PART ONE – SCIENTIFIC RESEARCH and ETHICS

Document 1 - Lab Leak Fight Casts Chill Over Virology Research

By Benjamin Mueller and Sheryl Gay Stolberg

The New York Times, Oct. 16, 2023

Questions about whether Covid leaked from a Chinese laboratory have cast a chill over American virus research, drying up funding for scientists who collect or alter dangerous pathogens and intensifying a debate over those practices.

The pullback has transformed one of the most highly charged fields of medical science. While some believe such experiments could fend off the next pandemic, others worry that they are more likely to start one.

At Pennsylvania State University, a proposal to infect ferrets with a mutant bird flu virus passed the federal government's most rigorous biosafety review only to be rebuffed by the National Institutes of Health. Troy Sutton, the scientist behind the studies, said that health officials referred to the public controversy over the lab leak theory in advising him to pursue different experiments.

In Washington, international development officials pulled the plug this summer on a $125 million program to collect animal viruses on several continents after two senior Republican senators demanded that they end the project.

And elsewhere in the United States, nearly two dozen virologists, some of whom spoke anonymously for fear of jeopardizing funding or career prospects, described a professionwide retreat from sensitive experiments. Some said that they had stopped proposing such work because research plans were languishing in long and opaque government reviews. One virologist said that university administrators had asked him to remove his name from a study done with colleagues in China.

Some of the affected experiments constitute gain-of-function research, in which scientists genetically alter a virus to see whether that makes the pathogen deadlier or more contagious.

To proponents of such work, there is no better way to home in on what mutations make a virus dangerous. Those findings, in turn, can help researchers spot the most worrisome of the new pathogens constantly jumping from animals to humans or prepare vaccines to target pandemic-ready viruses.

"The next flu pandemic is brewing in nature, but we have very little means of stopping it, very little means of identifying what the most dangerous viruses are," said Dr. Sutton, the Penn State virologist. "This freight train is coming, and we need to do anything we can do to get ahead of that."

But critics say that fiddling with deadly viruses poses intolerable risks for the sake of only hazy public health benefits. Lab mishaps have happened, including in the United States. However small the odds of a lab-generated outbreak, a leak could be catastrophic. (…)

"I think there's lots of good reason to try to remove politics from science, but I can't complain when what I regard as legitimate political criticism of certain kinds of science affects the judgment of funding agencies," said Marc Lipsitch, an epidemiologist at Harvard who has long questioned the benefits of disease-enhancing experiments. "Ultimately, they are spending tax dollars."

In the Covid pandemic, both sides of the debate have found powerful grist.

The possibility that Covid emerged from a lab fueled appeals from biosafety proponents for a clampdown on experiments with even a remote chance of triggering a similar outcome. At the same time, studies suggesting that Covid spilled instead from an illegal animal market reinforced scientists' fears of the dangerous mutations that viruses pick up in nature — and the need to prepare for them with safer studies in a lab.

The next threat may not be far off: A new bird flu variant known as H5N1 has felled many millions of birds globally, sporadically jumping into their handlers as it spreads.

Virologists and biosafety experts largely agree on one point: The federal government's vetting process is too opaque and too slow.

"Scientists are backing away from certain lines of research just in anticipation of the delays and paperwork," Anice Lowen, an influenza virologist at Emory University, said. "A lot of parties are becoming more conservative."

For biosafety proponents, the extra scrutiny has filled a void left by an absence of new regulations. But other scientists said that studies were being stifled even before health officials could assess them, driving research to nations with weaker biosafety practices and leaving basic questions about the coronavirus unanswered.

(681 words)

Document 2 - Human genome editing: ensuring responsible research

Editorial, *The Lancet,* March 18, 2023

In 2018, during the Second International Summit on Human Genome Editing in Hong Kong, Jiankui He shocked the world by announcing the birth of two children whose genomes he had edited using CRISPR technology. Following widespread condemnation and a criminal investigation, he was sentenced to 3 years in prison. The case caused international outcry and brought to the fore the need to reconsider the serious ethical, scientific, and social issues of heritable human genome editing. As science advances, especially in non-heritable, somatic gene editing for treatment of previously incurable diseases, regulatory gaps are becoming exposed. Governance of gene editing research was a major discussion point at the Third International Human Genome Editing Summit in London, on March 6–8, with widespread recognition for the need to build on existing guidelines to develop global standards for governance and oversight of human genome editing. As He's unconscionable actions showed, the ethical and scientific risks are substantial.

Gene editing regulations must consider the aims and consequences of the different practices involved. Somatic genome editing interventions (eg, targeted therapies such as chimeric antigen receptor T cells or small interfering RNA gene therapies) are not transmitted to offspring and are widely used. Heritable genome editing—also called germline editing—is aimed at research on human fertilisation and embryology or for reproductive purposes. From a genetic point of view, germline editing is of most concern because alterations are passed to offspring, with the risk of perpetuating unexpected and undesired changes through generations. It is impossible for our unborn descendants to give consent.

Loopholes and ambiguities in regulation need to be closed urgently to enable scientists to be held to account. In China, He's prosecution was based on practising medicine without a licence, rather than specifically based on a provision governing assisted reproduction or genome editing. China has since instituted new regulations, widely seen as a response to the He case, but they have been criticised in press reports for not doing enough to cover private companies. Wording of legislation needs to be explicit and clear. In the USA, use of funds by the FDA for the purpose of accepting and reviewing any application to begin a clinical trial for heritable germline editing is prohibited. While this, in effect, makes some reproductive editing illegal, it falls short of a ban on the practice itself. Similar ambiguities exist in many countries, and as the technologies involved become cheaper and more widely available, the risk increases.

A better international consensus is essential on how to advance gene editing while safeguarding humanity's collective genepool. There is broad agreement that altering embryo DNA for reproductive purposes should remain forbidden; a 2020 study showed that 75 of 96 surveyed countries have banned it. However, many do not have effective oversight and governance mechanisms to enforce existing regulations. (…) The lack of policy alignment between countries raises the possibility of scientists exporting their research to evade constraints established in their home jurisdictions.

How will a global consensus be enforced? The UN is the only body in a position to do so, and the prospect of an international legally binding treaty to govern genome editing was raised at the Second International Summit in 2018, but has seemingly proceeded no further. The Oviedo Convention, a legally binding instrument established by the European Council, permits somatic genome modifications for preventive, diagnostic, or therapeutic purposes, and prohibits germline editing, but only 29 countries have enacted it into law.

It is almost 20 years since scientists announced the mapping of the human genome. Now they are editing it, and the promise of a truly personalised medicine, tailored to an individual's genetic makeup, is becoming reality. The first CRISPR-based technology, for sickle cell disease, is expected to soon be approved by US regulators. Such advances have the potential to bring enormous benefits for humankind, but also bring unique social and ethical challenges.

Resolving these challenges will involve ongoing conversations within and outside the scientific community. To protect legitimate genetic research—to close loopholes in regulations and establish a global consensus on oversight and regulation—will require governance that is as dynamic as the science. (685 words)

More on Gene Editing

● **Podcast How genome editing will change humanity**

Our podcast on science and technology. This week, we report from a human genome editing summit to explore the applications and ethics of a technology that could transform medicine
https://www.economist.com/human-genome-editing-pod

● **Film - The power of gene editing**

Technological breakthroughs promise to change how we produce food, look after the sick and tackle climate change

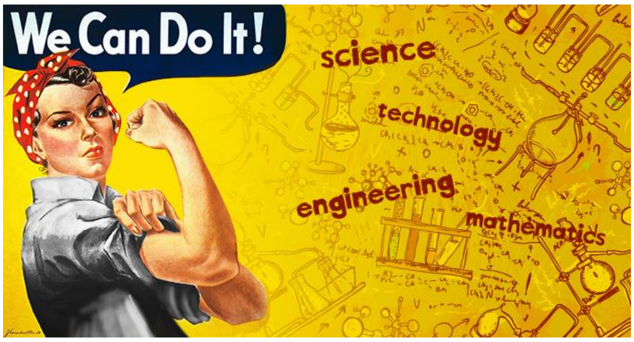
The Economist, Mar 17th 2022
Technologies such as genetic modification and 'CRISPR' will cure hereditary diseases, produce disease-resistant crops and enable the breeding of malaria-free mosquitos. But advances bring ethical and practical dilemmas. Genetically modified food is banned in the EU, and doctors worry that screening for genetic diseases may pave the way for more controversial uses, such as creating so-called designer babies. This film looks at the risks and rewards of gene editing.
https://www.youtube.com/watch?v=F7DpdOHRDR4&t=2s&ab_channel=TheEconomist
(The film has also been uploaded onto Cahier de Prépa)

PART TWO –
WOMEN SCIENTISTS

Document 3 - Women must not be obscured in science's history

EDITORIAL, Nature, 24 March 2021

The literature has failed to acknowledge many female researchers, especially those from marginalized backgrounds. But a new generation of historians is changing the narrative.



