HDRC Report

Towards a collaborative research culture:

Lessons from the origin of the replication crisis

Roll No. XXX

Word count: 1970

Introduction

There is no explicit definition of research culture (Evans, 2007), but to understand research culture, we can try to define them from three aspects, i.e. what it is used for, how it influences us, and where it comes from:

- When Rachael Ainsworth (2019) and others call for open science to heal broken research culture (Ayris *et al.*, 2018), she implies **a culture to produce and share scientific knowledge** that should benefit everyone.
- In the recent Wellcome Trust survey about research culture, researchers were asked about what they think about the culture they work in (Shift Learning, 2020), which defines research culture as a **work culture** for researchers.
- Andrew Cheetham (2007) of Western Sydney University emphasises that we l**earn how to research through a culture** of research, which is especially crucial to higher education.

Taken together, research culture can be defined as a culture that fosters the ability to research and support researchers to work to publish their scientific knowledge. As the worsening replication crisis calls for reform in our research culture (Lilienfeld, 2017), we should review the three perspectives to analyse what causes the replication crisis and provide our solutions.

Discussion

Research is a culture to publish

Since the birth of modern science, call for communication is part of its ethos, making research born with the pressure to publish (Woolf, 1986). On one hand, researchers are usually excited to share their research. On the other hand, “publish or perish” is a truth for all researches. Knowledges that are not delivered to enough people tend to vanish ultimately. In fact, only through the publications of previous researchers are we able to know their knowledges, credit their contribution and pass the knowledges to the next generation.

Historically, the publish-or-perish culture drives researchers to record their wisdom with publications and to reflect on human and scientific history. Thomas Kuhn (2015) points out that it happens in the history of science that researchers suddenly become sceptical about the norm of science until the majority of the scientific community has adopted a new paradigm. As the old and new paradigms are incommensurable, we may find everything wrong with the new paradigm and still find it right with the old paradigm (Horgan, 2012). Thus, we can hardly predict whether improper methods lead to right or wrong answers and should remain self-sceptical.

In fact, many of the classic researches have been proved not entirely true, for we realise that we are misusing some experimental designs, statistical analyses, or we have more advanced research

approaches. When Gregor Mendel counted peas to study the laws of inheritance, the laws named after him today, well-designed experiments and implications of statistics was not even the norm of research then (Gustafsson, 1969). However, modern-day scientists may still criticise Mendel's research for being "too good to be true" (Pligrim, 1984), although Mendel's conclusions about the laws of inheritance are still prevalent and fundamental.

However, we should also admit that the modern publishing industry also loosens the selection of quality researches, provided the exponential growth of the number of publications (Sarewitz, 2016). In the past, publications about less convincing "wisdom" vanish with time, with the remaining to be high-quality, which could create a false sense of overall high quality, whereas there were already 50 million existing scholarly articles in 2009, (Jinha, 2010), where many low-quality researches survived.

Selection ease in a competitive culture

Although research has its culture within itself, it also implies a work culture in a "cycle of credit" (Smith, 2010). Researchers need to publish their works to earn academic credit. The credit that they earn help funders decide whether the researcher is believed to be capable of starting a new research (Figure 1). Publication, fundraising and academic positions, instead of the pressure to publish alone, pushes researchers, especially young researchers who do not have enough credit. As one of the interviewees talked about his opinion on the pressure to publish (see Appendix),

> *"Certainly, when I was a postdoc, there was still the feeling, of course, that I had to publish. So, I would get an academic position and be able to get grants."*

In the academic treadmill, only the first is rewarded, which leads to the highly competitive nature of the current research culture as a work culture where winners take all. Top journals hardly publish replicate research (Brembs, 2019), which discourages anyone from being the second. Also, patents derived from scientific credit, are only rewarded to the first to claim them. To earn the credit to be the first, as Erik Sontheimer describes about the CRISPR patent war in *Science*, "everyone is trying to jockey themselves and minimise what others did," even if they are already highly reputable due to their contribution to science (Cohen, 2017; Rai and Cook-Deegan, 2017).

