

# How Research Works

## Funding, Ethics, Evaluation, and Openness

*How a grant is actually built and reviewed; where honest conduct shades into fabrication, and how the record catches it; how researchers and their papers are judged, by peers and by numbers; and the open-science expectations that now govern how it is all shared.*

## FRAMING THE CHAPTER

# The machinery behind every result in this course

Chapter 7 described who does research and the institutions that support it. This chapter turns to the practices that decide whether research happens at all, and how it is judged once it does — from a grant application's anatomy, through the norms (and well-documented failures of those norms) that define honest conduct, to how researchers and papers are evaluated, presented, and ultimately shared in the open.

1

### Funding & proposals

National agencies and European schemes such as the ERC; the components — and Gantt chart — of an actual application.

2

### Ethics

Questionable practices, outright fabrication — Schön, Dias, LK-99 — and the older case of Mendel, re-examined.

3

### Evaluation

Peer review, author contribution, journal impact factor, the h-index, and the DORA pushback against both.

4

### Conferences & open science

Genuine and predatory conferences; FAIR data, DOIs, and the repositories that make results findable.

*None of what six chapters of discovery have traced happens today without passing through this machinery.*

CHAPTER 8 · HOW RESEARCH WORKS

# Funding Schemes: National and European

*Every scheme, national or European, is defined by a call document that fixes topic, ceiling, and deadline.*

## 8.1 • TWO OVERLAPPING LAYERS

# National agencies, and a European layer above them



**National funding agencies** the Agence nationale de la recherche (ANR) in France, the Deutsche Forschungsgemeinschaft (DFG) in Germany, UK Research and Innovation (UKRI) in Britain, among many others — fund projects based in their own country through annual or twice-yearly thematic or generalist calls.



**European-level schemes** funded through the Horizon Europe framework programme: individually held European Research Council (ERC) grants, the mobility-focused Marie Skłodowska-Curie Actions, and large multi-partner “collaborative” projects funding consortia across several member states on a shared work programme.

### The document that actually governs an application

Every scheme is defined by a call document — sometimes called a lettre de cadrage, or scope note, in French usage — fixing eligible topics, career-stage or nationality restrictions, funding ceiling, and deadline. Reading it closely, rather than reusing a proposal written for a different call, is the first and most commonly overlooked step of a competitive application.

## 8.1 • THE ERC LADDER

# Grants structured explicitly by career stage

### Starting Grant

~2–7 years post-PhD (indicative window). Up to EUR 1.5 million over five years.

### Consolidator Grant

~7–12 years post-PhD (indicative window). Up to EUR 2 million over five years.

### Advanced Grant

No fixed career-stage limit, but requires a substantial track record. Up to EUR 2.5 million over five years.

### Synergy Grant

2–4 principal investigators jointly, for questions that genuinely need combined expertise. Up to EUR 10 million over six years.

# Numbers move; the shape behind them does not

## **Historiographical note**

The amounts, durations, and eligibility windows on the previous slide are current, indicative ERC figures and change over successive Horizon Europe work programmes; a candidate should always verify the current call text rather than relying on a fixed number from any single year, including this one. The structural point stands regardless: European funding is a graded ladder of instruments tied to career stage, from doctoral and postdoctoral fellowships (Chapter 7) through to senior single- and multi-investigator grants.