Mary W. Jackson's contributions to engineering have been recognized in the naming of NASA's headquarters building.Credit: NASA Langley Research Center

Last month, NASA named its Washington DC headquarters building after the late Mary W. Jackson, the agency's first Black female engineer and an aeronautics expert who specialized in how air flows around aircraft. It was a poignant moment, because this recognition for Jackson comes more than a decade after she died, in 2005. Indeed, her achievements might not have had such exposure had it not been for Margot Lee Shetterly's 2016 book, *Hidden Figures*, and the accompanying film released in the same year. Both recounted the story of a group of Black female mathematicians, including Jackson, who worked at the Langley Research Center in Hampton, Virginia.

Naming a government building in Washington DC after Jackson is noteworthy, but it is just one small step towards addressing wider problems in the study of the history of science and engineering. As Women's History Month draws to a close, we are very conscious of how the science-history literature — including much of the *Nature* archive — has failed to recognize the achievements of female researchers, and particularly those from marginalized communities. Their work has long been obscured, and sometimes even eliminated from the record, but initiatives are now under way to right this wrong.

As in most fields, it is men — often white men and men from institutions in high-income countries — that dominate the community of science historians and the scholarship produced in history-of-science journals. And the exclusion of female historians has been exacerbated by the COVID-19 pandemic. The history-of-science journal *Isis* has seen a sharp fall in the number of women submitting manuscripts. Female and male authors submitted papers in equal numbers in January and February 2020, but since March that year, male authors have outnumbered female authors by more than three to one, probably because more women than men shouldered caring and domestic responsibilities once lockdowns began.

However, a new generation of science historians is emerging, with potentially mould-breaking consequences. *Nature* spoke to several of these researchers, both women and men. They described the roots of some of the problems, and highlighted a number of efforts towards a more diverse, inclusive and global history of science.

The researchers reiterated how much of the literature in science and engineering history is framed around a narrative of the 'great hero scientist' — a man who often makes breakthroughs by himself, on the strength of some special insight or individual genius. Where the records show collaborators, these people are also more likely to be men. (…) Contributions from women, especially women of colour, have often been obscured, if not deliberately erased.

Cairo-based historian Heba Abd el Gawad, at University College London, recounts the story of a female excavator from the 1880s who worked with Egyptologist and eugenicist Flinders Petrie. Sadly, we will never know who she was because the records list only her father's name — Mohammed Hassan. She would have needed to provide his name to secure a job, a practice that still exists in some countries. Petrie never bothered to ask his female colleague's real name, el Gawad explains.

Unconventional sources

In science history, the archival manuscript is one of the main sources of evidence on which research — and, indeed, entire careers — is constructed. In today's context, such documents are the equivalent of a journal article or an academic monograph. So if historians are to take a more inclusive approach, the sources of evidence will need to be expanded, by searching for voices that have been silenced and acknowledging contributions that have been denied. That is now starting to happen.

Oral histories in different languages can serve as sources of information, and so can personal artefacts, which can be incorporated into archives, says Sarah Qidwai, a historian at the University of Toronto, Canada. An upcoming five-volume encyclopedia — a collection of primary sources of material from female scientists, including written sources, images and links to audio and other material — is due to be published in the next few years. (…)

Hidden figures will not be found without stretching the archive, says Emily Rees, who researches women and technology at the University of Leeds, UK. Rees and her colleagues are trying to do just that with their Electrifying Women project: they're searching conference archives and other under-explored sources for information about the contributions of female engineers from outside Europe and North America.

Leadership institutions involved in the history of science are also starting to move. Last July, the British Society for the History of Science held a global digital festival that tackled questions such as how to identify under-represented voices in archive material. (…)

All this work takes time, organization, funding and recognition of the importance of incorporating perspectives from researchers who have long been marginalized. (…) All fields of history are going through a process of reflection and change. Science's history should be no different if women are to get the recognition they deserve. (807 words)

Document 4 - Untangling Rosalind Franklin's Role in DNA Discovery, 70 Years On

By Emily Anthes, ***The New York Times***, April 25, 2023

On April 25, 1953, James Watson and Francis Crick published a landmark paper in ***Nature***, proposing the double helix as the long elusive structure of DNA, a discovery that a decade later earned the men the Nobel Prize in Physiology or Medicine.

In the final paragraph of the paper, they acknowledged that they had been "stimulated by a knowledge of the general nature of the unpublished experimental results and ideas" of two scientists at King's College London, Maurice Wilkins and Rosalind Franklin.

In the 70 years since, a less flattering story has emerged, thanks in large part to Dr. Watson's own best-selling book, "The Double Helix." In the book, he not only wrote disparagingly of Dr. Franklin, whom he called Rosy, but also said that he and Dr. Crick had used her data without her knowledge.

"Rosy, of course, did not directly give us her data," Dr. Watson wrote. "For that matter, no one at King's realized they were in our hands."

This account became a parable of poor scientific behavior, leading to a backlash against Dr. Watson and Dr. Crick and turning Dr. Franklin into a feminist icon. It also set off a long-running debate among historians: Precisely what role did Dr. Franklin play in the discovery of the double helix, and to what extent was she wronged?

In a new opinion essay, published in ***Nature*** on Tuesday, two scholars argue that what transpired "was less malicious than is widely assumed." The scholars, Matthew Cobb, a zoologist and historian at the University of Manchester who is writing a biography of Dr. Crick, and Nathaniel Comfort, a historian of medicine at Johns Hopkins University who is writing a biography of Dr. Watson, draw upon two previously overlooked documents in Dr. Franklin's archive.

These documents, they say, suggest that Dr. Franklin knew that Dr. Watson and Dr. Crick had access to her data and that she and Dr. Wilkins collaborated with them. "We should be thinking of Rosalind Franklin, not as the victim of DNA, but as an equal contributor and collaborator to the structure," Dr. Comfort said.

Other experts said that the new documents were interesting but did not radically change the narrative; it has long been clear that Dr. Franklin played a key role in the discovery. (…)

And regardless of what Dr. Franklin knew about who had access to her data, the new documents do not change the fact that she did not receive adequate recognition for her work, some historians said.

"What is unequal and has always been unequal and is still unequal about Rosalind Franklin is the credit that she didn't get in the aftermath of the discovery," said Dr. Jacalyn Duffin, a hematologist and historian of medicine at Queen's University, in Canada.

In the early 1950s, Dr. Watson and Dr. Crick were working together at the University of Cambridge, in Britain, trying to piece together the structure of DNA, largely by building models of the molecule.

At nearby Kings College London, Dr. Franklin and Dr. Wilkins were trying to solve the same puzzle experimentally, using X-rays to create images of DNA.

In "The Double Helix," Dr. Watson suggested that his breakthrough came after Dr. Wilkins showed him one of Dr. Franklin's images, known as Photograph 51. "The instant I saw the picture my mouth fell open and my pulse began to race," Dr. Watson wrote.

That book was published in 1968, a decade after Dr. Franklin died of ovarian cancer at age 37.