The culture is also making competition psychologically painful, as most researchers agree that there is an unhealthy competition in their research culture (Table 1). Over 40% of the PhD and master's students are suffering from depression and anxiety (Evans *et al.*, 2018), while the faculty are also suffering from chronic stress (Lashuel, 2020). The prevailing mental illnesses, which negatively affects decision-making (Porcelli and Delgado, 2017), is making it hard for researchers to balance their pressure to publish and their research quality.

Not only does the culture cause worse decision making, but the highly competitive work culture also discourages *post hoc* checks on biases and mistakes in our researches, including misuse and

misunderstanding of experimental designs and statistical analyses. Despite thousands of hours' unpaid investigation into Yoshihiro Sato's 33 published trial, top journals still acted slowly to the alleged academic fraud and refused to publish the whistle-blowers' papers (Kupferschmidt, 2018).

What goes wrong in our education?

How we compete or co-operate is influenced by our education (Boone and van Witteloostuijn, 1999). Cheetham (2007) attributes our concern over research culture to the commoditisation of higher education, which drives the universities to admit more students, hire more researchers and produce more results so that they can receive more public funding and private donation leading to competition for limited academic positions and funds.

However, what constitutes healthy competition is self-improvement, self-development and co-operation (Fülöp, 2009), which the universities fail to teach, as a result of the shift of focus. University students start suffering from mental illnesses soon after they enter the college (Macaskill, 2018), with little support from their institutions (Eleftheriades *et al.*, 2020). When failure to seek help from strangers becomes a norm, these future researchers might no longer try to seek help. When they need to co-operate with strangers to replicate previous studies and when they need helps from statisticians for the right decision, they may not request for help.

Also, our education does not tell them how to ask for help. First, our courses focus on teaching knowledge instead of training for problem-solving for them to use cross-disciplinary knowledge and training for interpersonal skills, such as co-operation with strangers. Second, practical knowledges for research, such as how to design experiments and use statistical analyses, are not delivered to students (Callier *et al.*, 2014; Weissgerber *et al.*, 2016). When the students become researchers, they will need to learn the knowledge all at once, which may lead to mistakes.

Potential solutions

As described above, the loosened selection from the publishers, the lack of incentives to replicate prior studies collaboratively, and the stressful education system contribute to the replication crisis (Figure 2). There are three lessons to learn, as listed below (Figure 3):

Lesson 1: Supportive education

Universities and other research institutions should provide career development counselling services to support students' self-improvement, self-development, which are key to healthy competition (Fülöp, 2009). Our education system should also to reduce the negative impact of the prevailing mental illnesses among faculty and students, with enough counselling services (Jenkins,

2015). Teaching and practising about common biases and mistakes in experimental designs and statistical analyses is important, for it enhances our brains' inhibition of the mistakes. Experts have stronger inclinations. The potent inhibition than non-expert is what differ experts from ordinary people (Brault *et al.*, 2015). However, since it is impossible to teach all the mistakes, students should be encouraged to learn interdisciplinarily so that they can know who to turn to and how to co-operate with others when they feel things could go wrong.

Lesson 2: Collaborative community

As the fight between Isaac Newtown and Gottfried Leibniz over the invention of calculus (Bardi, 2009) implies that there is a long-standing inclination to reward only the first which emerged even before the rise of academic publishing, which should be changed by liked-minded collaborative young generations with an acumen to find mistakes and biases. Open access, open data, open source and transparent peer reviews should be a norm to ensure research reproducibility and also benefit researchers themselves with a higher chance of citations and grants (McKiernan *et al.*, 2016). Then, industrial and academic researchers should unify their standards for research to enable better clinical translation and collaboration (Begley and Ellis, 2012). Publishers and journals should become a community of open science, e.g. *eLife*, where people, including reviewers, share their comments openly and provide practical advice to help publication (Patterson and Schekman, 2018). Companion paper publication, as *Cell* (Figure 4) and *Science* (Figure 5) did, and other forms of collaboration should be encouraged and facilitated by editors if possible and promote sharing of protocols, manuscripts, code and data that strengthen open science.

