

Reframing the debate around CRISPR and genome editing

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My research interests

- More about governance than ethics
- Understanding who gets to decide whether certain technologies are pursued and under what conditions?
 - how debates are framed, who makes what kinds of arguments
- How do we structure our institutions and societies to manage the risks and benefits of science?
 - how do current structures and arrangements promote particular ways of governing science?
 - how do different countries debate and govern science?



Is your lab using CRISPR?

Conference coffee talk...



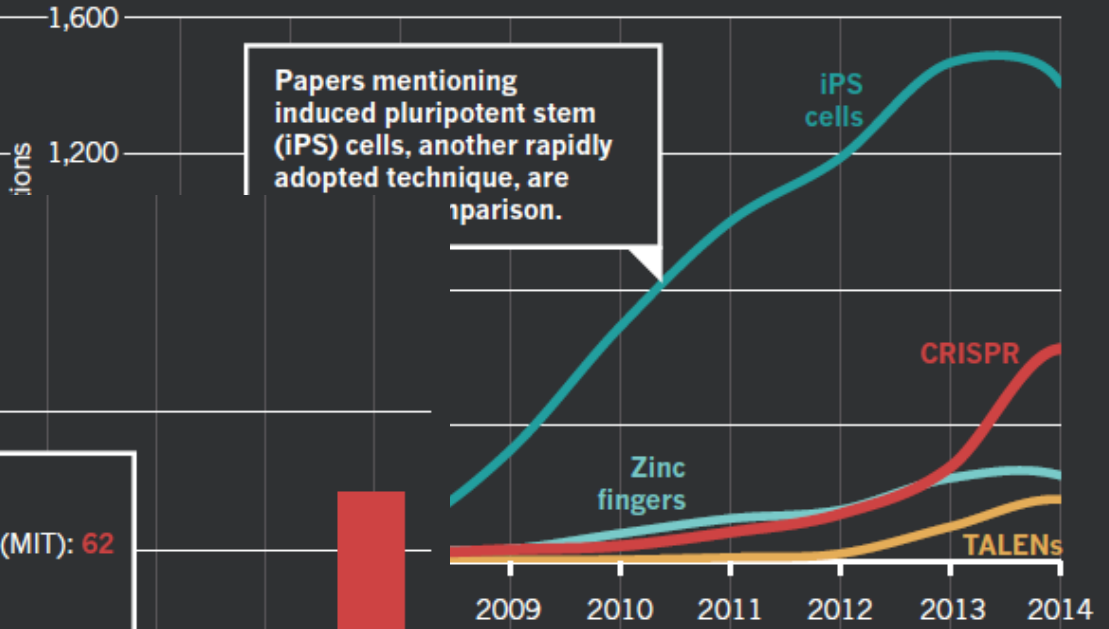
Is your lab using CRISPR?



Is your lab using CRISPR?

