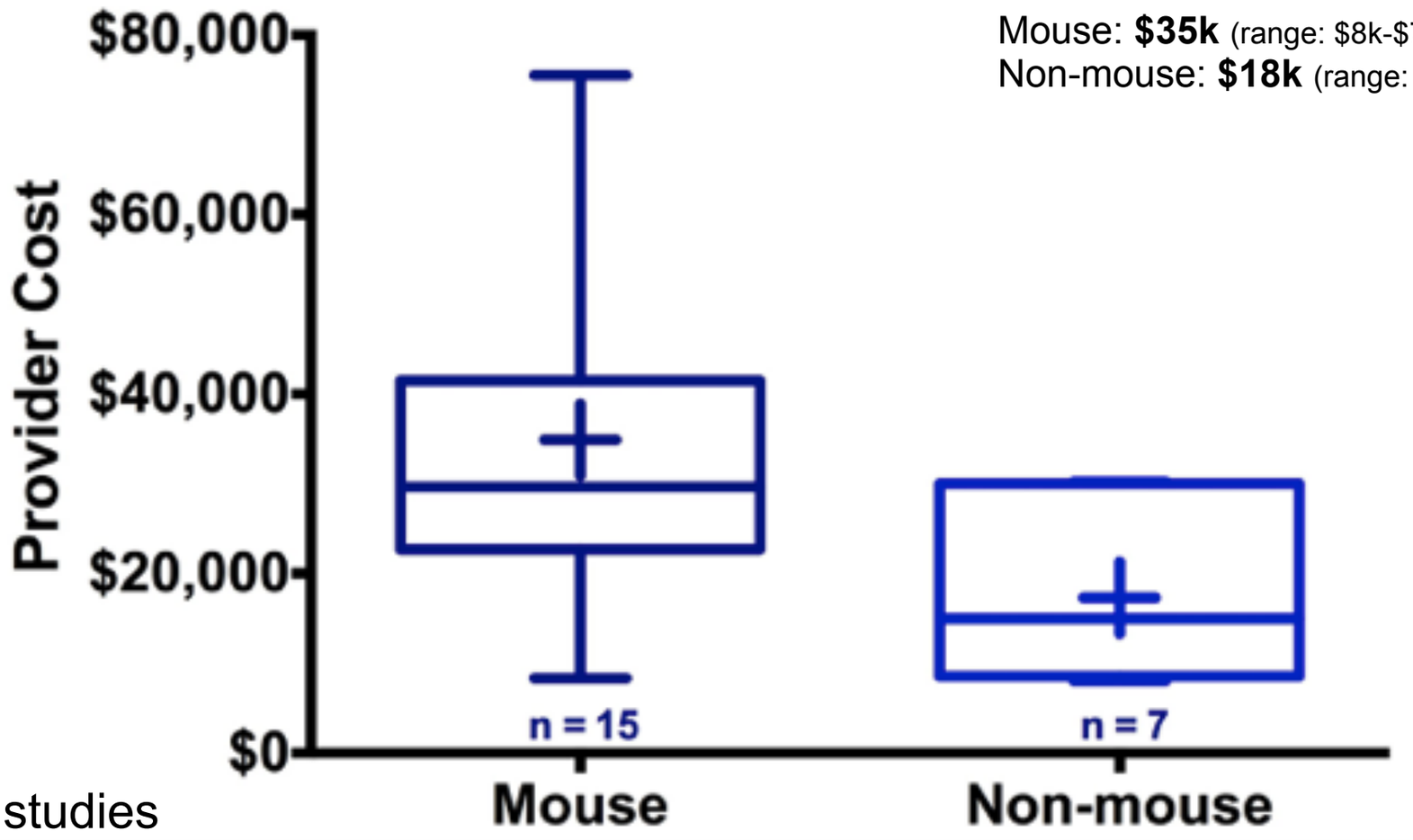
Author supportiveness:



RP: Cancer Biology

Project 1. Cancer Biology Reproducibility Project

Cost of replication studies:



