

Chapter 6

Invisible Contributors: Gender, Race, and Minorities in the History of European Science

Framing the chapter

Every earlier chapter in this course has told a story of credit: who discovered what, who published first, whose name a law, a unit, or an effect now carries. This chapter turns that same question around and asks how credit itself gets distributed – and how often it is distributed unevenly, along lines of gender, religion, ethnicity, race, sexuality, and disability, quite apart from the quality of the work done. The claim is not that European science was built exclusively, or even mostly, by people outside its recognised centres; the great majority of the individuals named in Chapters 1–5 really were the working core of the tradition this course describes. The claim is narrower and, properly understood, still important: that tradition also depended, at every period, on contributors whose work was minimised, misattributed, or actively suppressed because of who they were, and that recovering their place in the record is not a sentimental addition to the history of science but a correction to it. This chapter examines five overlapping axes along which that suppression operated in Europe – sex and gender; religion and ethnicity; race and colonial extraction; sexuality; and disability – through documented case studies, and closes by asking, as honestly as the evidence allows, why full recovery is so often impossible.

6.1 Naming a pattern: the Matthew effect and the Matilda effect

The sociologist of science Robert K. Merton gave the underlying mechanism its first name in a 1968 paper in *Science*. Studying how credit accumulates in collaborative research, Merton observed that eminent, already-recognised scientists tend to receive disproportionate credit for work done jointly with less well-known collaborators – junior colleagues, graduate students, technicians – whose own contribution to the same paper or discovery is correspondingly obscured. He named the pattern the “Matthew effect,” after the Gospel of Matthew’s line “For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath.” Merton’s own examples concerned

seniority and institutional prestige generally, not gender specifically.

It was the historian of science Margaret W. Rossiter who, in a 1993 article in *Social Studies of Science*, showed that the same mechanism operates with particular and additional force along the axis of sex, and proposed a companion name for it: the “Matilda effect.” Rossiter took the name from Matilda Joslyn Gage (1826–1898), an American suffragist and writer who, in an 1883 essay titled “Woman as Inventor,” had already argued – more than a century before Rossiter’s own article – that women’s scientific and technical contributions were systematically appropriated by, or credited to, the men around them: husbands, brothers, assistants, and collaborators. Rossiter’s contribution was to document the pattern historically and at scale, across dozens of cases from the seventeenth century to the twentieth, and to show that it was not simply the ordinary Matthew effect falling by coincidence on women more often than men, but a distinct and additional bias operating on top of it.

Historiographical note

The mechanism Rossiter and Merton describe is not usually a matter of individual dishonesty. It typically works through more diffuse channels: a woman’s institutional position (unpaid “assistant,” rather than salaried researcher) that formally entitled a male relative or supervisor to sole authorship; contemporaries’ and later historians’ unreflective assumption that the more famous name in a working pair must have done the more important thinking; and, simply, the far narrower range of institutional positions – university posts, academy memberships, journal editorships – through which formal credit and priority were historically assigned to women at all. Recognising the pattern does not require assuming that every underrepresented figure has been the unappreciated genius behind a more famous name; it requires, rather, examining each case on its own evidence, which is exactly what the sections below try to do.

6.2 Case studies in the Matilda effect

Caroline Herschel (1750–1848) worked for four decades as the indispensable collaborator of her brother William Herschel, the discoverer of Uranus (§1, Chapter 5 context aside): she ground and polished telescope mirrors, recorded and reduced his observations, and, increasingly, observed independently. Between 1786 and 1797 she discovered eight comets in her own right and compiled a corrected index to John Flamsteed’s British star catalogue, published by the Royal Society in 1798. In 1787, King George III granted her an annual salary of £50 for her astronomical assistance to William – the first payment made to a woman in Britain specifically for scientific work. In 1828 the Royal Astronomical Society awarded her its Gold Medal, the Society’s highest honour; she was the first woman to receive it, and the next woman would not receive it again until Vera Rubin, in 1996 – a gap of 168 years that is itself a measure of how exceptional, rather than representative, her formal recognition was.



Figure 6.1: Caroline Herschel (1750–1848), the first woman paid for scientific work in Britain and the first woman awarded the Royal Astronomical Society’s Gold Medal.