CHAPTER 8 · HOW RESEARCH WORKS

# Anatomy of a Grant Proposal

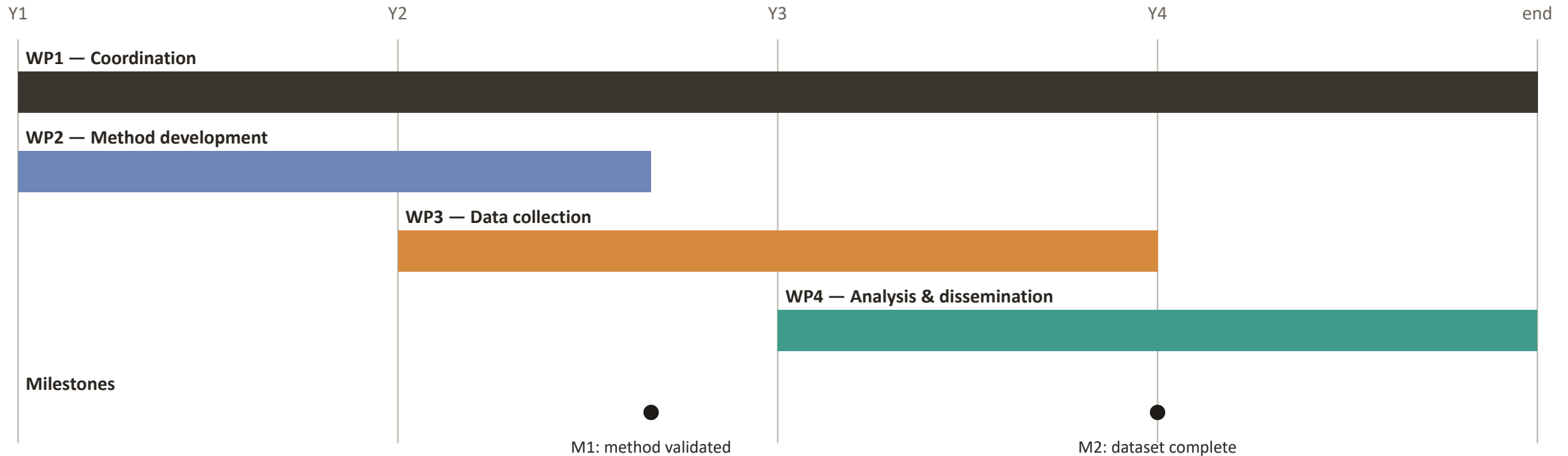
*Whatever the call, the document a successful applicant submits contains a strikingly similar set of components.*

# Consistent components, whatever the specific call

- 1 **Scientific context and work plan** state of the art and an explicit gap or question, followed by a methodology broken into work packages (WPs) with objectives, tasks, and deliverables — normally accompanied by a Gantt chart timeline (next slide).
- 2 **Data management, budget, bibliography** a data management and open-science section (data, format, licence, repository); an itemised budget tied to specific tasks rather than a lump sum; and a bibliography.
- 3 **Depending on the scheme** an ethics self-assessment (human participants, animals, dual-use technology), a gender-dimension statement, and a dissemination plan distinct from the open-science section.
- 4 **Review** external peer reviewers assess the proposal against published criteria — for Horizon Europe, typically excellence, impact, and quality of implementation — sometimes with a written rebuttal stage before a final decision.

## 8.2 • THE WORK-PLAN TIMELINE

# A schematic Gantt chart — illustrative only, not a real project



*A schematic Gantt chart of the kind expected in a multi-year proposal's work plan — named after the American engineer Henry Gantt, who popularised the format in the early twentieth century.*

CHAPTER 8 · HOW RESEARCH WORKS

# Research Ethics: From Questionable Practices to Fabrication

*A spectrum, not a single thing — and one every working researcher needs to be able to read.*

### 8.3 · A SPECTRUM OF MISCONDUCT

## From quietly convenient to unambiguously fraudulent



**Questionable research practices** selectively reporting only results that support a hypothesis; slicing one dataset into the minimum number of publishable papers (“salami-slicing”); listing a colleague as author despite no real contribution (“gift” authorship). Common, contested, rarely prosecuted formally — yet they distort the record.



**Outright misconduct — FFP** Fabrication (inventing data never observed), Falsification (manipulating materials or data so the research is misrepresented), and Plagiarism (presenting another's ideas, words, or results as one's own).

#### The distance that matters

The gap between quietly omitting one inconvenient data point and inventing an entire dataset from nothing is exactly what this spectrum is meant to capture.

## Physics' best-documented case of outright fabrication

- 1** **2000–2002, Bell Labs** Jan Hendrik Schön published a rapid sequence of high-profile results in organic semiconductors — including claimed molecular transistors and organic superconductivity — in Science, Nature, and the Physical Review journals.
- 2** **April 2002: discovery** colleagues reviewing a paper for a patent application noticed two supposedly independent datasets were numerically identical. A five-member committee chaired by Malcolm Beasley found reused noise traces and graphs generated from smooth functions, not measurements.
- 3** **Consequences** September 2002 report substantiated 16 of 24 allegations, fabrication attributed to Schön alone. 29 papers retracted 2002–2003; doctorate revoked 2004 (upheld 2014); DFG barred him 8 years.