Lesson 3: Responsible publishing

All the collaboration should be ensured by the checks and balances within the cycle of credit to avoid loosening control over the control for publication-quality (Figure 1). Funders should require replicability statements from the applicants (Horton, 2015) and force researchers to publish all their results, including null results (McKiernan *et al.*, 2016). Publishers and research institutions should encourage and, whereas possible, finance researchers to replicate previous studies and earn reward from the fraud they find (Kupferschmidt, 2018), especially there are allegations reported to the institution, like Internet companies who hire software testers to check for the function of their products and research how to develop testing techniques (Bertolino, 2007). Funders should consider setting up prizes to reward those who find influential academic fraud, in the same way Internet companies set up championships to award those who find the most dangerous vulnerabilities.

Reflection on success and failure

When my group was chatting with my tutor about research integrity online, he suddenly said, *"…when research became a very good career…*" It hit me immediately, for I never thought that way. First, he referred to research as a career instead of an activity. Second, he suggested that research used not to be a career. It leads me to reflect on the replication crisis from a historical perspective and think about how research becomes a researcher's career.

There are three lessons I learn individually:

1. **Separate the failures in our careers from those of science.** Stefan (2010) advises every researcher to record all their rejected PhD/fellowship applications, failed exams and unaccepted papers to create a CV of failure. Yet, these are all failures of careers instead of those of science. However, in some cultures, people tend to mix them up and struggle to fake successes in science or career and finally end up with failure in both.
2. **Read about the history of science.** Many excellent researchers were never well-recognised for their contribution throughout their life. Gregor Mendel, who discovered the laws of inheritance, still vowed before death, "my time will come." (Gustafsson, 1969) His confidence came from science that transcends time instead of his individual career.
3. **Think different**, as implied by the dual meaning of "research" and Apple's innovative advertisement (Shields, 2001). As Brock (2019) points out, the current replication crisis could be an "innovation opportunity" in science yet to be explored by the whole research community collaboratively.

Tables & Figures

Table 1. How do researchers find about the competition in the research culture?

	Disagree/Negative	*Agree/Positive*
Competition as used to describe research culture is positive/negative	20%	56%
Unhealthy competition is present within my working environment	37%	42%
Healthy competition is encouraged within my working environment	26%	32%
High levels of competition have created unkind and aggressive research conditions	11%	78%

Source: Shift Learning (2020)