PUBLICATIONS

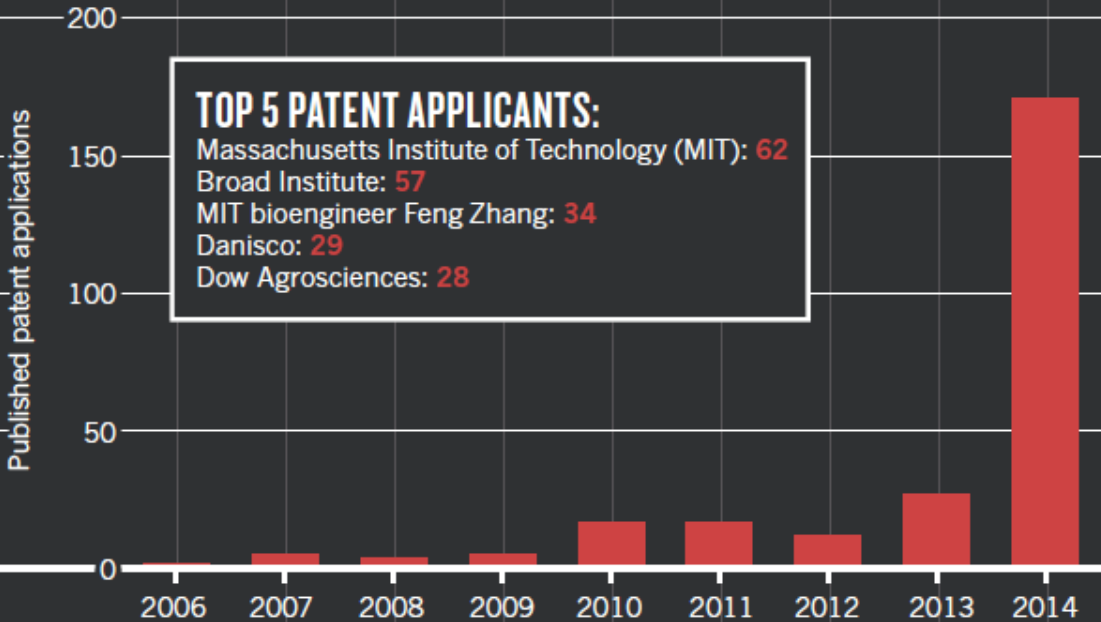
The number of papers about CRISPR has outstripped the numbers mentioning the gene-editing technologies known as TALENs and zinc fingers.



Papers mentioning induced pluripotent stem (iPS) cells, another rapidly adopted technique, are in comparison.

PATENTS

In 2014, worldwide patent applications that mention CRISPR leapt and a patent battle intensified.



TOP 5 PATENT APPLICANTS:

- Massachusetts Institute of Technology (MIT): 62
- Broad Institute: 57
- MIT bioengineer Feng Zhang: 34
- Danisco: 29
- Dow Agrosciences: 28

Ledford (2015)
Nature 522 (4 June): 23

Excitement around CRISPR-Cas9

- Faster, cheaper, more precise genome editing
- So far tried in 3 dozen organisms (Doudna)

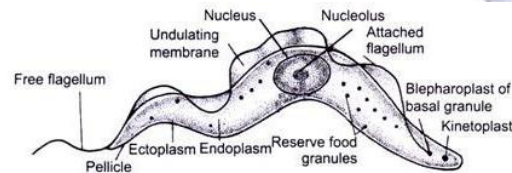
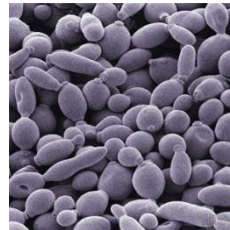


Fig. 9.22 A *Trypanosoma*



Candida albicans

Excitement around CRISPR-Cas9

- Studying and treating human disease
 - Easier creation of model systems for studying human diseases
 - Targeting DNA in differentiated cells
 - Germline modification
- Agricultural applications (animals and plants)
- Gene drive techniques to propagate new traits through wild-type populations (e.g. to control disease spread)

Growing concerns among scientists (2015)

Jan 2015: Napa valley meeting

March / April 2015: *Nature* and *Science* commentaries calling for moratorium

Don't edit the human germ line

Heritable human genetic modifications pose serious risks, and the therapeutic benefits are tenuous, warn **Edward Lanphier**, **Fyodor Urnov** and colleagues.

BIOTECHNOLOGY

A prudent path forward for genomic engineering and germline gene modification

A framework for open discourse on the use of CRISPR-Cas9 technology to manipulate the human genome is urgently needed

18 April 2015: publication of first study using CRISPR-Cas on human embryos (*Protein & Cell*)

A recurring pattern

“Debates on artificial intelligence, autonomous weapons, geoengineering and the use of gene-editing technology have all referred to Asilomar as a useful model.”