### 8.3 · WHY THIS CASE IS UNUSUAL

## Most misconduct is resolved far less visibly

#### **Historiographical note**

The Schön case is unusually well documented because Bell Labs ran, and fully published, a formal investigation. Detected fraud is understood in the research-integrity literature to substantially undercount the true rate, precisely because a well-executed fabrication is not straightforward to distinguish from a genuine, merely surprising result.

The case is often taught alongside other large, publicly investigated cases from outside physics — for instance the Dutch social psychologist Diederik Stapel, found in 2011 to have fabricated data in dozens of studies over more than a decade — because the cross-disciplinary recurrence of the same pattern (isolated access to raw data, high publication pressure, insufficiently sceptical co-authors and reviewers) suggests the vulnerability is structural, not confined to one field.

## The same pattern, under intensified scrutiny

- 1 **2020–2023, University of Rochester** a sequence of room-temperature superconductivity claims: carbonaceous sulfur hydride under extreme pressure (Nature, Oct. 2020), then near-ambient-pressure nitrogen-doped lutetium hydride (Nature, March 2023).
- 2 **Retractions** both Nature papers retracted (2022; November 2023, at most coauthors' request); a separate 2021 Physical Review Letters paper retracted mid-2023 for what the journal called convincing evidence of fabrication.
- 3 **Outcome** a University of Rochester investigation, informed by a US NSF-commissioned review, found misconduct (fabrication, falsification, and plagiarism in grant applications) in March 2024; Dias was dismissed in November 2024, five papers retracted in total.

## Not fraud — but a caution about announcement effects

### Historiographical note

In July 2023 a South Korean team posted two preprints — not submitted to, or reviewed by, any journal — describing an ambient-pressure room-temperature superconductor, LK-99. Unlike Schön's or Dias's papers, this was not fabricated data dressed up as discovery: it was a genuine, seriously incomplete result, amplified by social media well beyond the specialists equipped to evaluate it.

What followed was peer review's underlying logic operating by other means: dozens of laboratories attempted replication within weeks, entirely outside any editorial process, converging on a mundane explanation made definitive in a November 2023 study — a ferromagnetic copper-sulfide impurity producing a resistance drop that mimicked, but was not, superconductivity. The episode shows how far an unreviewed claim can travel before anyone competent has checked it, and equally that open, rapid, decentralised scrutiny can still catch an erroneous claim within months — without any journal's peer review ever being invoked at all.

## From Bell Labs' committee to a chi-squared test in 1936

- 1** **Institutional responses since Schön** most institutions and funders now maintain a research-integrity office; journals follow shared guidelines from the Committee on Publication Ethics (COPE); Retraction Watch maintains a public, searchable database of retracted papers.
- 2** **Gregor Mendel, re-examined** in 1936 the statistician Ronald Fisher argued Mendel's 1866 pea-plant ratios fit theory implausibly well — too well to be ordinary variation — implying the data had been adjusted. Repeated in textbooks for the better part of a century as settled fact.

## Fisher's method, not just Mendel's data

### Historiographical note

A 2019–2020 re-audit led by the geneticist Noel Ellis went back to Fisher's own chi-squared calculation rather than Mendel's data, and found the accusation did not hold up: Fisher had pooled results from several separate experiments — under different conditions, at least one involving traits genetically linked rather than independent — into a single aggregate test, manufacturing much of the apparent implausibility. Properly disaggregated, Mendel's results are not unusually close to expectation.

This does not prove Mendel's data were free of ordinary bias; it shows something narrower and, for this course, more important: an accusation of misconduct is itself an empirical claim, resting on stated methods and assumptions, and is no more entitled to a free pass from scrutiny than the result it targets — precisely the caution Chapter 6 raised, in the opposite direction, about overcorrecting a genuine pattern of historical erasure.

CHAPTER 8 · HOW RESEARCH WORKS

# Publishing and Being Reviewed

*A result only counts, in the ordinary working sense, once it has passed peer review.*

## From referee reports to a standardised contribution statement

- 1** **Peer review** independent researchers in the field — typically two or three referees, coordinated by a handling (“Associate”) editor — assess soundness, originality, and significance before an editor decides to publish, reject, or request revisions. Preprints (e.g. arXiv) make results available for scrutiny before that process concludes.
- 2** **Author contribution — CRediT** a growing number of journals require a statement itemising which of a set of standard roles each author performed. CRediT, the most widely adopted version, defines fourteen such roles (2012, Harvard/Wellcome Trust workshop) and is built into many publishers' submission systems — a direct, structural response to honorary and gift authorship.

