The evolution of biotechnology: From ancient civilisations to modern day

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doi: 10.56012/gxcw4769

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Abstract

This article takes you on an intriguing exploration of the intertwined histories of biotechnology and medical writing. From ancestral plant cultivation to revolutionary advancements in genomics, proteomics, and bioinformatics, we delve into the profound evolution and influence of biotechnology on humanity. We also shine a spotlight on the critical role of medical writers, who meticulously document, interpret, and communicate these scientific breakthroughs to wider audiences. This article offers a key to understanding the convergence of science and communication, highlighting the incredible journey of biotechnology and medical writing.

Introduction

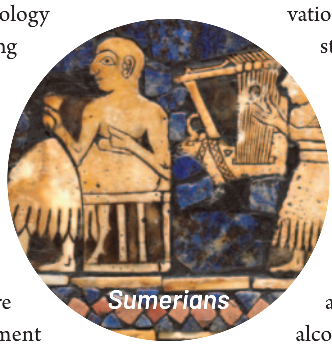
Exploring the history of Biotechnology and Medical Writing (Figure 1) reveals its evolution from ancient times when people harnessed living organisms for their benefit, to today's transformative advancements.

In the year 1919, the world of science was introduced to a term that would shape the future of numerous industries and finally give a 1000-year-old idea a name. Károly Ereky, a Hungarian agricultural engineer, conceived the term *biotechnology*.[1] His vision encapsulated the potential power of living organisms leveraged for industrial purposes. Broadly, biotechnology refers to the use of living systems and organisms, or their derivatives, to modify or produce products for humanity's benefit. This definition encompasses the recent growth in genomics, proteomics, and bioinformatics but also the advancements made by ancient civilisations.

Interestingly, this early form of biotechnology not only preserved the bodies but also inadvertently led to the preservation of ancient pathogens.

Biotechnology in ancient civilisations

In roughly 6000 BC, the Sumerians and Babylonians harnessed biotechnology and mastered the art of fermenting yeast to brew beer.[2] It was a practice rooted in observation and tradition, rather than scientific understanding. They harnessed the natural process of fermentation, which is now commonly used by many pharmaceutical companies, where yeast found in the environment interacts with the sugars in grains or fruits.[3] This interaction leads to the breakdown of complex molecules into simpler ones, producing alcohol as a byproduct. Beer and other alcoholic products became an integral part of their societal and religious practices.[3] Even without the knowledge of the biological intricacies, these ancient civilisations successfully used biotechnology in their everyday lives.



In 4000 BC, the Egyptians began using a form of biotechnology in their intricate process of mummification.[4] It was a religious and cultural practice aimed at preserving the body for the afterlife but showed a basic understanding of biotechnology. The Egyptians applied natural preservatives, such as natron, oils, and resins, which helped dehydrate the body and prevent decomposition.[4] The natron created an environment hostile to microorganisms, most commonly bacteria, thereby preserving the bodies for centuries. Interestingly, this early form of biotechnology not only preserved the bodies but also inadvertently led to the preservation of ancient pathogens. These pathogens, encapsulated within the mummified remains for millennia, present a unique opportunity for scientists today to examine and understand the diseases of the past with modern biotechnological tools.[5] These mummification practices, as with 6000 BC fermentation, were deeply rooted in observation, tradition, and empirical understanding, rather than scientific understanding. However, they still formed a vital component of life and culture in these times.

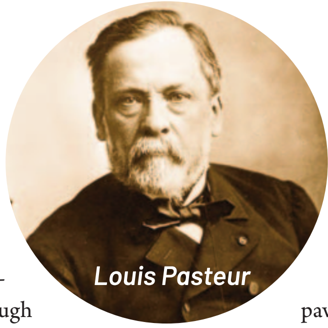
By 1000 BC, the Chinese were building on the fermentation discoveries of 6000 BC and using biotechnology to brew alcohol.[6] It not only served as a staple in social gatherings and religious rituals, but also as a symbol of hospitality and camaraderie. The consumption of alcohol became deeply woven into the fabric of their society, as it was customarily offered to guests as a gesture of goodwill and celebration.[6] The Chinese also recognised the therapeutic potential of alcohol, incorporating it into their traditional medicine practices – e.g., as an anaesthetic during surgery.[7]