Nature 526 (15 October 2015): 293-294

The visibility of Asilomar in the US

(compared with the UK)



Asilomar 1975

- Letter to *Science* in 1974 called for a moratorium on recombinant DNA research until a conference could be held (funded by NIH/NSF, hosted by NAS)
- Aim was to agree on a statement by the final day of the conference – Under what conditions may we proceed?
- Came up with a biosafety classification of low / moderate / high risk
- Made recommendations about containment, good laboratory practices and training
- Guidelines fed into the NIH oversight system through the Recombinant DNA Advisory Committee (RAC)

Arguments in support of Asilomar model

- A model of responsible scientific self-governance
- Scientists understand the technical details better than anyone else
- Biosafety and containment system has worked well and is still used by NIH (with modifications)
- Helped foster the growth of biotech industry
- Helped foster public trust in science – transparent and successful deliberations

Challenges to the Asilomar model

“The factors under consideration [at Asilomar] extend far beyond [the scientists’] technical competence. In fact they were making public policy. And they were making it in private.”

Senator Edward Kennedy (D-MA), 1975



Science

Political science

Human genetic engineering demands more than a moratorium

Expert calls for a moratorium on germline gene engineering are no substitute for richer public debate on the ethics and politics of our biotechnological futures.

Sheila Jasanoff, J. Benjamin Hurlbut and Krishanu Saha

Tuesday 7 April 2015 06.06 EDT



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A recent letter to Science, signed by a group of leading scientists and ethicists, called for a "prudent path forward for genomic engineering and germline gene modification." Photograph: Shutterstock



Science can't solve it

Democratically weighing up the benefits and risks of gene editing and artificial intelligence is a political endeavour, not an academic one, says **Daniel Sarewitz**.

Nature 522 (25 June 2015): 413

After Asilomar

Scientist-led conferences are no longer the best way to resolve debates on controversial research.

Nature editorial

526 (15 October 2015): 293-294

Critiques of Asilomar

- Short & intense
- Brought together a homogenous and like-minded community
- Discussions were restricted to biosafety; managing risk inside the laboratory
- No discussion of biosecurity, social, ethical, equity issues (deemed “peripheral”) – limited to technical discussions
- Communication to the public (e.g. newspaper accounts), but not discussion with the public

Additional contemporary concerns

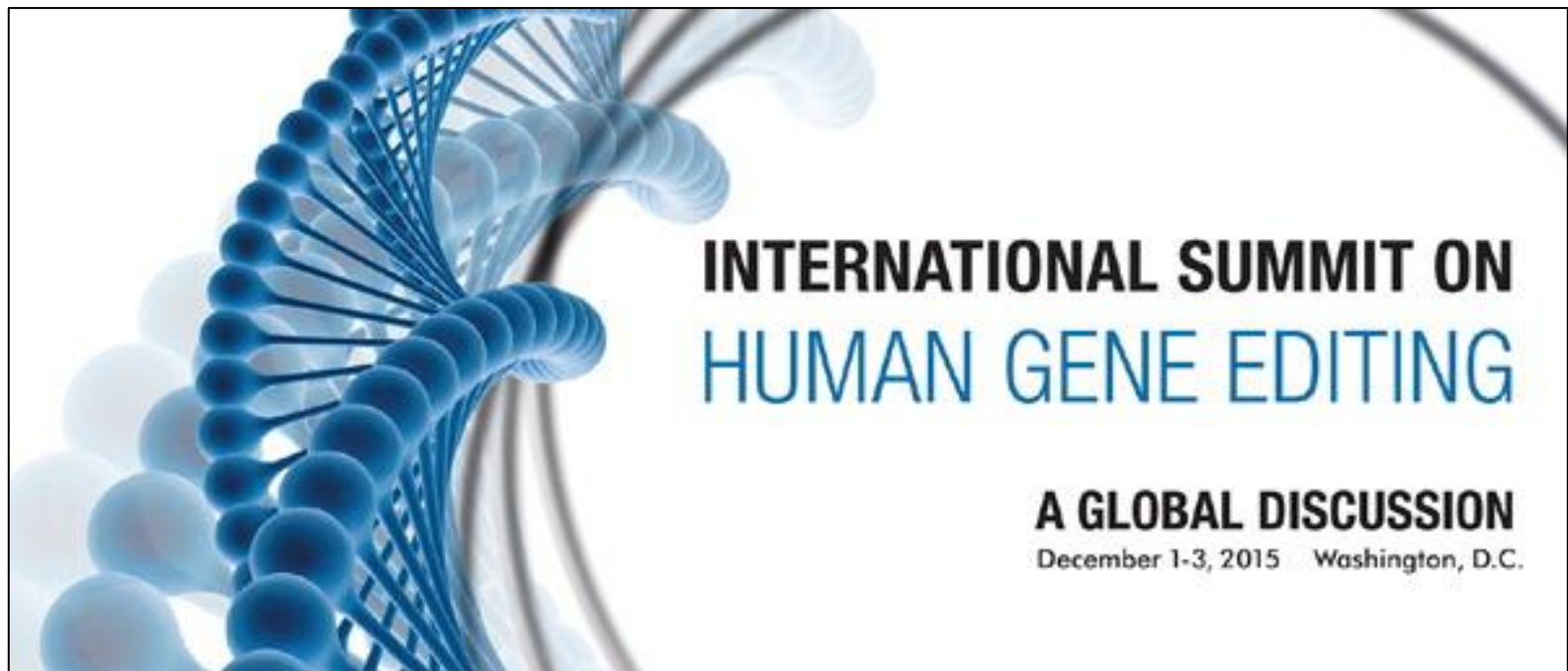
- Genome editing community is larger & more diverse than the recombinant DNA community of 1975
- Industry interests are more central today than in 1975