## Predatory journals, and how to spot one

### **Historiographical note**

A predatory journal charges publication fees — often only revealed after “acceptance” — while providing little or no genuine peer review, sometimes fabricating an editorial board, an impact factor, or an indexing status it does not hold. The librarian Jeffrey Beall compiled an influential public blacklist from around 2010 until discontinuing it in 2017 under legal pressure; the phenomenon has not gone away, and identifying it now falls on individual researchers, indexing services, and institutions checking a publication list, rather than any single maintained authority.

CHAPTER 8 · HOW RESEARCH WORKS

# Bibliometrics: Counting Citations, and Their Limits

*A single number was never designed to substitute for reading the work.*

## 8.5 • TWO WIDELY USED MEASURES

# Designed for journals; applied, controversially, to people

- IF** **Journal impact factor** introduced by Eugene Garfield, the average number of citations articles in a journal receive within a defined window. Designed to compare journals, not individual articles or their authors — though very widely used as exactly that kind of proxy.
- h** **The h-index** proposed by Jorge Hirsch (2005): a researcher has an h-index of h if h of their papers have each received at least h citations — rewarding productivity and impact together, resisting distortion by one exceptional paper.

### A shared limitation

Citation practices differ enormously between fields, both measures reward career length more than any single discovery, and both can be gamed — self-citation, citation cartels, or editorial pressure to cite the journal itself.

## A declaration of intent, unevenly implemented

### **Historiographical note**

The San Francisco Declaration on Research Assessment (DORA), drafted at the December 2012 annual meeting of the American Society for Cell Biology, recommends that funders, institutions, and journals stop using the journal impact factor as a proxy for an article's or researcher's quality in hiring, promotion, or funding decisions, and instead assess the scientific content of the actual work. Thousands of institutions have since signed — including, in France, the CNRS in 2018.

DORA is a declaration and a set of recommendations, not an enforceable standard; the gap between an institution's having signed it and its committees actually having changed how they read a CV remains a live, ongoing subject of research-policy debate rather than a settled outcome.

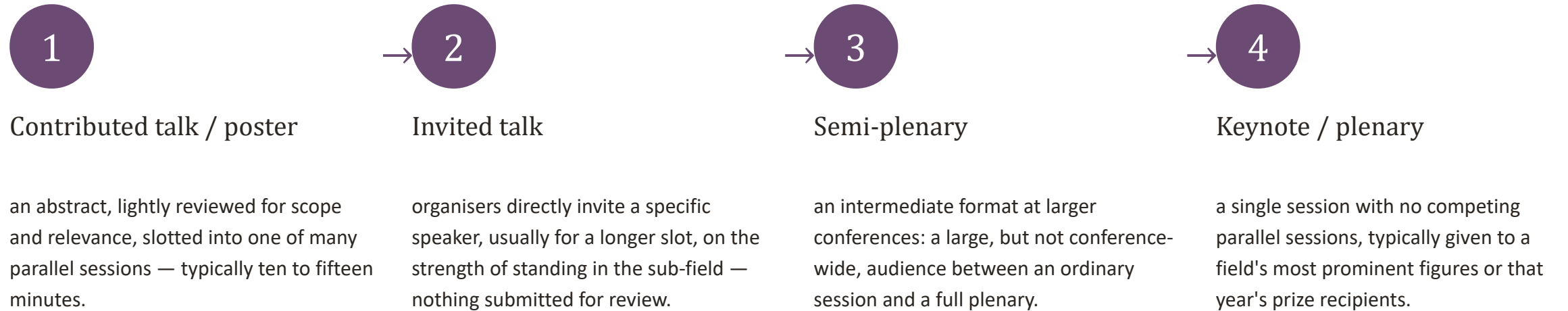
CHAPTER 8 · HOW RESEARCH WORKS

# Conferences: Formats, Prestige, and Predatory Imitations

*The other principal venue where results are presented — and, increasingly, imitated.*

## 8.6 · A FAIRLY CONSISTENT HIERARCHY

# From a ten-minute contributed talk to a conference-wide plenary



### At scale: the APS March Meeting

Now generally run jointly with the spring April Meeting as a single “Global Physics Summit,” one of the largest physics conferences in the world: thousands of contributed talks across dozens of simultaneous sessions, alongside curated invited-talk sessions and a small number of plenary and prize sessions drawing the entire meeting into one room.