Dr. Franklin's early death also meant she missed out on the Nobel Prize, but the Nobel Assembly could have found other ways to acknowledge her contribution, said Nils Hansson, a historian of medicine at Heinrich Heine University Düsseldorf, in Germany. Neither Dr. Watson nor Dr. Crick mentioned her when they accepted their awards, Dr. Hansson noted, although Dr. Wilkins, who also received the prize, did.

"She truly did get a raw deal," said Dr. Howard Markel, a physician and historian of medicine at the University of Michigan and the author of "The Secret of Life," a book about the discovery of the double helix. "Everyone likes to receive proper credit for their work. Everyone should care enough about their colleagues to ensure the process of fair play." (705 words)

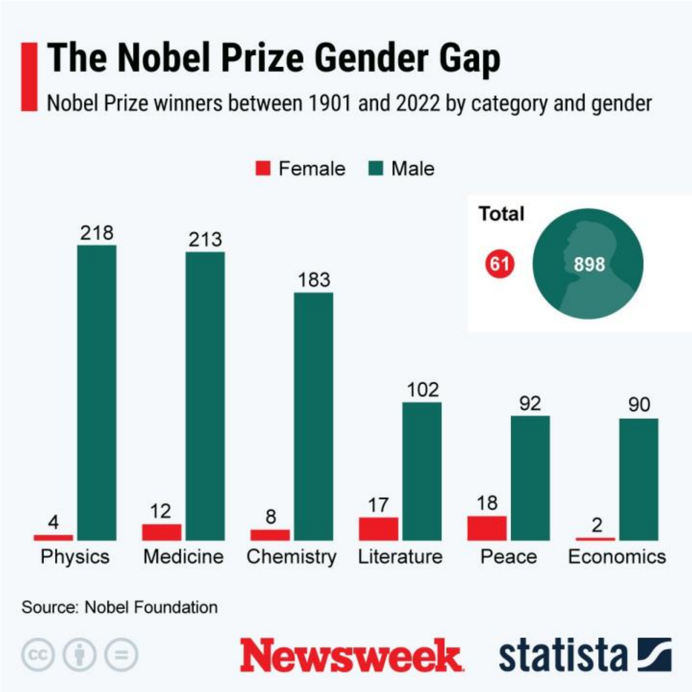
Document 5 - These Eight Inspiring Women Won the Nobel Prize in Chemistry

Newsweek, Oct 04, 2023 By **Jess Thomson**, Science Reporter

The 2023 Chemistry Nobel Prize has been announced today as going to Moungi G. Bawendi, Louis E. Brus and Alexei I. Ekimov "for the discovery and synthesis of quantum dots."

The news came just days after Katalin Karikó became only the 13th woman to win the Nobel Prize in Physiology or Medicine for the development of mRNA vaccines against COVID-19.

Despite 114 Nobel Prizes in Chemistry being given out throughout the years, with 189 individuals taking the prize, only eight women have ever received it. Of these, most prizes were shared.



The Nobel Prize Gender Gap: Nobel Prize winners between 1901 and 2022 by category and gender. STATISTA

Here are the eight women to have been honored. (See the rest of the article with the eight portraits in the long version of the file on Cahier de Prépa)

Document 6 - Audio document: Women winning Nobel Prize for Medicine

Extract from **The Conversation,** BBC Radio 4, Sept 10 2018

https://www.bbc.co.uk/sounds/play/w3cswp1y

You can listen to the whole conversation of course but we are going to focus on the beginning, up to 5 min 23 s

More on Women in Science

● https://www.nobelprize.org/womenwhochangedscience/

● A video in Indian English, for a change: **Chemistry Nobel 2020: The women who discovered CRISPR/Cas9 | Oneindia News**
https://www.youtube.com/watch?v=5fUKjoMg0Vw&ab_channel=OneindiaNews

● ***National Geographic***, December 2018, **What science has gotten wrong by ignoring women**
https://www.nationalgeographic.com/science/article/women-science-sexism-research

● **Breaking barriers: the US space programme's black women mathematicians, Nature.com Blogs, September 2016**
https://blogs.nature.com/aviewfromthebridge/2016/09/06/space-black-women-mathematicians/

● **Women in Science : a temporary liberation, Nature, 2014**
The First World War ushered women into laboratories and factories. In Britain, it may have won them the vote, argues Patricia Fara, but not the battle for equality.
https://www.nature.com/articles/511025a
See also audio document on Cahier de Prépa : Interview of Patricia Fara on Women in science around WWI

PART THREE –
SCIENTIFIC and GEOPOLITICS

Chart 1 - International S&T cooperation among nations based on the number of coauthored publication

Note: size of each node is proportional to the logarithm of the number of fractionally counted papers. Only countries with more than 500 papers are included

Document 7 - Protect precious scientific collaboration from geopolitics

EDITORIAL, ***Nature***, 26 May 2021

The COVID-19 pandemic has provided striking demonstrations of the value of research cooperation across borders. From sharing SARS-CoV-2 genome sequences to piecing together how the virus behaves, international research teams have worked together to the benefit of all.

At the same time, there are signs that mounting geopolitical tensions — particularly between the United States and China — might be diminishing the exchange of people and knowledge between nations. As countries move to protect their own interests, effort is needed on all sides to strike an appropriate balance that safeguards the great rewards that flow from mutually beneficial cooperation between researchers.

The stakes could not be higher. Problems such as climate change, environmental degradation and infectious diseases cannot be addressed fully without global scientific collaboration. International research teams help lower-income countries to build the knowledge required to sustain progress; they also help wealthier nations to pursue equitable, inclusive research based on diverse sources.

Regional collaborations — which are encouraged by the European Union and much-needed in Africa — are likewise crucial to collective science advancement.

An analysis of more than 10 million papers tracked by Web of Science found that the number of internationally co-authored papers rose from 10.7% to 21.3% between 2000 and 2015. By 2015, some 200 countries were represented in the collaborative literature. But there is a risk that a golden era of open scientific cooperation is coming to an end.

In 2018, the FBI warned that China was exploiting the open research and development environment in the United States. A tsunami of investigations by the National Institutes of Health and other federal agencies identified hundreds of federally funded scientists suspected of breaking the rules on disclosing foreign ties. Although many were later exonerated, several were found guilty or are facing charges.

The United States is not alone. Japan, Australia, the United Kingdom, Germany and India have also increased their scrutiny of international research relationships in the interests of protecting national security, with China widely understood to be the country of primary concern.

Research leaders are worried that researchers in Western nations are shying away from collaborations with those in China, partly for fear of being caught up in geopolitical tensions, and also because of the administrative burden of complying with beefed-up regulations.

In Australia, higher-education enrolments from China are down compared with pre-pandemic levels. In the United States, although student intake from China held steady in the 2019–20 academic year compared with the previous one, the number of scholars visiting from China on temporary visas fell. Pandemic-related travel restrictions mean it is not possible to blame geopolitics alone. But the publication record also suggests that collaborations between the United States and China might be under threat.

An analysis published in this issue shows zero growth between 2019 and 2020 in US–China co-authored publications in the Nature Index, which tracks the author affiliations in 82 natural-sciences journals selected by reputation. By contrast, during the previous four years the growth was more than 10% annually. Publications co-authored by researchers in China and Germany, the United Kingdom, Australia and Japan all increased during the same period. (Nature Index is published by Springer Nature; *Nature* is editorially independent of its publisher.)

Studies that look at a broader swathe of journals also hint that collaborations between the United States and China are changing. (…)

As more data accumulate, researchers, institutions and governments must all play their part to guard against a chill in scientific collaboration. Countries erecting barriers need to set unified and consistent research-security guidelines to give researchers the confidence to collaborate across borders. China, meanwhile, could help to ease tensions by providing greater transparency, in particular about the workings of Chinese science, its policy motivations and priorities, and how decisions are made.

In a landmark speech on science and technology in September, Chinese President Xi Jinping urged scientists to "adhere to the supremacy of the national interest", but also highlighted the need for international cooperation. As China's scientific strength grows, so, too, does the responsibility on all sides to retain a clear-eyed view of the global benefits of collaboration relative to any risks.