Asilomar as a dominant imaginary

“There’s a nearly reflexive tendency to think of Asilomar, but Asilomar has become for biology what Woodstock has become for youth culture—a mythology that’s grown but that obscures how muddy the event itself was at the time.”

- Moreno (2015) *Nature Biotechnology* 33: 482

Last week...



Similarities to Asilomar 1975	Differences from Asilomar 1975
Scientists raising the initial alarm	
Meeting hosted by NAS*	
Organizing committee includes Paul Berg & David Baltimore	
Final statement permissive of basic & pre-clinical research (parallels with 'contained use')	
Safety considerations emphasized	
Little discussion of ownership / intellectual property	

* With NAM, Royal Society, Chinese Academy of Sciences

Similarities to Asilomar 1975	Differences from Asilomar 1975
Scientists raising the initial alarm	More attendees (500)
Meeting hosted by NAS*	Webcast + Twitter feed
Organizing committee includes Paul Berg & David Baltimore	More diverse participation
Final statement permissive of basic & pre-clinical research (parallels with 'contained use')	Sessions devoted to governance, biosecurity, societal implications, equity
Safety considerations emphasized	Several speakers with commercial interests in gene editing
Little discussion of ownership / intellectual property	Call for a broader forum for debate

* With NAM, Royal Society, Chinese Academy of Sciences

Resolving the concerns about Asilomar?