## Predatory conferences

### **Historiographical note**

A predatory conference solicits attendance and paper submissions indiscriminately, often merging unrelated fields into a single nominal “conference” purely to maximise registration revenue, provides little or no genuine peer review of abstracts, and frequently misrepresents its organising committee or sponsorship. WASET and OMICS International are repeatedly identified in the research-integrity literature; OMICS was fined by the US Federal Trade Commission in 2019 for deceptive practices in both its journals and its conferences.

As with predatory journals, an unsolicited invitation flattering a researcher's expertise in oddly generic terms, an implausibly broad range of topics, and fees large relative to the actual scientific programme are the most reliable warning signs.

CHAPTER 8 · HOW RESEARCH WORKS

# Open Science: FAIR Data, Identifiers, and Repositories

*Closing the loop from how research is funded to how its results are shared.*

# Findable, Accessible, Interoperable, Reusable

## Findable

described and identified well enough to be located, even by machines searching at scale.

## Accessible

retrievable, via a clear and, where appropriate, authenticated protocol.

## Interoperable

using formalised, shared vocabularies so data can be combined with other datasets.

## Reusable

richly enough described, with a clear licence, to be correctly reused by someone else.

### **Formulated 2014, published 2016**

At a Lorentz Center (Leiden) workshop, published by Mark Wilkinson et al. in Scientific Data. “Open” and “FAIR” are related but distinct: FAIR data must be well enough described to be found and correctly reused even when not fully open to the public.

## A DOI only does useful work if something durable sits behind it

- 1 Persistent identifiers** just as an article gets a DOI through Crossref, a dataset — or a specific version of analysis software — can be assigned a citable DOI through DataCite, letting it be formally cited and its use tracked.
- 2 General-purpose repositories** Zenodo (hosted by CERN, linked to OpenAIRE, free for research outputs of essentially any discipline); HAL in France for preprints and author manuscripts; Software Heritage (Inria) archiving the history of public source code.
- 3 Discipline-specific repositories** the Protein Data Bank for macromolecular structures, the Crystallography Open Database for crystal structures, GenBank for nucleotide sequences.

## LOOKING AHEAD

# The machinery this course's first six chapters left implicit

Together, this chapter and the one before it have described the practical machinery underlying every result this course has discussed: the careers and institutions research runs on, and the funding, integrity, evaluation, and openness norms that decide which research gets done, which of it can be trusted, and how it reaches the rest of the scientific community.

None of this is static.

*Funding instruments, integrity procedures, and open-science requirements have all changed substantially within the past two decades, and are still changing. Situating any scientific result within the institutional conditions of its own time — exactly as earlier chapters have done for archives, journals, and academies — applies as much to research being done today as to any historical case this course has examined.*

## FURTHER READING

- European Research Council, ERC Work Programme (Horizon Europe, current call year), [erc.europa.eu](http://erc.europa.eu)
- Agence nationale de la recherche, Guide au montage de dossier (current call year), [anr.fr](http://anr.fr)
- Committee on Publication Ethics (COPE), Core Practices and case-report database, [publicationethics.org](http://publicationethics.org)
- Eugenie Samuel Reich, *Plastic Fantastic: How the Biggest Fraud in Physics Shook the Scientific World* (Palgrave Macmillan, 2009)
- Jorge E. Hirsch, “An Index to Quantify an Individual's Scientific Research Output,” *PNAS* 102, no. 46 (2005): 16569–16572
- San Francisco Declaration on Research Assessment, full text and signatory list, [sfdora.org](http://sfdora.org)
- Mark D. Wilkinson et al., “The FAIR Guiding Principles for Scientific Data Management and Stewardship,” *Scientific Data* 3 (2016): 160018
- Ivan Oransky and Adam Marcus, *Retraction Watch* (blog and database), [retractionwatch.com](http://retractionwatch.com)

## Chapter 8

# Questions?

*From a Gantt chart in a grant proposal to a chi-squared test re-audited eighty years later: how research works is judged by the same standard of evidence this course has applied to every case in it.*