682 words

Document 8 - American and Chinese scientists are decoupling, too

That will be bad for both countries

The Economist, Oct 11th 2023

There are lots of ways to measure China's rise. It is the world's second-biggest economy, its biggest manufacturer and its biggest creditor. In 2021 it passed another milestone. That year, for the first time, Chinese scientists published more papers than their counterparts in America or the European Union (see chart 1). It is not just the quantity that is improving. The *Nature* Index, run by the publishers of the journal of the same name, tracks contributions to the world's best-regarded health and natural-sciences journals. Chinese researchers rank first in the natural sciences, and second overall.

Cause for celebration, no doubt, in Beijing. In Washington, though, the news may have been less welcome. America is increasingly dismayed by China's rise—and especially its growing scientific and technological prowess. Under Donald Trump, the previous Republican president, and Joe Biden, the current Democratic one, it has imposed tariffs, rules and subsidies designed to hobble China's high-tech firms while boosting its own. China has retaliated, moving against some big American tech companies. Twenty years ago, politicians endorsed globalisation and free trade. Now "decoupling", national security and "friend-shoring" are the hot topics.

Conscious uncoupling

Academia is not immune. New rules and chilly politics in both countries are making it harder for researchers to collaborate. In August America agreed on a temporary, six-month extension for a landmark scientific co-operation agreement signed in 1979. Several American politicians want the deal scrapped entirely, claiming in an open letter that, by collaborating with Chinese researchers, America was "fuelling its own destruction."

image: the economist

The strains can be seen in the figures. In 2020 the number of papers jointly written by American and Chinese researchers fell for the first time. It fell again the following year, the most recent for which data are available, though it is still rising for some other countries, such as Britain. The number of visas America awards to Chinese students and academics is down as well, to around a third of its peak in 2015 (see chart 2). Scientifically as well as politically, the countries are drawing apart.

The Science and Technology Agreement, as the 1979 pact is called, was the first bilateral treaty signed between America and China after they re-established diplomatic relations. Several landmark studies have come under its umbrella. A long-running project following 285,000 Chinese women, begun in 1983, helped demonstrate that folic acid could prevent spina bifida, a rare birth defect. These days folic acid is added to flour, bread, cereal and other staple foods; pregnant women are encouraged to take more. Co-operation in influenza research helps anticipate which strains of flu are likely to be dominant each year, improving vaccines.

Even superpower rivals can agree that medical research is a good thing. But China's advances in other areas of science, such as computing, materials science and ai, have made American policymakers uneasy. Critics argue that science in China has benefited from American academic transparency and know-how—but that China has not always returned the favour. Doubters also point to China's policy of "civil-military fusion", in which the fruits of civilian research are scrutinised for any useful military applications.

China retorts that America's worries about national security have led to the unfair targeting of Chinese researchers at American universities. One frequent target of complaint is the Department of Justice's "China Initiative", which ran between 2018 and 2022 and was designed to investigate alleged instances of Chinese technological espionage. But cases seem to have been thin on the ground. The initiative investigated at least 150 academics of Chinese origin, but managed to secure only a handful of convictions. Some were for less offences such as grant fraud.

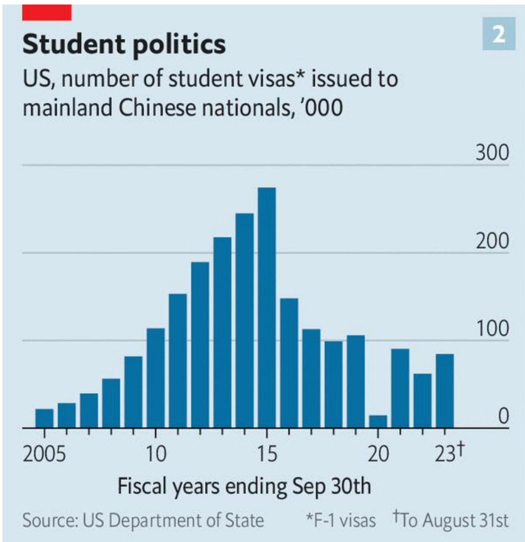


image: the economist

Some of the investigations have become very public fiascos, as with the case of Gang Chen, a well regarded mechanical engineer of Chinese origin who is now at the Massachusetts Institute of Technology. Dr Chen was arrested in 2021. He spent a year on academic leave before all the charges against him were dropped. Other researchers have been sacked by their universities and found themselves on no-fly lists. Academics say the initiative led to an atmosphere of suspicion and mistrust.

China, meanwhile, has national-security concerns of its own, which can likewise impede co-operation. Rules introduced in recent years all but prohibit the export of many different kinds of data. Officials have banned the collection of genomic data by non-Chinese entities, for instance. Foreign social-science researchers are rarely given access to economic and social surveys without a friend in the government. The rules are vague, leaving even researchers keen to work with colleagues overseas unsure what they are allowed to share.

A cooling of ties will make life harder for both sides. Chinese academics will find it harder to get experience in American universities, which still dominate the world rankings in almost every subject. And because China is now a scientific power in its own right, with cutting-edge researchers in several fields, American science will suffer, too.

The benefits of collaboration are "significant," and benefit American institutions slightly more than Chinese ones, says Jonathan Adams, who tracks academic information at Clarivate, a data provider. A study published in 2020 by Jenny Lee and John Haupt at the University of Arizona, found that, when papers co-written with Chinese scientists were excluded, the number of American publications in science and engineering fell slightly between 2014 and 2018.

Give me your brainy masses

America's scientific pre-eminence has been built at least partly on its ability to attract the world's best. Before the pandemic around 16% of graduate students in science, technology, engineering and mathematics at American universities were Chinese. The grad students of today often become the professors of tomorrow. Like Dr Chen, many Chinese students choose to stay in America after completing their degrees. That is something America's leaders should be keen to encourage. (970 words)

Document 9 - UK's years out of EU Horizon programme did 'untold damage', say scientists

Robin McKie *Science Editor,* ***The Observer,*** Sat 9 Sep 2023

Britain may have rescued its scientific fortunes with a last-minute decision to rejoin the EU's Horizon research programme – but the move should not be treated as a cause for jubilation, scientists have warned.

The sluggish pace at which the agreement was reached has had too severe an impact on UK research for widespread elation, say many British researchers, who believe that science in this country suffered a major blow after being locked out of the £82bn programme for almost three years since Brexit. Putting it right has taken far too long, they argue.

Since 2020 the UK government has been negotiating to rejoin Horizon after its membership was blocked because of the protracted dispute over Northern Ireland's trading rules.

Last week's final announcement that ministers had decided to go ahead with rejoining Horizon was greeted with joy and relief by many senior scientists.

But some of their colleagues have since warned that being locked out of Horizon for so long has done irreversible damage to UK science. This was a time when Britain could have taken key leading roles in major programmes on climate change, AI and new medicines.

"There is little reason for celebration for something that should have happened years ago," said Prof Bart De Strooper, a group leader of the UK Dementia Research Institute at University College London. "For the past few years we have faced complete uncertainty about what is happening in key research areas. Britain used to dominate the Horizon programme, and it will take a long time to get back to such a position."