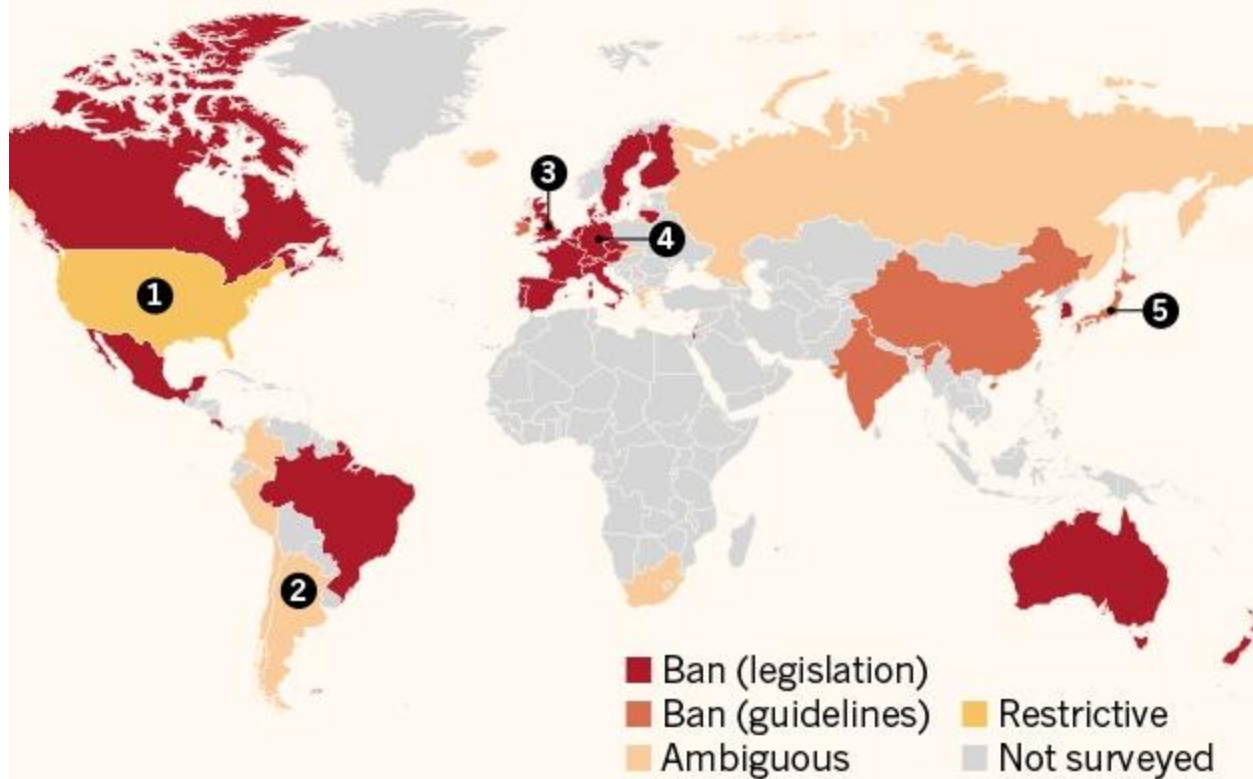
“we can create something that appears public but really is meant to insulate the science”

- Ruha Benjamin (speaker)

Different national approaches

CRISPR EMBRYOS AND THE LAW

Regulations governing genetic modification in human embryos vary. Some countries ban the practice through legislation that carries criminal penalties; others have unenforceable guidelines.



A different set of institutions & processes

- Authority invested in the HFEA
- Created as a result of public debates & discussions in the 1980s, leading to the 1990 HFEA Act
- UK statutory body that oversees the use of embryos in fertility treatment and research
- Not chaired by a scientist or physician



UK framework

- Ban on editing human embryos for treatment
- But research on human embryos is permitted (2009)
 - Researchers apply to HFEA for a license



The image is a screenshot of a news article from the journal Nature. The header features the 'nature' logo in white on a dark red background, with the tagline 'International weekly journal of science' below it. A navigation bar includes links for Home, News & Comment, Research, Careers & Jobs, Current Issue, Archive, Audio & Video, and For A. Below this is a breadcrumb trail: News & Comment > News > 2015 > December > Article. The article title is 'UK scientists apply for licence to edit genes in human embryos'. The sub-headline reads: 'Team from London's Francis Crick Institute wants permit to use CRISPR/Cas9 technology in basic research.' The authors are listed as Daniel Cressey, Alison Abbott & Heidi Ledford. The date is 18 September 2015, with a note that it was updated on the same date. Social media sharing icons for Facebook, email, and print are visible on the right side of the article header.

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NATURE | NEWS   

UK scientists apply for licence to edit genes in human embryos

Team from London's Francis Crick Institute wants permit to use CRISPR/Cas9 technology in basic research.