Mouse: **$35k** (range: $8k-$75k)
Non-mouse: **$18k** (range: $8k-$30k)

n = 22 studies

RP: Prostate Cancer

Science EXCHANGE

Project 2. Reproducibility Project: Prostate Cancer

MOVEMBER FOUNDATION
CHANGING THE FACE OF MEN'S HEALTH

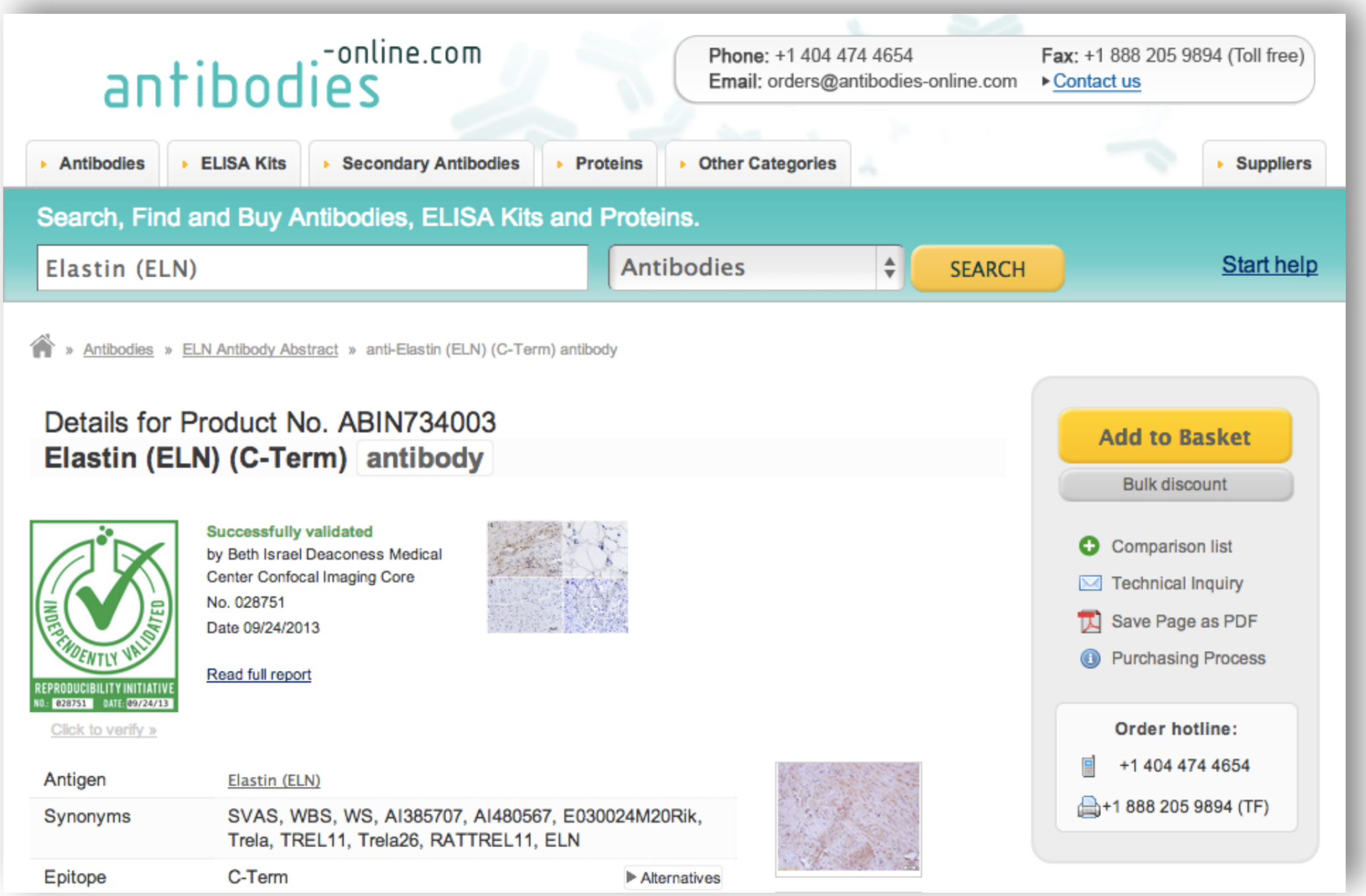
PROSTATE CANCER FOUNDATION

"Science Exchange, in collaboration with PCF, will identify faster high-impact biomedical research findings that could speed earlier detection and new cures."

MOVEMBER

Reagent verification

Science EXCHANGE



Verified: Implications

- Reproducibility will become a primary metric for researchers
- Reproducibility requirements will promote greater documentation and sharing of reagents, equipment, protocols and data
  - ➡ potential opportunities to automate and facilitate this process
- Quality control of reagents will become increasingly important
  - ➡ certification as a means to build trust

Research trends: Summary

Science EXCHANGE

ONLINE

COLLABORATIVE

VERIFIED