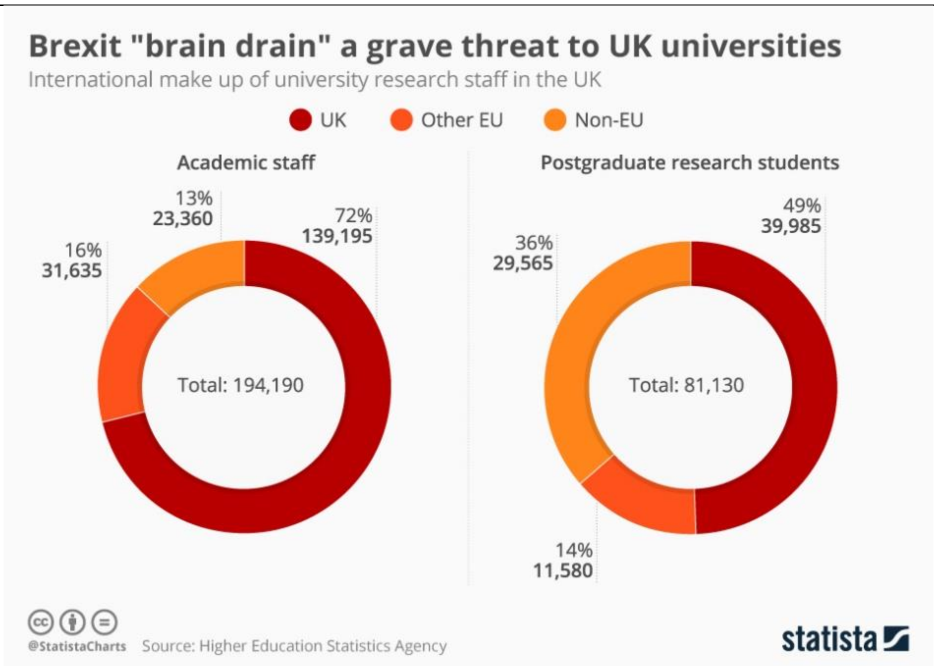
This point was reiterated by Prof Sir John Hardy, a neurogeneticist at the same institute. "Our absence from Horizon for the past three years has had a number of detrimental effects that have made the UK less attractive as a place to do science," he told the *Observer.*

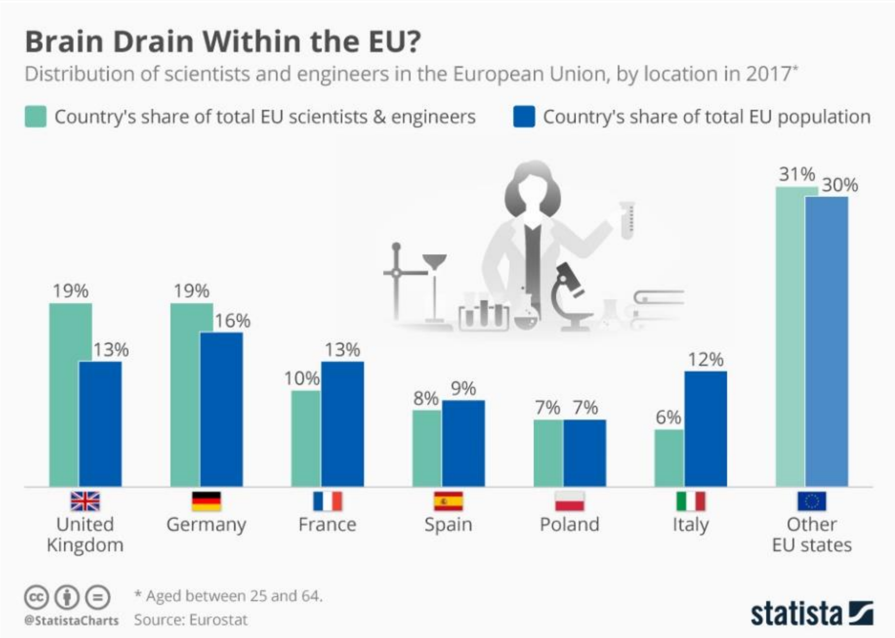
"We have not been part of the great science that Horizon funds and we have lost the trust of European colleagues. Will we leave Horizon again in future, they might ask. Many scientists have simply left the UK and, post Brexit, moving between the UK and labs in the EU has become a slow, costly, bureaucratic nightmare. All other things being equal, why would people want to do that?"

Other scientists were more cautious, however. “I don’t know what took so long, but this news will make it much easier for those of us who spend time trying to recruit the best scientists from around the world to get them to come to Britain,” said Prof Matthew Freeman, head of the Dunn School of Pathology, at Oxford University.

Prof Martin Rees, emeritus professor of cosmology and astrophysics at Cambridge University, added that the decision to rejoin Horizon represented a rare level of consensus across the scientific community in the UK and on mainland Europe. “However,” he said, “we have all been frustrated by the unconscionable delay in reaching this agreement.”

Document 10- Statistics for 2017





Document 11 - Explainer - What does rejoining EU's Horizon scheme mean for UK research and innovation?

Scientists relieved they can once again apply for funding from world's largest such programme after three-year hiatus

The Guardian, Thu 7 Sep 2023

The UK has rejoined the flagship Horizon Europe research programme, to the widespread relief of the scientific community. But what is Horizon Europe and what does it mean for UK science?

What is Horizon Europe?

With a budget of £85bn, Horizon Europe is the world's largest transnational research and innovation programme. It is open to EU member states and countries that associate to the programme, as the UK has now done after leaving it due to Brexit. The funding supports international collaborations focused on a wide range of issues, from cancer and infectious diseases to the climate crisis, food security, artificial intelligence and robotics.

What does association mean?

Rejoining the programme means UK researchers can again apply for grants from Horizon Europe. Because the current cycle of funding runs until 2027 and will be replaced by a seven-year funding cycle and another seven-year cycle after that, it provides scientists with long-term financial support.

Universities UK talked of "the 30-year" collaboration that had been interrupted by Brexit.

What about PhD students and other recruits?

It will help secure scientific talent. While the UK was locked out of Horizon Europe, it could not take the lead on research and therefore could not recruit EU scientists to work out of British universities. Britain can now throw open the door to academics including fellows and PhD students who are vital to research teams.

It means that Britain will once again be an attractive prospect for many top young scientists who want to be sure that they can conduct world-class research wherever they settle.

Will the funding change?

No. It will resume at similar levels to the predecessor programme Horizon 2020. European grants have been a substantial boon to UK research in the past. Before Brexit the UK used to get about £2bn a year from Horizon 2020. When the UK was locked out of Horizon Europe in 2020, the UK government stepped in to replace funding. However, as one source said, it has turned into "life support" in the last two years.

UK scientists could still collaborate with European counterparts but were barred from leading programmes. Their participation withered, with the UK government issuing just £1bn for 2021 and 2022 to scientists, a quarter of receipts under Horizon 2020.

Can the UK make up lost ground?

UK researchers were among the greatest beneficiaries of previous Horizon programmes and the country sometimes landed more awards than Germany, at the forefront of European science.

After being locked out of Horizon they were "level with Belgium or the Netherlands", said one British source.

Whether the UK can return to the top flight is uncertain, but both London and Brussels have expressed confidence that with a "turbo boost" in promotion of Horizon Europe, the UK can claw back its previous leading position in the programme within one to three years.

The EU has agreed to send a communique to all scientists to announce that they can, from Thursday, work with British scientists again. To avoid any confusion, the same language will be used in communiques sent out by the British government.

What about Copernicus?

Along with Horizon Europe, the UK has joined Copernicus, the EU's Earth observation programme. The system draws on satellites and air, ground and sea sensors to provide rapid information on natural disasters such as floods and fires and climate and the environment more broadly. Being part of Copernicus is seen as crucial for UK climate researchers and means UK aerospace firms can bid for satellite contracts with hundreds of millions of euros.

How much will it cost?

The UK is expected to pay £2.2bn a year (€2.43bn) into Horizon Europe and Corpernicus with about £2.1bn going to the science programme. One of the issues that delayed the deal was the correction mechanism that allows for rebates if the UK's participation is financially disastrous. Under the 2020 trade deal, the UK would have been allowed to enter negotiations on compensation if its awards were 16% lower than its contributions. But under a hardening-up of the trade and cooperation agreement, "underperformance clause" compensation will kick in automatically at the 16% threshold. Both sides have indicated they are confident this clause will never be triggered.

Will Euratom involvement continue?