Daniel Cressey, Alison Abbott & Heidi Ledford

18 September 2015 | Updated: 18 September 2015

Voting on changes to framework

- e.g. Mitochondrial donation case
 - 3 years of scientific reviews and public consultations (2011-14)
- Put to a vote: House of Commons & House of Lords



3 February 2015: vote in House of Commons

382 YES

128 NO

Courtrooms?

NIH & funding agencies?

What kinds of venues and models of
deliberation are appropriate for
debating ~~new technologies?~~
collective futures?

National Academies?

Presidential Commission on Bioethical Issues?

Citizens' juries?

Federal agencies?



Thank you!

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engineering
life



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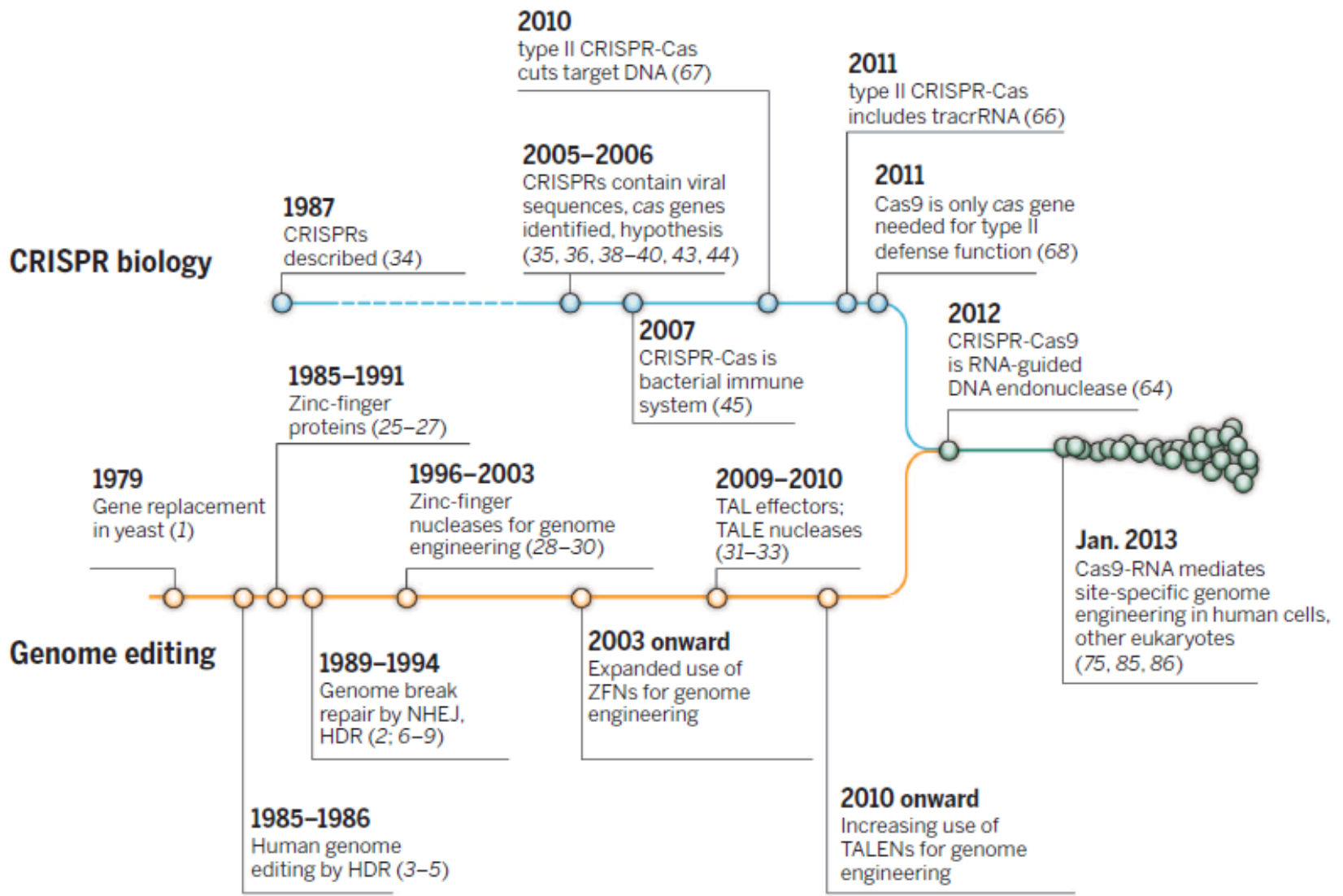
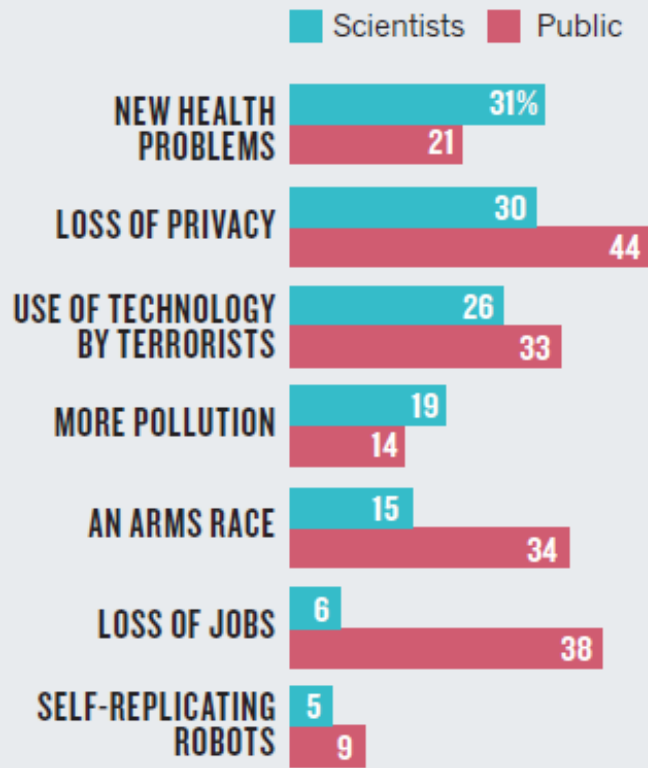