Ada Lovelace (1815–1852), working with Charles Babbage on his unbuilt Analytical Engine, published in 1843 an extensive set of notes – longer than the paper they annotated – appended to her translation of an Italian engineer’s description of the machine. Her “Note G” includes an algorithm for computing Bernoulli numbers on the Engine, and, more importantly, articulates a conceptual leap beyond Babbage’s own framing: that such a machine could manipulate any symbols following defined rules, not only numbers, and so could in principle compose music or process any symbolic content, not merely calculate.

Historiographical note

Lovelace’s status as “the first computer programmer” is a genuinely contested historiographical claim, not a settled fact, and this course states it as such rather than repeating the popular version uncritically. Some historians of computing, including the Babbage scholar Doron Swade, have argued that Babbage’s own unpublished working notes already contain algorithms comparable to Lovelace’s Bernoulli-number program, and that her most distinctive and durable contribution was conceptual – the idea of general symbolic manipulation – rather than the specific algorithm itself. What is not contested is that Note G is the most detailed and clearly reasoned published account of how the Analytical Engine might actually be used, that it appeared under Lovelace’s own name in a period when women rarely published original scientific or mathematical work at all, and that her framing of the machine’s generality anticipated, by a century, the distinction between calculation and general-purpose computation that defines the modern computer.

Mileva Marić (1875–1948) was one of the small number of women admitted, in the late 1890s, to the physics and mathematics section of the Swiss Federal Polytechnic in Zurich, where she was Albert Einstein’s classmate, and later his first wife (1903–1919). A body of popular writing, beginning in the 1970s and continuing online since, has claimed that Marić was an uncredited co-author of Einstein’s 1905 papers, including the special theory of

relativity.

Historiographical note

This is the single most contested claim in this chapter, and the mainstream historical consensus, based on the surviving correspondence, examination records, and the testimony of contemporaries, does not support it: the available evidence does not show Marić as a co-author of the 1905 papers, and specialists in Einstein's early work, including his principal modern biographers, regard the strong versions of the co-authorship claim as unsubstantiated. This course states that consensus plainly, precisely because the claim circulates widely and because repeating it uncritically would itself be a disservice to careful history – the corrective to one kind of erasure is not a second, equally unevicenced, story. What the documented record does show is worth stating on its own terms without inflation: Marić was one of very few women in Europe studying physics at this level in the 1890s, she failed her final Polytechnic examinations twice (the second time while pregnant) in a programme that offered essentially no institutional accommodation for a woman in her position, and she did not complete the degree or pursue an independent research career of her own thereafter. Her case illustrates the structural barriers facing even the small number of women who reached the threshold of a scientific career in this period, which is a different, better-evidenced, and ultimately more instructive story than the co-authorship claim.

Rosalind Franklin (1920–1958), an X-ray crystallographer at King's College London, produced in May 1952 an X-ray diffraction image of DNA fibres, known as “Photo 51,” whose sharp cross-shaped diffraction pattern gave the clearest experimental evidence then available that DNA had a helical structure. Her colleague Maurice Wilkins showed the image to James Watson, without Franklin's knowledge, in January 1953; Watson and Francis Crick used it, together with Franklin's own unpublished measurements of the DNA unit cell, to complete their double-helix model, published in *Nature* in April 1953 alongside separate papers by Franklin and by Wilkins. The 1962 Nobel Prize in Physiology or Medicine went to Watson, Crick, and Wilkins; Franklin, who had died of ovarian cancer in 1958, was by the Nobel Foundation's own rules ineligible regardless, since the prize is not awarded posthumously. Watson's own 1968 memoir, *The Double Helix*, portrayed Franklin dismissively and inaccurately; Anne Sayre's 1975 book *Rosalind Franklin and DNA* and, more fully, Brenda Maddox's 2002 biography *Rosalind Franklin: The Dark Lady of DNA* reconstructed a far more accurate account of her independent scientific standing and her specific, documented contribution to the discovery.

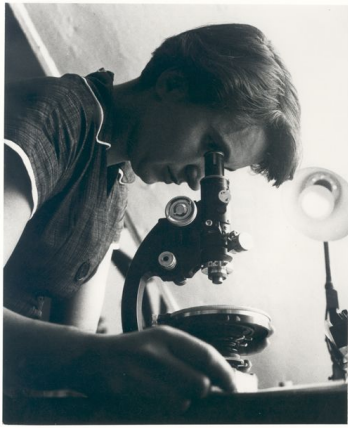


Figure 6.2: Rosalind Franklin (1920–1958).