No. Under the new deal, the UK will leave Euratom, the EU's nuclear research programme. That puts an end to the UK's involvement in Iter, the multibillion-euro project to build a prototype nuclear fusion reactor in the south of France. While the science community was almost unanimous that the future lay in Horizon Europe, those working on peaceful, including medical, uses of nuclear energy said the near three-year absence from Euratom meant there was no longer a strategic value in paying into the programme. Instead, the UK will focus on its own fusion energy strategy backed by up to £650m to 2027.

What changed to clinch the Horizon deal?

Once the path was cleared in March for a deal with the new Northern Ireland trading relations, association with Horizon Europe should, as Ursula von der Leyen had promised, have been swift. Sources say the EU's initial offer to the UK was to cancel any bill for 2021 and 2022 but they wanted the full £2bn or thereabouts to be paid for 2023 even when they were already four months into the calendar year and January 2023 funding rounds had already come and gone. The new deal gives the UK a free pass for the remainder of 2023 and no contributions kicking in until 2024, to give time to scientists to work up submissions for next year's rounds.

Document 12 - Le Royaume-Uni retourne dans le programme de recherche de l'Union Européenne

Poursuivant la normalisation post-Brexit des relations entre Londres et Bruxelles, le Royaume-Uni retourne dans les programmes Horizon et Copernicus, mais reste hors d'Euratom.

Par Eric Albert (Londres, correspondance) ***Le Monde***, 08 septembre 2023

Pas à pas, les relations entre Londres et Bruxelles continuent leur normalisation post-Brexit. Jeudi 7 septembre, le gouvernement britannique et la Commission européenne ont annoncé que le Royaume-Uni allait rejoindre les programmes Horizon, de coopération internationale dans la recherche, et Copernicus, les satellites européens d'observation météorologique.

« L'Union européenne (UE) et le Royaume-Uni sont des partenaires stratégiques et des alliés, et cet accord vient le prouver », se réjouit Ursula von der Leyen, la présidente de la Commission. *« C'est un accord qui va permettre aux scientifiques britanniques de prendre part avec confiance au plus grand programme de collaboration dans la recherche au monde »*, ajoute Rishi Sunak, le premier ministre britannique.

En revanche, le Royaume-Uni a décidé de ne pas retourner dans Euratom, ce qui exclut sa participation à Iter, le programme de recherche sur la fusion nucléaire. Il a *« décidé de mener sa propre stratégie »* dans ce domaine, explique Downing Street.

Soulagement généralisé

Le monde scientifique pousse un soupir de soulagement généralisé. *« Permettre à nos scientifiques de travailler ensemble, quelles que soient les frontières, est dans l'intérêt de tous »*, estime Sally Mapstone, qui dirige Universities UK, un réseau représentant les 142 universités du pays. Elle cite des programmes de recherche sur la détection des cancers des ovaires ou sur l'énergie verte, auxquels les laboratoires britanniques vont pouvoir à nouveau participer. Paul Stewart, de l'Académie britannique des sciences médicales, célèbre un *« tournant pour la science britannique »*, après un *« hiatus »* provoqué par le Brexit. Depuis 2020, les laboratoires britanniques n'avaient plus accès aux subventions d'Horizon, dont le budget pour 2021-2027 est de 95 milliards d'euros.

Théoriquement, le Brexit n'a jamais empêché le Royaume-Uni de rester dans ces programmes. Horizon compte déjà dix-sept pays hors de l'UE qui sont *« membres associés »*, dont la Norvège, Israël et la Nouvelle-Zélande. Mais au moment des négociations du Brexit, fin 2020, les tensions politiques étaient telles qu'il n'avait pas été possible de trouver un accord sur le sujet.

L'ensemble de la communauté scientifique, côté européen comme côté britannique, l'avait regretté. Les Britanniques comptent parmi les meilleures universités au monde et ils sont à la pointe sur des sujets comme la santé ou l'environnement.

Le déblocage politique est venu de la démission de l'ancien Premier ministre Boris Johnson, toujours prompt à attiser le feu anti-européen, et de l'arrivée au pouvoir de Rishi Sunak en octobre 2022. Le nouveau leader du gouvernement britannique s'est attelé au principal point de blocage : l'Irlande du Nord.

Le traitement douanier des marchandises exportées de Grande-Bretagne vers l'Irlande du Nord (qui fait partie du Royaume-Uni mais est de facto à l'intérieur du marché unique européen) était un sujet de contentieux qui bloquait l'avancée de toutes les autres négociations. En février, un accord a finalement été trouvé. M^me^ von der Leyen s'est rendue tout sourire à Windsor, près de Londres, pour annoncer aux côtés de M. Sunak un nouveau cadre sur les modalités de fonctionnement de la frontière nord-irlandaise. Immédiatement, elle a ajouté que la porte était désormais ouverte pour que le Royaume-Uni rejoigne Horizon.

« Il n'y a ni réduction ni rabais »

Il a pourtant fallu sept mois pour y parvenir. Preuve que rien n'est jamais simple dans les relations post-Brexit, les négociations ont traîné sur la question financière. Londres va verser 2,6 milliards d'euros par an (2,43 milliards pour Horizon, 154 millions pour Copernicus). En échange, ses organismes de recherche (universités, laboratoires…) pourront accéder dès 2024 aux subventions.

Mais qu'arriverait-il si la contribution de Londres était excédentaire, dépassant ce que toucheront en retour ses universités ? Jeudi matin, M. Sunak affirmait fièrement qu'un système de *« récupération »* de l'argent était prévu. *« C'est un bon accord pour le Royaume-Uni (…), y compris pour les contribuables. »*

A Bruxelles, les fonctionnaires de la Commission rejettent cette lecture. Certes, si les contributions britanniques dépassent de 16 % les subventions touchées, un mécanisme est prévu pour que les contributions futures du pays soient réduites. Mais ce n'est ni nouveau ni exceptionnel, affirment-ils. Le principe était déjà inscrit dans l'accord du Brexit de 2020 et tous les pays ont un système similaire. *« Il n'y a ni réduction ni rabais »*, affirme une fonctionnaire européenne. La normalisation des relations a encore quelques progrès supplémentaires à faire.

COMPLEMENTS

2022: Carolyn R. Bertozzi

Bertozzi won the Nobel Prize in Chemistry in 2022, alongside colleagues Morten Meldal and K. Barry Sharpless. Their research involved "the development of click chemistry and bioorthogonal chemistry," showing that molecules that quickly snap together to build larger, more complex molecules.

Bertozzi, who was born in October 1966 in Boston, Massachusetts, used click chemistry inside living organisms during her work at Stanford, and developed bioorthogonal reactions, which can occur within cells without disrupting the usual chemistry. These discoveries can now be used to explore cells, improve the targeting of cancer pharmaceuticals, and track biological processes.

Stanford Professor Dr. Carolyn Bertozzi poses for a photo in front of the Sapp Center for Science Teaching and Learning after she was jointly awarded the Nobel Prize in chemistry on Wednesday, Oct. 5, 2022, in Stanford, California. Bertozzi was one of three scientists that were jointly awarded the 2022 Nobel Prize in chemistry .PHOTO BY JUSTIN SULLIVAN/GETTY IMAGES

2020: Emmanuelle Charpentier and Jennifer A. Doudna

Doudna and Charpentier both won the Nobel Prize in Chemistry in 2020 for their joint work into "the development of a method for genome editing" using CRISPR/Cas9.

Emmanuelle Charpentier (L) and Jennifer Doudna (R) celebrate on the stage after receiving the 2015 Princess of Asturias Award for Technical and Scientific Reseach from Spain's King Felipe during the Princess of Asturias awards ceremony at the Campoamor Theatre in Oviedo, on October 23, 2015. MIGUEL RIOPA/AFP VIA GETTY IMAGES

CRISPR/Cas9 allows scientists to precisely cut out genes and swap them between organisms, allowing for the development of a huge variety of genetic modification and therapies.

"There is enormous power in this genetic tool, which affects us all. It has not only revolutionized basic science, but also resulted in innovative crops and will lead to ground-breaking new medical treatments," said Claes Gustafsson, chair of the Nobel Committee for Chemistry, at the time.