Fig. 1. Timeline of CRISPR-Cas and genome engineering research fields. Key developments in both fields are shown. These two fields merged in 2012 with the discovery that Cas9 is an RNA-programmable DNA endonuclease, leading to the explosion of papers beginning in 2013 in which Cas9 has been used to modify genes in human cells as well as many other cell types and organisms.

Scientists can see the world differently

A MATTER OF PERSPECTIVE

Surveys conducted in 2007 suggested that nanoscientists had different ideas from the general public about the main risks of nanotechnology.



“Scientists are not elected. They cannot represent the cultural values, politics and interests of citizens — not least because their values may differ significantly from those of people in other walks of life.”

- Sarewitz (2015) *Nature* 522: 413



“The Asilomar meeting achieved agreement in part by bracketing off three serious concerns: environmental release of engineered organisms; biosecurity; and ethical and social aspects of human genetic engineering. Decades later, these are precisely the issues we are still wrestling with in the public domain.”

– Jasanoff, Hurlbut & Saha



“The revelation in April that scientists had edited the genome of a human embryo ... has sparked the biggest bioethical debate of the year and one that will last for decades.”

Nature editorial (2 July 2015): 5

UK scientists apply for licence to edit genes in human embryos

Team from London's Francis Crick Institute wants permit to use CRISPR/Cas9 technology in basic research.

[Daniel Cressey](#), [Alison Abbott](#) & [Heidi Ledford](#)

18 September 2015 | Updated: 18 September 2015

“Genome editing of embryos for use in treatment is illegal. It has been permissible in research since 2009, as long as the research project meets the criteria in the legislation and it is done under an HFEA licence. We have recently received an application to use CRISPR-Cas9 in one of our licensed research projects, and it will be considered in due course.”

-- Ian Semple (18 Sept 2015) *The Guardian*