The Romans made use of biotechnology in many aspects of their lives.[8] Their innovative use of concrete was formed from a biotechnological process involving the microbial mediation of minerals, resulting in the hardening of the concrete.[8] This process, like the natural formation of minerals, was leveraged by the Romans to create concrete structures that have stood the test of time. The Pantheon and the Colosseum are examples of Roman concrete's resilience, hinting at the success of the biotechnology process involved.

Biotechnology in the common era and the development of medical writing

The Renaissance period saw significant advancements in medical writing. A renewed interest in studying the human body and the natural world led to notable developments in medical knowledge. The invention of the printing press in the 15th century played a crucial role in disseminating this knowledge through the widespread publication of medical journals and texts.[9] These journals served as platforms for physicians and scientists to share observations, discoveries, and theories, promoting the exchange of ideas and collaboration within the medical community.

During the Middle Ages, the practice of traditional medicine witnessed significant advancements with an increased reliance on biological substances.[10] Herbal remedies became prevalent, with healers and apothecaries cultivating medicinal gardens to source a variety of plants.[10] These plants were used in concoctions, balms, and tinctures, prepared using knowledge passed down through generations, often incorporating elements of fermentation and distillation.[10] Another groundbreaking discovery was also made: certain types of mould could effectively treat infections[2] – e.g., probably penicillin. Initially, applying mouldy bread or decaying plant matter to wounds may have seemed counterproductive. However, it was later observed that such treatments significantly improved wounds. Unknown to them, medieval practitioners were harnessing the bacteria-inhibiting properties of the mould, effectively using a form of biological warfare to combat infections. This innovative use of natural resources laid the foundation for the earliest forms of antibiotics and paved the way for many modern antibiotics to be derived.



Scientific revolution and medical writing

Fast forward to the 1800s: the scientific revolution took off. A more formalised study of biotechnology led Louis Pasteur to make groundbreaking discoveries in the field of germ theory that revolutionised microbial biotechnology.[2] His research focused on the causes of various diseases through the identification and understanding of microorganisms. The experiments and observations he conducted led to the development of