The discovery was kickstarted when Charpentier, born in December 1968, in Juvisy-sur-Orge, France, found a molecule called tracrRNA inside *Streptococcus pyogenes* bacteria, which they used to fight viruses by cleaving their DNA. Working together with Doudna, who was born in February 1964 in Washington, the scientists reprogrammed this molecule, allowing it to not just cleave virus DNA, but any DNA molecule at a predetermined site.

2018: Frances H. Arnold

Arnold won the 2018 Nobel Prize alongside colleagues George P. Smith and Sir Gregory P. Winter, receiving a 1/2 credit "for the directed evolution of enzymes", while Smith and Winter received 1/4 each for "for the phage display of peptides and antibodies."

Scientist Frances Arnold, winner of the 2018 Nobel Prize in Chemistry, smiles at a celebratory press conference at Caltech on October 3, 2018 in Pasadena, California. MARIO TAMA/GETTY IMAGES

Born in July 1956 in Pittsburgh, Arnold was the first person to perform directed evolution of enzymes, which are specialized proteins that catalyze reactions in the body. Arnold's methods are used to create new enzyme catalysts for pharmaceutical manufacture and renewable fuel. Her co-winners also created a method of pharmaceutical manufacture, using bacteriophages to evolve new proteins.

2009: Ada Yonath

Yonath, born June 1939 in Jerusalem, won the 2009 Nobel "for studies of the structure and function of the ribosome," alongside colleagues Venkatraman Ramakrishnan and Thomas A. Steitz.

Israeli Nobel laureate Ada E. Yonath talks to delegates during the BioAsia 2016 conference at the Hyderabad International Convention Centre (HICC) in Hyderabad on February 9, 2016. NOAH SEELAM/AFP VIA GETTY IMAGES

Their research involved the discovery of what the ribosome—an organelle within our cells that translates DNA into proteins—looks like and how it functions at the atomic level, using X-ray crystallography. Yonath and her colleagues each created 3D models, showing how different antibiotics bind to the ribosome.

1964: Dorothy Crowfoot Hodgkin

In an era where women weren't always taken seriously in the scientific field, Hodgkin won the 1964 Nobel "for her determinations by X-ray techniques of the structures of important biochemical substances."

Professor Dorothy Crowfoot Hodgkin at work in her laboratory. She was awarded the Nobel Prize for Chemistry in 1964. PHOTO BY © HULTON-DEUTSCH COLLECTION/CORBIS/CORBIS VIA GETTY IMAGES

The sole recipient of the Nobel, Hodgkin used X-rays to determine the structure of various molecules, by studying the patterns formed as the X-rays pass through. In 1946, she discovered the crystal structure of penicillin, and in 1956, she did the same for the most complexly structured vitamin: vitamin B12.

1935: Irène Joliot-Curie

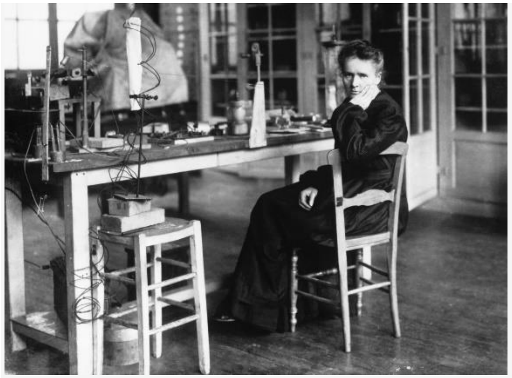
Jolior-Curie was the daughter of Marie Curie and wife to Frédéric Joliot, with whom she co-won the Nobel Prize in Chemistry 1935 "in recognition of their synthesis of new radioactive elements."
Born in 1897, Joliot-Curie had worked with her mother Marie during World War I, providing mobile X-ray units, and went on to study in Paris.

Frederick Joliot and his wife, Irene Curie, Physicists, who shared the Nobel Prize in 1935. ISTOCK / GETTY IMAGES PLUS

Joliot-Curie and her husband discovered the first instance of a radioactive element being created artificially, after bombarding a thin piece of aluminum with alpha particles (helium atom nuclei). They found that after this bombardment, the aluminum continued to be radioactive, having converted some of the aluminum atoms into a radioactive isotope of phosphorus.

1911: Marie Curie

The first woman to win the Nobel Prize in Chemistry, and one of only two to win the prize alone, Curie won in 1911 "in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element."



Marie Sklodowka Curie (1867 - 1934) in her laboratory. She shared a Nobel Prize in Physics in 1903 with her husband Pierre for their work in radioactivity. In 1911 she became one of the few people to be awarded a second Nobel Prize, this time in chemisty for her discovery of polonium and radium.© HULTON-DEUTSCH COLLECTION/CORBIS/CORBIS VIA GETTY IMAGES

Born in 1867, Curie worked with her husband Pierre to discover the radioactive elements polonium and radium, and in 1910, produced radium as a pure metal for the first time.
She and Pierre were jointly awarded the 1903 Nobel Prize in Physics, making her one of only four people in history to have won two Nobels.

Even More…

Women in science: A temporary liberation

Nature, Patricia Fara 02 July 2014

The First World War ushered women into laboratories and factories. In Britain, it may have won them the vote, argues Patricia Fara, but not the battle for equality.

Women testing explosives at a factory in Gretna, UK, turned yellow from the toxic TNT and were paid one-third less than their male colleagues. Credit: SSPL/Getty

In the early twentieth century, female scientists felt beleaguered. It is "as though my work wore petticoats", cries Ursula, the fictionalized version of distinguished physicist Hertha Ayrton in the 1924 novel *The Call*. The real-life Ayrton was denied entry to the Royal Society in 1902 because she was married; later she struggled to make the British government's War Office consider her design for a wooden fan to protect soldiers against gas attacks. Pre-war, alongside fellow suffragettes, Ayrton had marched behind banners embroidered with scientific figureheads including Marie Curie and Florence Nightingale, but such protests often aroused contempt rather than support.

"I do not agree with sex being brought into science at all," declared Ayrton. "Either a woman is a good scientist, or she is not." Ringing words — so have we yet achieved the ideal she was fighting for a century ago?

Overt discrimination is now illegal — equality of opportunity is firmly entrenched. But all over the world, traditional attitudes linger on. Glass ceilings and leaky pipelines still present tough challenges for ambitious women in science, especially at higher levels. Exposing prejudice is the first step to eliminating it. By examining the past, we can understand how we have arrived at the present — and how to improve the future.

In Britain, where the suffragists and violent demonstrations had failed, the First World War persuaded the government that women belonged in the polling booth as well as the parlour. "Oh! This War! How it is tearing down walls and barriers, and battering in fast shut doors," enthused a female journalist in 1915 in the *Women's Liberal Review*. By 1918, women had helped Britain to victory by making drugs, explosives, insecticides, alloys, electrical instruments and other essential laboratory products, and by carrying out research, running hospitals and teaching students.

Yet after the war, it was almost universally assumed that female workers should give up their jobs and slip back into their previous roles as wives and mothers. Only much later did the authorities recognize the twin follies of converting highly educated men into cannon fodder and of failing to deploy female brains effectively.

From embroidery to explosives

As men left in their thousands for the war front, women, encouraged by the suffragist movement, seized the chance to enter fields that were previously reserved for men, including science and industry. Those with little education were trained to carry out technical but relatively routine tasks — such as inspecting bombs, testing radio valves and synthesizing chemicals. Women with scientific training stepped in to fill empty positions in universities, museums, boys' schools and government departments, or volunteered to serve abroad.

For most women involved in scientific and industrial work, the war offered a temporary reprieve from domestic servitude or leisured boredom. Wartime statistics are unreliable, but the proportion of women in employment rose from less than one-quarter to more than one-third, many of them working in munitions. Old stereotypes prevailed, so women were mainly allocated boring, repetitive tasks. They were paid at lower rates than men and regarded as intellectually and emotionally inferior. Then, as now, critics focused on women's appearances, accusing them of behaving immorally by cutting their hair or wearing uniform. Even when working with dangerous equipment, female scientists were obliged to wear long restrictive skirts rather than practical trousers.

