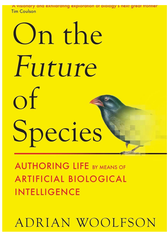
"It made me wonder what I would design, for what purpose, with such technology"

Professor Paul Freemont FRSB tackles a huge and important new book on the power and possibilities of AI-powered synthetic biology – and what it all means for the future of life on Earth

By **Paul Freemont FRSB**, 19 Feb 2026

In bioethics, biomedicine, book reviews, genetics and genomics, opinion & analysis, synthetic biology, tools and techniques, zoology



On the Future of Species: Authoring Life by Means of Artificial Biological Intelligence
Adrian Woolfson
Bloomsbury, £25

In the late 1990s and early 2000s, synthetic biology emerged as a new field of research where biologists began applying engineering design principles, and computational and molecular biology methods, to the design and redesign of biological systems and organisms. Whilst technically very challenging, the concept of designing and creating new biological genetic code at a genetic and organismal level is now firmly established. But with the rapidly developing convergence of AI with biological sciences, exemplified by alpha-Fold protein structure predictor and the Evo 2 biology foundation model, a new field is emerging called 'generative biology', or GenBio.

GenBio aims to design and create novel biological molecules, systems and genomes by combining AI and machine learning (ML) and large-scale biological data with automation and large-scale DNA construction. The overall aim of GenBio is to define the genetic design rules for living systems by essentially understanding the language, syntax and grammar of DNA as written in genomes and chromosomes and expressed in living cells. *On the Future of Species* by Adrian Wolfson tackles this new field head on, providing an extensive and personal overview of how we got to this point and where we may go once we have a complete understanding of how to write DNA.

Receiving the book over Christmas, I was daunted to find over 300 pages of text with no figures and an extensive 99-page bibliography full of primary literature (many of which may not be accessible to the reader). This is a very wide-ranging text that will not suit readers who prefer their information in Instagram packets – nor readers who want the shortest, logical path to go from A to B. However, if like me, you are a reader who likes to meander off the beaten track, discover new places and new information and enjoys multiple picnic/knowledge stops along the way, then you will certainly enjoy this book.

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The book begins at the start of the story of DNA biotechnology – explaining the language of the molecule and introducing the Swiss chemist Friedrich Miescher, who first isolated cell nuclei from pus. Early chapters give a nice scientific history of Watson and Crick's discovery of the structure of DNA, and explain how the contributions of Arthur Kornberg, Herman Muller, Paul Berg, Herbert Boyer, Stanley Cohen, Har Gobind Khorana, Craig Venter and many more have led to the molecular and synthetic biology of today. Woolfson has a reverential respect for the MRC Laboratory of Molecular Biology in Cambridge, having been a graduate student of Cesar Milstein (monoclonal antibodies), and his anecdotes and perspectives on Milstein, Max Perutz and Fred Sanger (all Nobel laureates) are very interesting.

As the same time as taking us through everything from the history of biotechnology, a series of detailed divagations also introduce us to the Argentinian author and polymath Jorge Luis Borges, and his 'Library of Bable' – an imagined library containing all the possible books that could be written, and the fantastical world imagined by 17th century English philosopher Francis Bacon, where nature was highly malleable. When Woolfson first introduces us to AI, large language models and the idea of Artificial Biological Intelligence, be ready for a fast-moving knowledge journey.

Moving on to the basics of evolutionary theory, Woolfson finds some lovely real-world examples to illustrate mechanisms such as horizontal gene transfer and evolutionary trade-offs, and some remarkable facts about the diverse and 'accidental' nature of life on Earth (such as that the New Caledonian fork fern has a genome 50 times larger than ours). He concludes this section with the striking thought that the species we observe today are only a tiny fraction of biological possibility, and therefore the rational engineered design of species from first principle will require streamlining and a reduction in genomic and biological complexity.

As a past structural biologist, I was excited to read Woolfson's chapter on biological machines, but here I found the narrative so meandering that by the end I was uncertain as to what his conclusions were, other than that engineering biological systems is extremely difficult. Comparing manmade and biological machines, Woolfson highlights the flawed or 'botched' designs, configurations and organisations found in nature (which grated a little as they evolved from scratch!). One senses that Woolfson is a little frustrated with the 'human ground state' and hopes for a future where human biological flaws like disease and ageing can be genetically designed out are something that he returns to later.

The self-assembly of viral capsids and termite mounds are used to introduce discussions of the constraints of evolution and biological redundancy. Woolfson's summary is that natural biological systems, in their current state, are too intricate to be engineerable or programmable – setting the scene for the chapters on 'Rewriting Genomes'. His idea that legacy computer code accumulating 'code burden' over time is analogous to how genetic code has evolved over 3.6 billion years is a very interesting concept, and provides further motivation for Woolfson's belief that we should ultimately be able to rewrite the entire source code of living organism using defined rules.