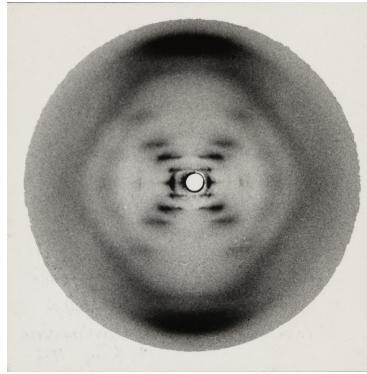


Figure 6.3: “Photo 51,” Franklin’s May 1952 X-ray diffraction image of DNA.



Figure 6.4: Jocelyn Bell Burnell (b. 1943).

Jocelyn Bell Burnell (b. 1943), as a PhD student at Cambridge, helped build a large radio telescope and, in 1967, identified in its data an unusual, precisely repeating radio signal – the first observed pulsar, a rapidly rotating neutron star. The 1974 Nobel Prize in Physics for this discovery was awarded to her supervisor, Antony Hewish, and to the radio astronomer Martin Ryle; Bell Burnell was not included. The omission was controversial at the time – the astronomer Fred Hoyle publicly criticised it within days of the announcement – though Bell Burnell herself has consistently and graciously declined to characterise it as an injustice, noting that PhD students were not customarily named on such awards in this period. In 2018 she was awarded the \$3 million Breakthrough Prize in Fundamental Physics for the 1967 discovery; she donated the entire sum to the UK Institute of Physics to fund PhD studentships for women, under-represented ethnic minorities, and refugees entering physics – a direct, practical response, in her own words, to the very pattern this section describes.

6.3 Religious and ethnic exclusion in European science

Formal, legally codified exclusion of religious and ethnic minorities from European scientific and academic life was neither a medieval relic nor a uniquely Nazi invention: it recurred, in explicit statutory form, across the century before the Second World War. Imperial Russia imposed a *numerus clausus* – a fixed percentage quota – on Jewish enrolment in secondary schools and universities in 1887, restricting Jewish students in most of the empire to roughly ten per cent of places (three per cent in the capitals), a restriction that drove a significant emigration of Jewish scientific talent westward in the following decades. Hungary went further in 1920, when its post-war government passed Act XXV, formally capping Jewish university enrolment at six per cent – proportional to the Jewish share of the national population – making it, as historians of the period note, the first overtly antisemitic law enacted anywhere in interwar Europe, years before comparable German legislation.

Germany's own version came with the Nazi seizure of power: the Law for the Restoration of the Professional Civil Service, enacted on 7 April 1933, expelled Jewish and politically suspect academics from state universities and research institutes essentially overnight. Roughly one fifth of all university physicists in Germany lost their positions within the law's first year, and a parallel movement calling itself *Deutsche Physik* denounced relativity and quantum theory themselves as expressions of an allegedly alien "Jewish physics" – the same episode Chapter 5, §5.4, describes from the standpoint of the continental physics community the purge scattered. Lise Meitner's own escape from Nazi Germany in 1938, and her subsequent role in interpreting nuclear fission from Swedish exile, is recounted in full in Appendix ??; Max Born, James Franck, and, in protest though not himself Jewish, Erwin Schrödinger all left German-speaking Europe within a few years of the 1933 law.

Historiographical note

It is worth being precise about chronology here, because the three episodes above are often run together. The Russian and Hungarian quotas were explicit, statutory *numerus clausus* laws restricting admission by fixed percentage, enacted well before the Nazi period; earlier exclusion of Jewish scholars elsewhere in nineteenth-century Europe – for instance the informal social and professional barriers that kept most German universities from appointing Jewish full professors before the 1860s–80s – operated through custom, university statute, and professional gatekeeping rather than national law, and so is a different, if related, phenomenon from either the 1920 Hungarian or 1933 German legislation. The pattern across all three, however, is the same one this chapter is tracing: formal institutional mechanisms, not merely private prejudice, determined who could enter and remain in European scientific life.