Many women were recruited into analytical chemistry because they were deemed to be well-suited to following routine recipes — but they were paid at around two-thirds of the men's rate for hazardous work. Housed in a 16-kilometre-long complex in Gretna near the Scottish–English border, women working on TNT (trinitrotoluene) and other explosives earned the nickname 'canary girls' because their skins turned yellow from the toxic environment.

In universities around the country, isolated handfuls of female researchers diverted their attention to secret military and medical projects. Highly qualified, these women had fought hard to pursue an academic career, often facing hostility from their own families and from the men who taught them. Banned from most scientific societies, they found it hard to get teaching posts. “Women high up in scientific positions, women with international reputations,” protested the palaeobotanist Marie Stopes, “are shut out from the concourse of their intellectual fellows.” One of the first female lecturers in science, Stopes studied coal power for the government during the war, only later dedicating herself to sexual education and family planning.

Scientific women were keen to volunteer their expertise. “I can put all my time and energy at your service for the next 6 weeks,” wrote Margaret Turner, a pharmacologist at the University College of Wales, to the government, “and am anxious to know whether the few helpers down here could not be allowed to contribute further to the needs of the country?” Little trace is left of women's wartime activities, and details can be hard to glean. For example, in 1914, the chemist Frances Micklethwait joined a team in London making explosives and was awarded an MBE (Member of the British Empire), one of Britain's highest distinctions — but because the work was top secret, little further information has survived.

Unprecedented openings arose for a few women. Like other female curators, the palaeontologist Dorothea Bate was ineligible for an official position at the Natural History Museum in London, but a few months after the hostilities began she stepped in to replace men who had volunteered to fight abroad. As more men disappeared to the front, some never to return, Bate's role expanded, but she was still paid piecework, so her weekly earnings remained lower than those of less-skilled male assistants. Even after the war, pressure remained high because of the backlog of uncatalogued specimens, but it was not until 1928 that the museum permitted women to apply for jobs — the ones at salaries too low to attract men. Thirty-seven years later, Bate was still there and still on a temporary contract.


Physicist Hertha Ayrton (left) designed a fan to protect soldiers from poisonous gases; chemist Martha Whiteley (right) tested such gases in artificial trenches at Imperial College London. Credit: Ayrton: Science Photo Library; Whiteley: Imperial College Archives

Protectionism could bring temporary advantages. Up to 1914, the single-sex Balfour Biological Laboratory at the University of Cambridge offered a secluded environment in which women conducted high-level research in a supportive community. Crucial for the first generations of female scientists, the laboratory closed when the departure of male volunteers to the war increased the available places across the university.

Having successfully demonstrated their scientific prowess, women were no longer automatically excluded from laboratories and lecture theatres. Then and later, in emerging fields such as genetics and X-ray crystallography, a few men — including William Bateson and William Lawrence Bragg — welcomed women to their teams. Perhaps they recognized that those who had reached such an advanced level must be of an exceptionally high calibre and could be employed more cheaply than men to carry out the same work.

Entrenched attitudes

Like their male colleagues, the few female researchers spent the war years divorced from their own interests. In the artificial trenches dug in the gardens of Imperial

College London, the pharmaceutical chemist Martha Whiteley experimented with her team of seven female assistants on explosives and poisonous gases. Almost 40 years later, in a 1953 lecture intended to inspire young women, she described examining the first sample of mustard gas, a blister agent, to arrive in Britain: "I naturally tested this property by applying a tiny smear to my arm and for nearly three months suffered great discomfort from the widespread open wound it caused in the bend of the elbow, and of which I still carry the scar." Unusually, Whiteley resumed her own research on organic analysis after the war.

Botanist Helen Gwynne-Vaughan, the first overseas commander of the Women's Army Auxiliary Corps and a commandant of the Women's Royal Air Force, painted by William Orpen (1918). Credit: © Imperial War Musuem

Especially at the beginning of the war, the official policy was clear: women were unsuitable for action overseas; their role was to keep the home fires burning. Patriotic scientists who relished the excitement and independence of travelling abroad had two main options — to volunteer for medical teams or to join the army.

Within a fortnight of war being declared, suffragist organizations had raised funds for a professionally staffed and fully equipped research hospital to be sent abroad. The offer was rejected by the War Office, which replied curtly that serving soldiers "did not want to be troubled with hysterical women". By contrast, Britain's allies — including Belgium, Russia and France — eagerly accepted, and British female teams worked in Serbia and Thessaloniki, Greece, throughout the war, later joined by US units. In well-kitted laboratories they carried out research into tropical diseases such as malaria and dysentery. And like their foreign colleagues, including Austrian physicist Lise Meitner and Marie Curie, British female scientists volunteered as radiologists.

These volunteers endured atrocious conditions, building hospitals from scratch, often in freezing weather, and dealing with horrific injuries and illnesses. And they continued to experience substantial discrimination. The War Office decreed that the former research botanist Edith Stoney was unfit to become head radiologist in Thessaloniki because she was a woman. They would have changed their mind, commented the doctor Isabel Emslie Hutton, had they seen her "carry heavy loads of equipment, repair electric wires sitting astride ridge tents in a howling gale, and work tirelessly on an almost starvation diet".

Some scientists found themselves unexpectedly recruited for military service. Helen Gwynne-Vaughan was head of the botany department at Birkbeck College, London, when she was plucked from what she described as "perhaps the only sphere in which at that time young men and women worked freely together — the laboratories of a modern university". As the first overseas commander of the newly formed Women's Army Auxiliary Corps (WAAC), Gwynne-Vaughan crossed the English Channel in 1917 "into a new and different world". She immediately set about changing it, insisting that women be treated exactly the same as men, and persuading male officers that jokes such as "Would you rather have a slap in the eye or a WAAC on the knee?" would not be tolerated. After subsequently running the Women's Royal Air Force for a year, Gwynne-Vaughan returned to her former position laden with national honours, but keen to resume her research into the genetics of fungi — an important topic at a time when refrigerators were scarce and food transport was slow.

Laboratory politics

After the armistice, women over the age of 30 quickly gained the right to vote. Nonetheless, most were deemed extravagant opportunists who were taking the rightful wages of fathers and husbands.

As soon as the men returned, university women were forced to relinquish their wartime positions, especially in lecturing, which was seen as a male preserve. A sympathetic chemistry professor protesting to the War Committee on behalf of his female colleagues wrote: “these women gave their services, services which have not received any public recognition”. At University College London, the female academics eventually secured a tea room (a former chemistry laboratory, with a gas burner in the fume cupboard) — one brave individual ventured into the men's common room and there was “such a sanacker-towzer of a row” that she backed out, defeated.

Although women did benefit from the post-war expansion of education and research, they still faced enormous obstacles in pursuing scientific careers. Female students, who had made up the majority during the war, were now outnumbered by men and were once again unwelcome in lecture rooms and laboratory classes. As the feminist journalist Cicely Hamilton lamented in 1935 that “we are retreating where once we advanced; in the eyes of certain modern statesmen women are not personalities — they are reproductive faculty personified.” At Cambridge, women could not formally graduate until 1948. Although some scientific societies accepted female members, separate common rooms survived until after the Second World War.

Scientific opportunities in industry opened up after the war, but married women with the vote often supported the conventional view that women belonged at home. As unemployment soared, they preferred available jobs to go to their menfolk, rather than to younger single women. Younger women were forced to take unskilled jobs at lower pay and found themselves trapped near the foot of the career ladder. As Kathleen Culhame, a disillusioned drugs researcher, explained: a male chemistry graduate could expect to progress well, but the “girl who worked side by side with him at the university is hard up and constantly humiliated ... She will be happier if she is not too enterprising because then her sense of frustration will be less.”

So, yes, the war enabled more women to enter science. But a century on we are still rooting out the discrimination that was built right into the heart of the system.

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