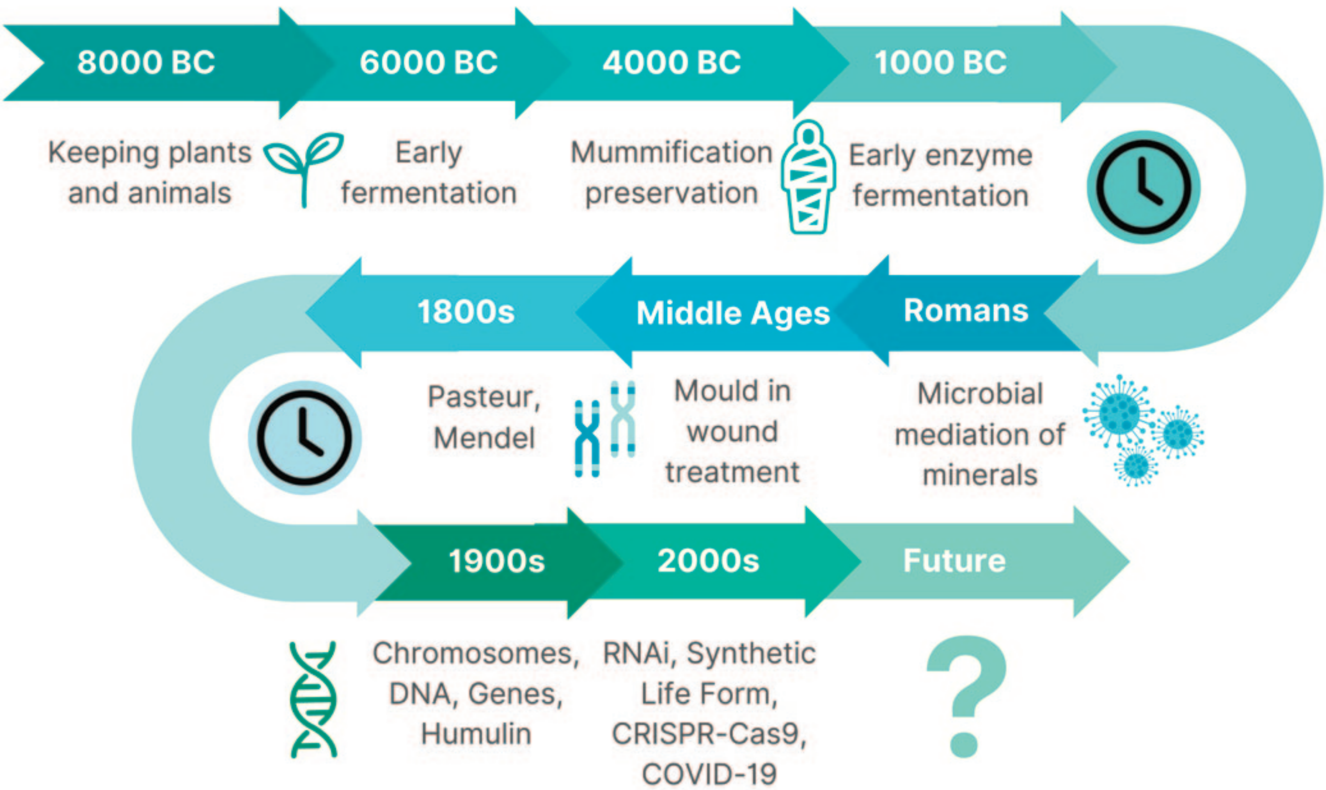
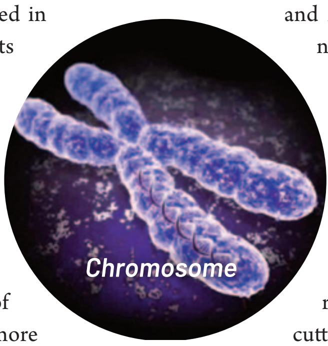


Figure 1. An overview of the history of biotechnology from 8000 BC to recent advancements made in the 2000s

techniques like pasteurisation, which played a significant role in food safety and disease prevention.

In 1865, Gregor Mendel, an Austrian priest and scientist, began studying his pea plant and decided to do some experimentation in biotechnology.[2] He crossed plants that had different forms of the same trait, such as purple or white flowers, and recorded the traits of the saplings. He noticed some traits only appeared when both parents had them, different traits were inherited independently of each other, and the ratios of the sapling traits could be predicted by mathematical law. These observations led him to make the ground-breaking discovery of dominant and recessive traits and discover the fundamental principles of genetics, now known as Mendel's laws of inheritance.[2]

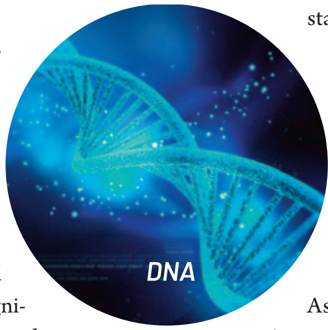
It was during this period that medical writers began to form vital roles in the scientific community. They played a large part in documenting Pasteur's work and communicating his findings to the medical community and public in a more comprehensible and accessible way. Early medical writers mostly consisted of physicians, surgeons, or professors who wrote about their own observations, experiments, or discoveries in medicine. They wrote textbooks, manuals, or treatises for teaching or reference purposes. Building on the Renaissance period advancements and as the scientific revolution took off, journalists, editors, and publishers began to write pieces on medical topics for newspapers, magazines, and journals. *The Lancet*, a popular journal that is still highly influential today, was founded during this time in 1823 by Thomas Wakley.[11] The American Medical Association (AMA) was founded in 1847 and started publishing its own journal.[12] A turning point for medical writing came in 1896 when Henry Smith Williams published *The History of Science from the Ancient Greeks to the Scientific Revolution*, which was one of the first comprehensive histories of science and medicine.[13] As more medical discoveries were made, the roles of these medical writers became more imperative to keep the public and students updated.