6.4 Iberian expulsions and the fate of al-Andalus science

The Iberian peninsula under Islamic rule (al-Andalus, from 711) had, for several centuries, hosted one of medieval Europe's most productive scientific and philosophical cultures, sustained by a religiously mixed community of Muslim, Jewish, and Christian scholars: the Cordoban philosopher and physician Ibn Rushd (Averroes, 1126–1198), whose commentaries transmitted and reinterpreted Aristotle for the Latin West, and the Cordoban-born Jewish philosopher and physician Moses Maimonides (1138–1204), who fled Almohad persecution in his own lifetime, both worked within, and were eventually displaced from, this milieu. The Reconquista's completion coincided with two large, state-mandated expulsions that dismantled the demographic base of that culture entirely. The Alhambra Decree of March 1492, issued by Ferdinand and Isabella immediately after the fall of Granada, ordered the expulsion of all Jews from Castile and Aragon who would not convert to Christianity; between roughly 40,000 and 100,000 people left. A century later, between 1609 and 1614, the Spanish crown expelled the Moriscos – Muslims and their descendants who had nominally converted to Christianity after 1492 but were widely suspected of continued crypto-Islamic practice – removing an estimated 300,000 people, a substantial fraction of the population in regions such as Valencia and Aragon.

Historiographical note

That these expulsions caused enormous human suffering and permanently ended a genuinely distinctive scientific and intellectual culture on the peninsula is not in dispute. Whether they are the principal explanation for Spain's relative scientific decline over the following two centuries – a claim made repeatedly in general histories – is more contested among specialists than it is often presented as being. Historians who study early modern Spain in detail point to other, contemporaneous factors of comparable or greater weight: the Spanish Inquisition's tightening censorship of books and foreign university study from the mid-sixteenth century, the economic strain of near-continuous imperial warfare, and the Counter-Reformation church's growing institutional caution toward the new experimental philosophy taking hold elsewhere in Europe. The defensible claim is that the 1492 and 1609–14 expulsions removed, in a matter of years, communities of scholars, translators, and skilled artisans who had been structurally important to al-Andalus's earlier scientific culture, and that this loss compounded, rather than single-handedly caused, Spain's altered scientific trajectory thereafter.



Figure 6.5: The Alhambra, Granada: the Nasrid palace complex whose fall in January 1492 preceded, within weeks, the decree expelling Castile and Aragon's Jewish population.

6.5 Colonial science and unattributed knowledge: the case of quinine

Not every erasure this chapter documents is a matter of who received a prize. Some concern entire bodies of knowledge whose original holders were never credited at all. The bark of the cinchona tree, native to the eastern slopes of the Andes, was used medicinally by Quechua and other Indigenous Andean peoples, who understood its value against fevers, well before any European contact; Spanish colonists and Jesuit missionaries in Peru learned of this use in the early seventeenth century and began exporting the dried bark to Europe, where it became known as “Jesuit's bark” or “Jesuit's powder” and, by the later seventeenth century, the most effective treatment available anywhere for malarial fevers.

Historiographical note

A popular legend, still widely repeated, holds that the bark was introduced to Europe after it cured the Countess of Chinchón, wife of a Spanish viceroy of Peru, of a fever in 1638 – the story that gave the genus its eventual botanical name, *Cinchona*, when Carl Linnaeus formalised it in the eighteenth century. Historical research, notably a detailed 1941 study by A. W. Haggis examining the Countess's own surviving diary and travel dates, found the story does not hold up: the timeline in the diary is inconsistent with the legend, and no contemporary source closer to the events supports it. The scientifically significant and well-evidenced history is a different one, and this course follows it rather than the legend: Andean Indigenous communities possessed and used the relevant medical knowledge first, and transmitted it to European colonisers, who exported the finished commodity while the knowledge itself, and the people who held it, went essentially uncredited in the European record that followed.

Two centuries after the bark itself reached Europe, the French chemists Pierre-Joseph Pelletier and Joseph-Bienaimé Caventou isolated, in 1820, the specific alkaloid responsible for the bark's antimalarial effect, naming it quinine; their work let physicians dose the drug precisely for the first time and is properly credited, in the standard history of chemistry, as a landmark of early natural-products chemistry. The asymmetry this section highlights is not that Pelletier and Caventou's chemistry was unimportant – it plainly was important, and correctly recognised as such in their own time – but that two centuries of prior Indigenous Andean pharmacological knowledge, without which the raw material and the medical rationale for isolating it would not have existed at all, left almost no trace of individual or communal attribution in the European scientific record that followed.



Figure 6.6: Botanical illustration of *Cinchona officinalis*, the source of quinine, whose anti-malarial use was first understood by Andean Indigenous communities.

