

## Book review

## Better than James Bond

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*The Vaccine: Inside the Race to Conquer the COVID-19 Pandemic*Joe Miller, Uğur Şahin and Özlem Türeci  
(Welbeck, London; 2021)  
ISBN: 9781802791242

*“The vaccine’s key ingredient was not RNA. It was Uğur Şahin and Özlem Türeci.”*

This book is a thriller. And it is written for everyone, not just for boffins. It is especially for those interested in COVID-19, science itself, scientific research, cancer, biotechnology, business, economics and enterprise. And it reaches into some contemporary issues, such as the bureaucrat versus the scientist, regulation versus risk, state sponsorship versus private enterprise, translational versus blue sky research and chauvinism versus internationalism. The narrative itself recounts a scientific adventure story that ranks in excitement with the best of the Bond books but has one signal advantage: it is real. Here, our heroes, with the clock ticking, pitch the power of scientific knowledge and experiments, evidence and argument against the rapidly advancing scythe of death.

Joe Miller is a *Financial Times* journalist based in Frankfurt. *The Vaccine* is his first book and written with the help of married couple Uğur Şahin and Özlem Türeci, who founded and head the German company BioNTech. The heart of the account is the 10 months and 8 days required for the genesis, making and approval of the most successful vaccine (so far) against COVID-19. But it also makes sure that we are prepared to understand and appreciate these breathtaking months. At first, it seemed to me that Şahin and Türeci must have detailed memories plus meticulous notes for each day, but actually the timeline was reconstructed by Miller from e-mails, electronic records and interviews. The result is a gripping analysis that was

cross-referenced as well as checked with those involved and only possible because, thanks to COVID-19, almost every step of progress left some electronic trace. This allows Miller to unpick in detail the particular track taken by Şahin, Türeci and their collaborators through a maze packed with different routes and dead ends.

Before going on, I must praise the clarity of the prose, the logical way the facts and concepts are presented and the well-judged moments when Miller incorporates some lessons about basic molecular biology, oncology and immunology into the narrative. This is ingeniously done as sections on these subjects could easily have become heavy and demanding, yet Miller gives them life as he fits them in and around how Şahin and Türeci developed from their start as academics. He describes how their interest in personalised RNA vaccines against cancer began and how they moved towards founding BioNTech. Miller also gives us clarifying lessons about the immune system — for we will need to have some grasp of how it works. Now, I don’t know about you, but for me immunology has been both ever present and impenetrable in my life, having a unique vocabulary, a bewildering complexity and being only understood by a subspecies of scientists. To teach us about dendritic cells and other elements of the immune system, as well as throughout the book, Miller uses military metaphors (for example, the dendritic cells are both the sentinels and the top generals, and the T cells are the snipers). Miller also dwells on other larger issues as they come up. The result is a book that is not tailored to a reader but will involve and educate each reader differently. However, one lesson that everyone will learn is how complex the process of making the vaccine was and how crucial each of the myriad factors were, ranging from scientific research done decades ago to cash on the table in Mainz.

I will not surf through the plot as that might spoil reading this book but will pick out a few lessons as if it were a moral tale. Of course, we all know the ending: this vaccine is a success and hundreds of thousands of lives have already been saved. But we should remember that, to get there, Şahin, Türeci and their many helpers



Türeci and Şahin, 1995, early in their collaboration at the University Hospital of Saarland in Homburg.

Photo courtesy of Türeci and Şahin.

had to have sufficient confidence in their plans to work day and night as well as suppress their knowledge that failure was always likely. Also, scientific research feels very different when one is in the dark oneself and muddling around trying to find a way forward. From outside and looking back, discovery can seem straightforward. Scientific papers can also reinforce that misapprehension because they are usually dressed up with a logical structure that bears little relation to history. But here we accompany the scientists, engineers, architects and financiers in real time, day by day, who are meeting obstacles, roadblocks and forks in the road, and thanks to Miller’s lucid style and a mass of authentic detail we are helped to understand enough almost to feel as though we are taking part in the trip.

There are no villains in this story, but there were brakes on the speed of progress, the most exterior ones being precedent and regulation. There was the stultifying and demotivating conviction that approval of a new vaccine must take up years because it had always done so. Miller describes how many of those involved, including some regulators, were asking themselves at each juncture: why has the next step always taken so long? After all, at first thousands and then hundreds of thousands of people were dying amidst increasing chaos in hospitals. He describes just how, thanks to some free thinking plus intellectual and technical ingenuity, everyone in BioNTech working long shifts 24/7 and the deep involvement of the pockets and workforce of Pfizer, months were saved again and again. He also describes how, thanks to cooperation

from regulators and the generosity of thousands of volunteers, the essential blinded trials were sped up to a point where everything was accomplished within the year.