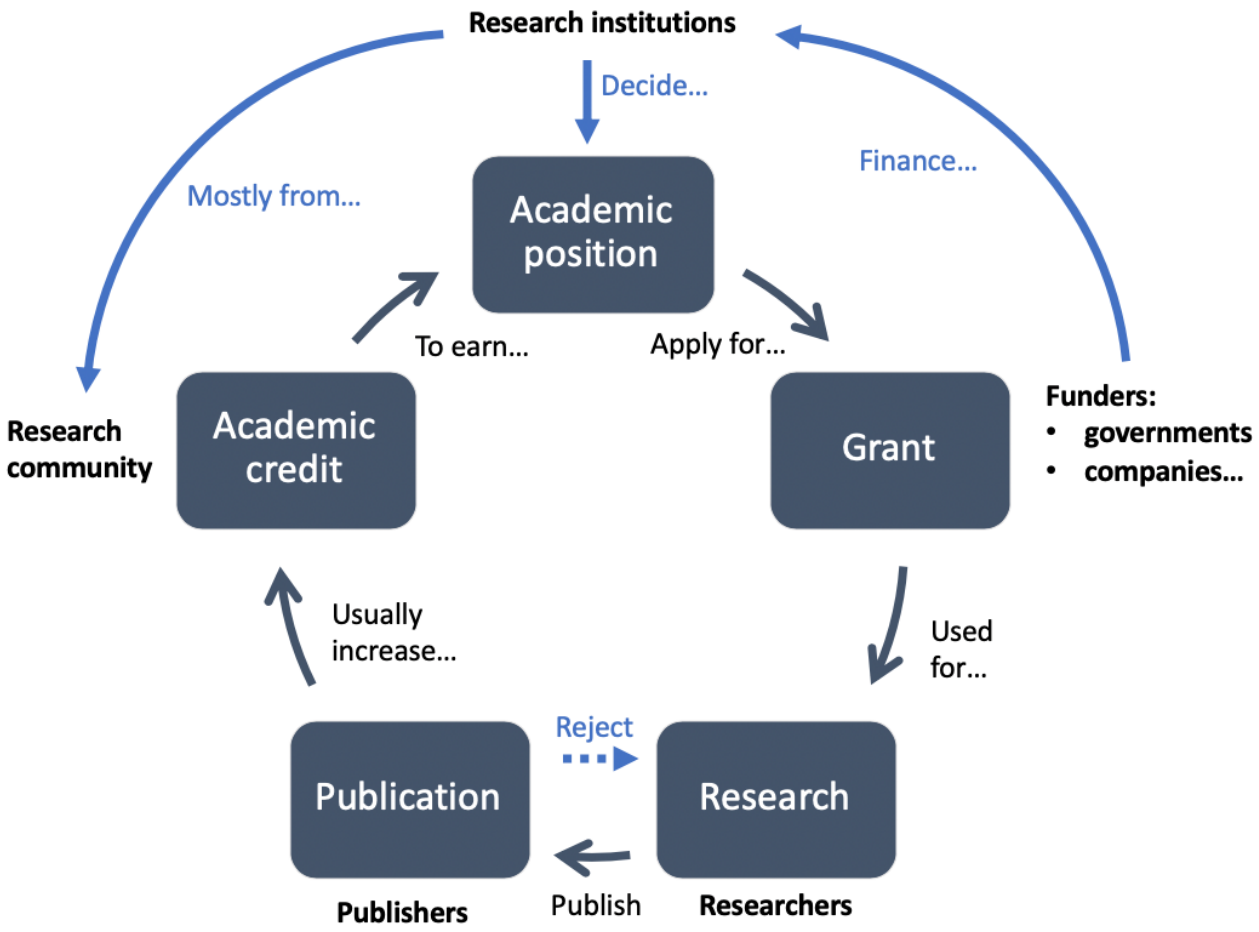

Figure 1. The cycle of credit, also named the academic treadmill, plus a simplified sketch of checks and balances in the system—my own work according to my own understandings and Smith (2010).The names of **stake-holders** in each phase are bolded. Blue lines show checks and balances.

Although the research community can "vote" for different journals with their works, whether they can be published is still decided by journal editors, weakening the strength of research community to balance the power of publishers. Modern publishing is loosening control over publication as more researches can be published due to the increasing number of journals (Jinha, 2010), whereas there are few checks and balances for researchers and publishers. Also, funders rarely examine the behaviour of researches *ad hoc*, which reduces the chance of discovering misconducts.