6.6 Sexual and gender minorities: Alan Turing and the criminalisation of homosexuality

Alan Turing (1912–1954) supplied, in a 1936 paper written while still in his twenties, the theoretical foundation of modern computing – the abstract “Turing machine” – and, during the Second World War, led the team at Bletchley Park whose codebreaking work against the German Enigma cipher is widely credited with shortening the war substantially and saving many lives. In January 1952, Turing reported a burglary to the police in Manchester and, in the course of the investigation, disclosed a sexual relationship with another man; under British law, consensual homosexual acts between men were then a criminal offence, and Turing was charged with gross indecency and convicted in March 1952. Offered a choice between imprisonment and probation conditional on hormonal treatment intended to suppress libido – what is now generally described as chemical castration – Turing accepted the latter. He died on 7 June 1954 of cyanide poisoning; an inquest returned a verdict of suicide.

Historiographical note

The suicide verdict, though the official and most widely repeated account, has been disputed by at least one serious historian of Turing’s work. Jack Copeland, in his 2012 biography *Turing: Pioneer of the Information Age*, argued that the original inquest was conducted hastily and without

full attention to an alternative explanation: Turing kept a small home laboratory that included cyanide, used in an electroplating process, and Copeland contends that accidental inhalation of cyanide fumes cannot be ruled out on the available evidence. This course states both the standard account and Copeland's dissent because the underlying evidence genuinely does not permit full certainty either way; what is not disputed is the criminal prosecution itself, the chemical treatment imposed as its condition, and their place in a much broader pattern of criminalisation.

Turing's prosecution was not exceptional; it was the ordinary operation of a law – and of comparable statutes across much of Europe – under which an unknown but substantial number of scientists, along with tens of thousands of other men, were convicted, imprisoned, or coerced into medical treatment on the same grounds across the twentieth century, their careers and, in many documented cases, their lives cut short by prosecutions unrelated to the quality or importance of their work. Recognition of Turing's own case came only decades later: the British Prime Minister Gordon Brown issued a formal public apology on the government's behalf in 2009; Queen Elizabeth II granted Turing a posthumous royal pardon in 2013; and the Policing and Crime Act 2017 – informally known as the “Turing Law” – retroactively pardoned other men convicted under the same and related historical offences.

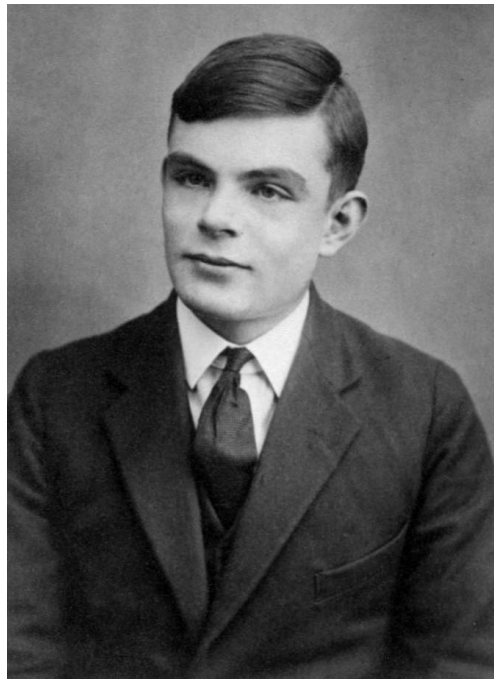


Figure 6.7: Alan Turing (1912–1954), photographed in the 1930s.

6.7 Disability and scientific achievement: Nicholas Saunderson and beyond

Nicholas Saunderson (1682–1739) lost his sight to smallpox at about one year old and was, by every surviving account, entirely blind for his working life. He nonetheless became one of early eighteenth-century Cambridge's most admired mathematics lecturers, appointed to the Lucasian Professorship of Mathematics – the chair Isaac Newton had held until 1701 –

in 1711, two years after Newton’s immediate successor William Whiston was removed from the post for religious heterodoxy, leaving a roughly year-long vacancy before Saunderson’s appointment. Saunderson lectured for nearly three decades on Newtonian mechanics, optics, and algebra, developed a tactile calculating board (a grid of pins and pegs later known as “Saunderson’s palpable arithmetic”) that let him and blind students perform arithmetic and algebraic calculation by touch, and published, in the year of his death, a substantial algebra textbook still cited by historians of mathematics education.

Historiographical note

Saunderson’s case is frequently framed, in popular retellings, purely as an inspirational anomaly. The more historically useful observation is narrower: his blindness required him, and the university around him, to develop specific instructional technology – the tactile board chief among it – that did not previously exist in this form, which is itself a documented instance of disability driving methodological innovation in the history of science and mathematics education, rather than merely being an obstacle Saunderson overcame in spite of the surrounding institutions.