The discussion of human genetic complex traits, and the causal networks for such traits, is particularly relevant to the future goal of engineering away human genetic disease. The conclusion that it is near impossible to predict complex genetic traits in humans, given the influence of external factors like environment and even culture, is a reassuring counter to the idea of a 'Brave New World' where people are designed to be a certain way. Woolfson goes on to propose a human 'informione', an interesting concept aimed at capturing all information contributing to human nature which would counter human genetic exceptionalism. As the possibility of large-scale engineering biology emerges, Woolfson argues that we need to reassess what constitutes human disease, given that life expectancy in the future might be considerably extended. He warns of authoritarian societies of the future where human dissent and free could become classified as diseases and 'treated' accordingly.

Controversial biotech company Colossal Biosciences is already attempting to rewrite elephant genomes, using ancient mammoth DNA, in the hope of resurrecting this long-extinct species.

Writing on current research to understand the grammar and syntax of life, Woolfson feels we are only at the 'babbling' stage of speaking biological language. However, he argues that with sufficient data we should be able to establish the generative rules of biological grammar – the nirvana of which is to discover how the source code of genomes encodes biological structure and function in living organisms. All the while Woolfson continues to divagate into topics ranging from the contributions of video games to the development of AI to the history of origami.

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Chapter 10 is a rollercoaster ride as Woolfson explains his thinking on how these new genome writing technologies might be used. He begins by proposing a 'species catalogue' (comparable to Ancient Greek star maps) containing not just genomic sequence information but extending to all future forms of designed and constructed life, including the use of non-natural amino acids and brand-new chemistries, and perhaps even a catalogue of all possible species.

Woolfson goes on to suggest how we might apply rewritten or synthetic genomes, from humanising the humble mouse to create more relevant model organisms, to rewriting plant genomes that could help address global challenges like climate change, food security and biodiversity loss. He ponders the creation of an easy-to-use AI interface that allows us to enter simple requests such as 'design me a minimal human genome' – which prompted me to wonder what I would want to design, and for what purpose, and who would have access to such powerful technology.

Chapter 11 has the provocative title 'Authoring Human Genomes'. Woolfson does an excellent job in summarising the current technical state of technologies for assembling huge sizes of synthetic DNA, including a new method just publicised in *Nature* called Sidewinder. Interestingly this technology is being commercialised by the author's start up, Genyro, with the strap line 'Building Biology at the Rate of Design'. This section ends with his thoughts on synthetic 'miniature human genomes' that could encode synthetic protein designs for new classes of biotherapeutics.

If combating disease and ageing are key drivers of the desire to rewrite human genomes, Woolfson goes into depth on topics like the genetic and functional basis of schizophrenia, moonlighting proteins, the sub-optimality of nature, and tumour suppressor genes to highlight the complexity of designing effective genetic therapies using genome rewriting and/or refactoring. I turned the page to the last chapter, 'A Manifesto for Life', mentally exhausted. This final chapter is a stream of thinking on the eleven main issues we must consider when developing ABI and generative biology.

Woolfson's 'manifesto' sets out to define the key issues (formatted as 'clauses') and is both political and philosophical in parts. These range from the need to conserve and protect existing species, nature and human culture, to biosecurity and biosafety measures, to the establishment of international regulatory agencies and global moratoria on certain work – such as the introduction of synthetic human genomes into the germline and the de-extinction of extinct humanoid species.

Some of these clauses, such as the need to establish the rules of generative rules of biology or the need to better define disease, are repetitive of issues covered earlier in the book, while some overlapped with the 17 UN sustainable development goals, which were not referenced but do cover many of the challenges a new bioengineered world needs to address.

Many of the issues raised I agreed with – but I was struck by some contradictions, and I sensed an author who is wrestling with the fact that he is CEO of a company excitedly leading the private sector development of this technology who is also deeply concerned about the future of humanity and the human species.

Issues around governance, bioethics and public dialogue are arguably the most important areas for action in human genome writing. Here Woolfson adopts an idealistic and utopian position, arguing for an international framework and global body with regulatory powers. He feels important decision making must not be dominated by the private sector and their considerations only of profit and share prices – sadly we have a poor track record of regulating rapidly developing technologies, such as social media and AI. He also argues for a global citizens assembly representative of the full diversity of the human species, including culture and religion, and that this body should remain free from political interference and lobbying. Our track record on such bodies is also poor and it does not chyme with modern geopolitics, where international organisations like the UN are diminished in the face of unilateral actions by superpowers. It seems to me highly unlikely that we will ever be able to achieve the utopian future that Woolfson dreams of, and certainly not in time for the rapid development of generative biology.

While I enjoyed parts of Woolfson's manifesto and applaud the ethos that runs through it, many of the identified areas have been well-trodden by a very active social science (and technology) and bioethics community who have been tackling the consequences of a synthetic biology-driven world for well over 20 years.

As I turned the last page, I reflected on what must have been a mammoth writing project by an author who clearly has a polymath streak. If I was to be critical it would mainly be around the many divagations the reader needs to navigate, which often mean the important points and calls to action are in danger of being lost. The level of detail described in the book oscillates between popular science writing and a detailed scientific review paper that might be beyond the average reader.

Having said all of that, Woolfson's book is a very important and extremely timely contribution to the growing literature of books aiming to break down knowledge barriers around synthetic biology for the general population. It is super current, as generative biology develops around us, and the discussions prompted by the book are extremely timely.

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