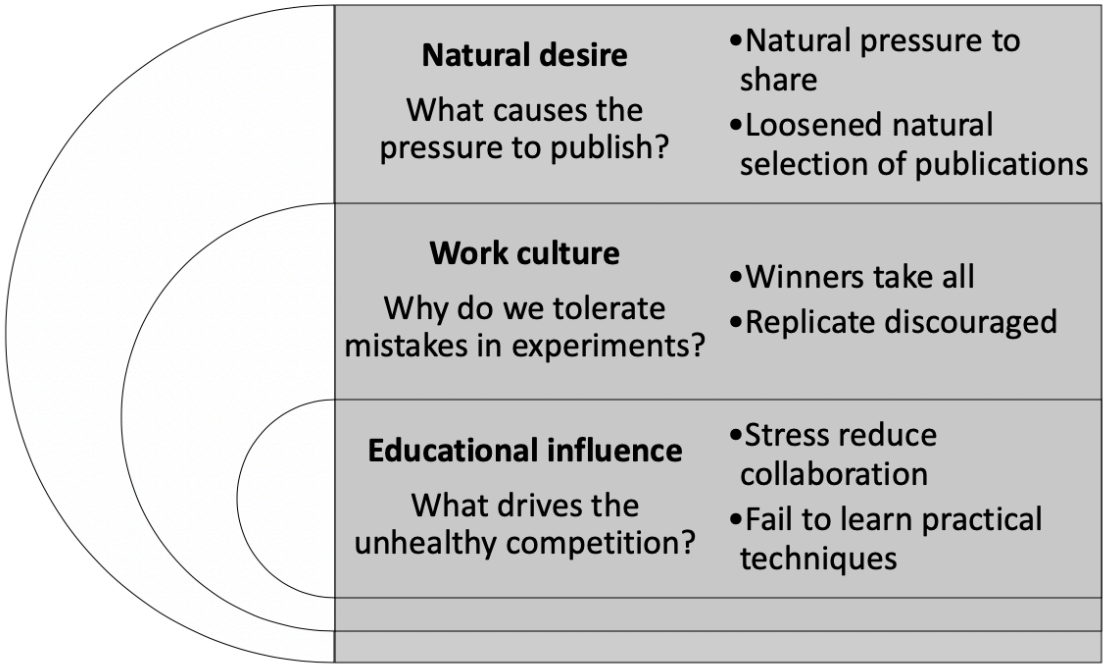

Figure 2. The causes of the replication crisis by three levels—my own work. The publication pressure is a natural desire for researchers which is strengthened by the winner-take-all culture. For only the first is/are rewarded, the rest are discouraged from replication, plus already loosened selection of academic publication, leads to the accumulation of the abnormalities, leading to the replication crisis. Our lack of co-operation and collaboration and lack of ability due to the negative impact from the education may also be responsible for poor decision making for the misuse and misunderstanding of experimental designs and statistical analyses, speeding up the accumulation.