This story has many educational aspects. For instance, when I began a student course more than 60 years ago, in Cambridge University, UK, we were not taught about translational science or the pharmacology industry. At that time, small biotechnology companies barely existed. For many of us, our ambition was to reach high up in academe, industry was thought not to be for the best brains and salary was not that important. Since then, academic research, for most and especially for the young, has evolved into a frustrating process full of career failures and frequent spells of crippling insecurity, in which pay is poor, research is fitful and progress is dogged by applying for grants. Most apply to government granting agencies who are overwhelmed with applications and can appear picky, prescriptive and, above all, skint. When I started research, universities provided teachers/researchers with support and even technicians. Now they treat us as cash cows whose survival in post and place usually depends on us raising enough money from outside. Watching these changes over decades has made me despondent (<http://making-of-a-fly.me/files/pdf/Lawrence-2016.pdf>).

But I have found reading *The Vaccine* refreshing and even curative. It has taught me how a biotech company, driven by a high sense of purpose, can develop over years. It helped me to recall that sense of collegiate adventure and freedom from bureaucracy that I felt in the 1960s and 1970s in the Laboratory of Molecular Biology (LMB) in Cambridge, UK. Miller has also helped me to understand more about the essential role played by money, especially that which is arriving early and free of strings as well as coming from those who can trust, help and hope and who accept that risk is unavoidable if any creative adventure is to be supported. In *The Vaccine*, the Strüngmann twins, Andreas and Thomas, emerge as angels in both senses of the word. They have helped fund the enterprising ideas and brave decisions of BioNTech again and again over years, often at crucial moments.

As just one example, Şahin and Türeci foresaw early the forthcoming need to make vast quantities of a specific messenger RNA, which used to be made in micrograms but later would be needed in kilograms per year. To tool up to do this, they saw an opportunity to buy a company with 30 employees, expertise and a nearby factory for a knockdown price of 2.5 million dollars. With the twins' agreement, they just went ahead — one of many key early decisions that have brought us the vaccine now. It is difficult to imagine raising funds so rapidly for something so speculative from conventional sources. Of course, it has paid off for the twins, but they didn't know that then, when they and their advisors made these financial decisions. The later search for funds for the vaccine itself is described very well by Miller, including the pricing of the vaccine, the involvement of Pfizer, the US marketplace, the EU, the German government and even their very first purchase order — this came from the UK via the person of Kate Bingham, whose appointment as a real scientist and not a politician was in my opinion one of the very few wise decisions regarding the pandemic made by my current UK government.

For some years now I have been advising young people seeking a rewarding career in biological research to look away from academe and consider joining imaginative biomedical companies, large and small, and this book has strengthened my confidence in that advice. Against this is an environment of suspicion in which it is asked whether it is right that any company or individual should make profits from disease — a morality play in which 'big pharma' is commonly cast as the devil. When the vaccine project was started in January 2020, BioNTech had a debt of around half a billion dollars that had accumulated as the company invested in developing cancer vaccines. Currently, BioNTech has a capital valuation of about 85 billion dollars and it brought in 6 billion in only this last quarter. But the costs of this success were massive and much of the money coming in will be used to fund one of the most imaginative and expensive (of many) attempts to help people suffering and dying from cancer. We need an environment in which effort and money



**Kai Bader and Vanessa Garthe, two production operators holding up the very first batch of pure mRNA produced at the Marburg facility.**

Production was started on February 19, 2020 at 7 p.m. CET and finished on February 20, 2020 at 1 a.m. CET. (Photo: © BioNTech SE 2021, all rights reserved.)

will continue to be put into biomedical companies such as BioNTech and to remember that most companies that work to improve or solve a huge range of medical problems fail and the money invested is all lost. As with the theatre, a few successes are vital if angel investors are to keep putting up their money.

Miller describes life at the top of BioNTech, but the company employs hundreds of people. So we do not understand much about how the main ranks of the company work, but the book gives us occasional glimpses, when we are reminded that, before the big decision to make this vaccine, the company was largely researching cancer vaccines and had built a resource of RNA know-how. We learn how the project is based on academic research (Şahin and Türeci began their careers in universities) and that the whole company (and indeed Angela Merkel) has shared the excitement. Another partially subliminal message that emerges from the story is the power of internationalist science, both academic and commercial.

I rate *The Vaccine* a triumph of scientific storytelling.

#### DECLARATION OF INTERESTS

My wife and I own some shares in BioNTech, bought on the open market in New York.

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