The same Lucasian chair provides an instructive, if imperfect, modern bridge. Stephen Hawking (1942–2018), diagnosed with the motor neurone disease amyotrophic lateral sclerosis in 1963, held the Lucasian Professorship from 1979 to 2009 – two and a half centuries after Saunderson occupied the same post under the same disqualification of sight replaced, in Hawking’s case, by profound and progressive physical disability. The difference between the two men’s careers lies less in scientific attitudes toward disability, which changed only unevenly across that interval, than in institutional and technological accommodation: motorised wheelchairs, dedicated care support, and, from the mid-1980s, computer-based speech synthesis gave Hawking means of continued research, lecturing, and publication that had no equivalent available to Saunderson or to any of his blind contemporaries.

6.8 Why recovery is hard: sources, silence, and the limits of historiography

The cases assembled in this chapter did not become visible by accident. Rossiter’s own multi-volume history, *Women Scientists in America*, and Londa Schiebinger’s *The Mind Has No Sex?* (1989) are examples of a broader historiographical project, beginning in earnest only in the 1970s and 1980s, that deliberately went looking for exactly this kind of case in archives that had not been organised to preserve it: personal correspondence rather than published papers, laboratory notebooks kept in a collaborator’s rather than a principal investigator’s name, institutional records of admission and dismissal rather than of achievement. That project has recovered a great deal, and the cases above are drawn directly from it. It has real limits, and this course states them rather than implying the record can now be fully restored.

Historiographical note

Two limits deserve particular emphasis, because they cut in different directions. First, the archival record itself is biased in the same direction as the original exclusion: a scientist who was never given a laboratory, a publication venue, or an official position generally left behind fewer, not more, of the kinds of documents historians rely on, so the cases historians *can* document – Herschel, Franklin, Bell Burnell – are necessarily the better-documented, and so to some degree the less severely excluded, examples of a much larger and less recoverable pattern. Second, and in the opposite direction, the corrective effort itself carries a real risk of overcorrection: once a pattern of historical erasure is established and widely publicised, claims that fit the pattern can spread and be repeated – as with the Mileva Marić case above – well beyond what the surviving evidence actually supports, producing a new kind of historical distortion in the act of correcting an older one. The discipline this chapter has tried to model throughout – crediting what the evidence shows, flagging clearly what it does not, and resisting both the older erasure and its overcorrected inverse – is, in the end, simply the ordinary standard of historical evidence applied to a set of cases that too often escaped it.

Looking ahead

This chapter has examined five axes – gender, religion and ethnicity, race and colonial extraction, sexuality, and disability – along which European science’s own record of credit has been demonstrably uneven, through cases ranging from the seventeenth century to the twenty-first. None of these axes operated in isolation from the others, and none of them is now a closed historical question: the institutional mechanisms this chapter describes, from admissions quotas to criminal prosecution to unattributed extraction of Indigenous knowledge, changed form across the periods this course has covered without ever fully disappearing, and assessing how far they have genuinely receded in the present is a live question for the historiography of science rather than a settled one this course can answer on its behalf.

Further reading

- Margaret W. Rossiter, “The Matthew Matilda Effect in Science,” *Social Studies of Science* 23, no. 2 (1993): 325–341.
- Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins University Press, 1982), and its two sequel volumes.
- Londa Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science* (Cambridge, MA: Harvard University Press, 1989).
- Patricia Fara, *A Lab of One’s Own: Science and Suffrage in the First World War* (Oxford: Oxford University Press, 2018).
- Anne Sayre, *Rosalind Franklin and DNA* (New York: W. W. Norton, 1975).
- Brenda Maddox, *Rosalind Franklin: The Dark Lady of DNA* (London: HarperCollins, 2002).

- Andrew Hodges, *Alan Turing: The Enigma* (New York: Simon & Schuster, 1983; new ed. Princeton: Princeton University Press, 2012).
- B. Jack Copeland, *Turing: Pioneer of the Information Age* (Oxford: Oxford University Press, 2012).
- Henry Kamen, *The Disinherited: Exile and the Making of Spanish Culture, 1492–1975* (New York: HarperCollins, 2007).
- Saul Jarcho, *Quinine's Predecessor: Francesco Torti and the Early History of Cinchona* (Baltimore: Johns Hopkins University Press, 1993).