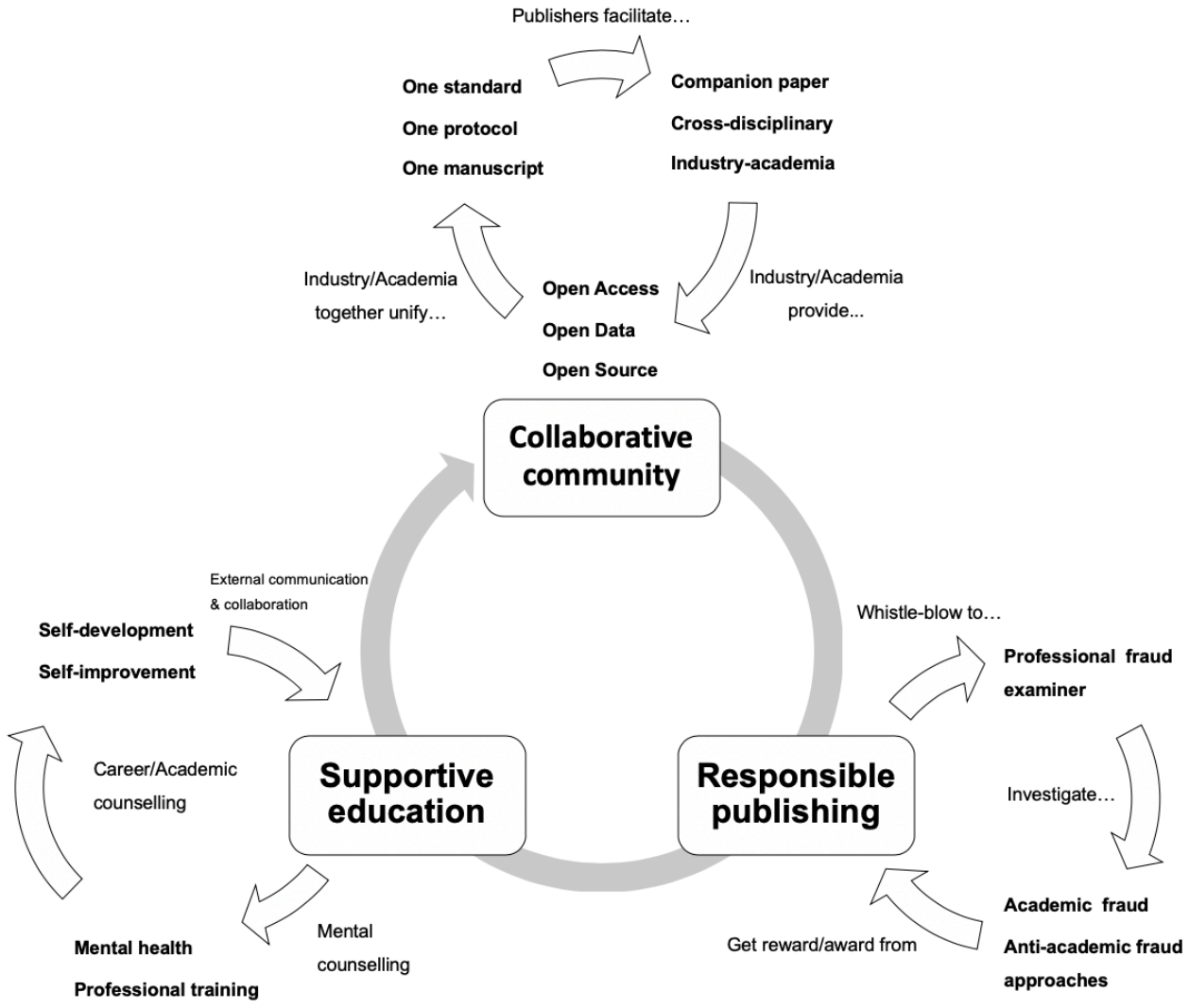

Figure 3. Approaches to collaborative research culture—my own work, which summarised the approaches used in this paper. Three are three parts. The first part is a supportive education that provides help for their mental needs and career development to support their collaboration with the external researchers. The second part is about an existing and still growing community of open science. Data sharing can attract collaboration with the industry and other people to raise and unify the standards for research (Begley and Ellis, 2012) to reduce replication failure. The third part is the try to introduce professional fraud finders into our current system. This part is hard but worth trying. Although we mostly talk about research culture, especially academic integrity, but fail to construct an institutionalised method to deal with academic frauds. As both modern publishing and software services are growing global industries that can be hardly be regulated externally by any single government, their self-discipline should be ensured by similar ways, as mentioned here.

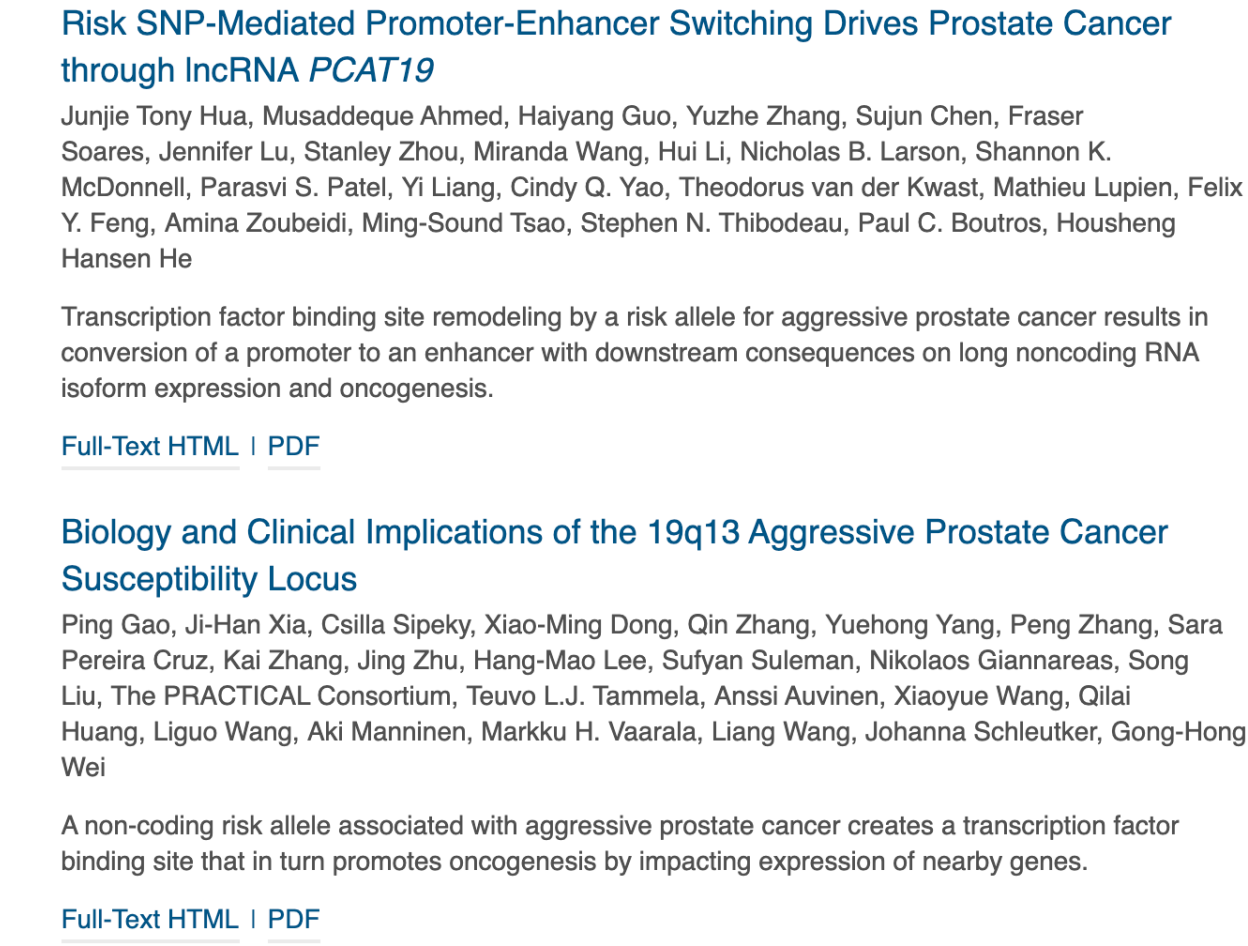

Figure 4. Example of companion papers in *Cell*

Two papers regarding rs11672691-derived PCAT19-long lncRNA function in prostate cancer were published in Volume 174, Issue 3 of *Cell* on 26 July 2018. (Gao *et al.*, 2018; Hua *et al.*, 2018)

Evaluation of an antibody to $\alpha_4\beta_7$ in the control of SIVmac239-*nef-stop* infection

BY M. DI MASCIO, J. D. LIFSON, S. SRINIVASULA, I. KIM, P. DEGRANGE, B. F. KEELE, A. J. BELLI, K. A. REIMANN, Y. WANG, M. PROSCHAN, H. C. LANE, A. S. FAUCI

SCIENCE | 06 SEP 2019 : 1025-1029 |

Anti-$\alpha_4\beta_7$ treatment did not have a detectable impact on plasma viremia, tissue viral load, or $CD4^+$ T cell counts.

Editor's Summary Abstract Full Text PDF Supplementary Materials

Lack of therapeutic efficacy of an antibody to $\alpha_4\beta_7$ in SIVmac251-infected rhesus macaques

BY PETER ABBINK, NOE B. MERCADO, JOSEPH P. NKOLOLA, REBECCA L. PETERSON, HUBERT TUYISHIME, KATHERINE MCMAHAN, EDWARD T. MOSELEY, ERICA N. BORDUCCHI, ABISHEK CHANDRASHEKAR, ESTHER A. BONDZIE, ARSHI AGARWAL, AARON J. BELLI, KEITH A. REIMANN, BRANDON F. KEELE, ROMAS GELEZIUNAS, MARK G. LEWIS, DAN H. BAROUCH

SCIENCE | 06 SEP 2019 : 1029-1033 |

Anti-$\alpha_4\beta_7$ treatment did not have a detectable impact on plasma viremia, tissue viral load, or $CD4^+$ T cell counts.

Editor's Summary Abstract Full Text PDF Supplementary Materials

Blocking $\alpha_4\beta_7$ integrin binding to SIV does not improve virologic control

BY NAMI IWAMOTO, ROSEMARIE D. MASON, KAIMEI SONG, JASON GORMAN, HUGH C. WELLES, JAMES ARTHOS, CLAUDIA CICALA, SUSIE MIN, HANNAH A. D. KING, AARON J. BELLI, KEITH A. REIMANN, KATHRYN E. FOULDS, PETER D. KWONG, JEFFREY D. LIFSON, BRANDON F. KEELE, MARIO ROEDERER

SCIENCE | 06 SEP 2019 : 1033-1036 |

Anti-$\alpha_4\beta_7$ treatment did not have a detectable impact on plasma viremia, tissue viral load, or $CD4^+$ T cell counts.

Editor's Summary Abstract Full Text PDF Supplementary Materials

Figure 5. Example of companion papers in *Science*

Three studies by Abbink *et al.*, (2019), Di Mascio *et al.*, (2019) and Iwamoto *et al.*, (2019) against the 2016 *Science* paper of “Sustained virologic control of SIV+ macaques after antiretroviral and α4β7 antibody therapy” by Byrareddy *et al.* (2016) were published as companion papers in Volume 365 Issue 6457 of *Science* on 6 September 2019. An Editorial of Concern by Sills (2019) for the 2016 paper was published in the same issue.

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Appendix

Interviewee information

We interviewed three research-active principal investigators (PIs) studying biomedical sciences. They are designated CN1, CN2, UK1 for anonymity. CN1 and CN2 are based in China, who have 5-10 years after acquiring a PhD. UK1 is based in the UK who has 10-15 years' research experience. All of them have agreed to allow students to use their comments for the coursework.

Their information is summarised below:

	Researcher A1	**Researcher A2**	**Researcher A3**
The countries they are currently doing research in…	China	China	UK
After acquiring a PhD, he/she had a research experience of …	5-10 years	5-10 years	10-15 years
His/her field of research is…	Biomedical sciences		

Apart from the interviews we conducted, we also exchange interview transcripts with another group, who interviewed another three PIs, designated B1, B2, B3. B1 based in China has 5-10 years' research experience after PhD, while B2 based in China has a research experience of less than 5 years after PhD. B3 based in the UK has over 15s as researchers after PhD. All of them have agreed to allow students to use their comments for the coursework.

Their information is as summarised below:

	Researcher B1	**Researcher B2**	**Researcher B3**
The countries they are currently doing research in…	China	China	UK
After acquiring a PhD, he/she had a research experience of …	5-10 years	< 5 years	> 15 years
His/her field of research is…	Biomedical sciences		

Since the interviews did not happen simultaneously, we made changes to our questions after each interview in order to acquire more concrete answers. I list all the questions our group use below, as stipulated by the coursework guideline. I also a present relevant comment from the other group.

(Details of Q&A removed)