Biotechnology and medical writing in the twentieth century

In the early 20th century, biotechnology reached new heights. A pivotal moment in genetic research occurred when Walter Sutton and Theodor Boveri proposed the chromosome theory of inheritance.[2] This ground-breaking theory established a connection between the laws of inheritance formulated by Gregor Mendel and the observable behaviour of chromosomes during cell division. Their work provided a crucial foundation, forging a deeper understanding of how genetic traits are passed from one generation to the next. In 1928, Alexander Fleming discovered penicillin, the world's first antibiotic, when he noticed the inhibition of bacterial growth by a mould.[2] Fleming's discovery underscored the power of biotechnology, drawing on the knowledge of ancient civilisations and projecting it into the realm of modern medicine.

The 20th century was a landmark moment in the history of biotechnology, with ground-breaking scientific discoveries acting as catalysts for the modern biotech era. In 1944, a trio of scientists – Oswald Avery, Colin MacLeod, and Maclyn McCarty – made a significant contribution to our understanding of heredity, demonstrating that DNA is the genetic material that carries hereditary information.[14] Their discovery set the stage for another monumental discovery in 1953 when James Watson and Francis Crick, leveraging the X-ray diffraction data of Rosalind Franklin and Maurice Wilkins, proposed the now universally recognised double helix structure of DNA that would later serve as the blueprint for life, influencing all aspects of biology.[2]



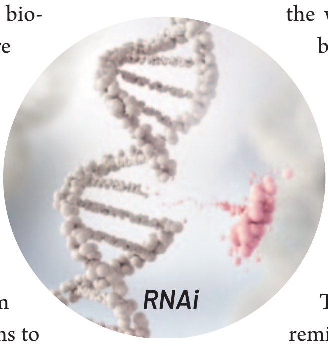
A new era dawned in 1970 when Hamilton Smith and Kent W. Wilcox discovered restriction enzymes, capable of cutting DNA at specific sequences; this later won him a Nobel Prize.[15] This discovery paved the way for a turning point in biotechnology in 1973. Herbert Boyer and Stanley Cohen successfully performed the first recombinant DNA experiment, demonstrating the transfer of a gene from one bacterium to another using a plasmid vector.[2] This trailblazing experiment laid the groundwork for genetic engineering, a fundamental technique in modern biotechnology.

In 1982, the world's first biotechnology drug was approved by the FDA. Developed by Genentech, Humulin is a human insulin drug produced by genetically-engineered bacteria. This marked a milestone in the field, displaying the extraordinary potential biotechnology held for transforming healthcare and improving human lives.[2] The approval of Humulin signposted the emerging power of genetic engineering as a tool for drug development, setting a new precedent for the start of the millennium. This era of genetic breakthroughs also saw the contributions of scientists like Kary Mullis, who invented the polymerase chain reaction (PCR) technique, revolutionising the way we study and manipulate DNA.[2]

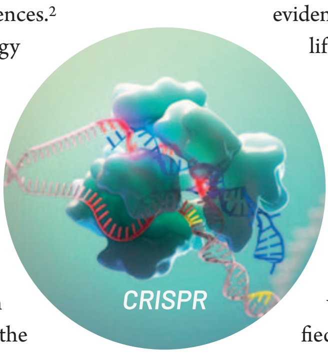
During the 1900s, medical writing started to look familiar to its role today. New fields and disciplines such as genetics and biochemistry, among others, pushed medical writers to new limits; they had to constantly learn to keep on top of new discoveries and innovations. The European Medical Writers Association (EMWA)[16] and the American Medical Writers Association (AMWA)[17] were established and provided support for medical writers through training, networking, and opportunities to extend their work. The standards and guidelines they published became deeply rooted in ethical and quality medical writing and are still used worldwide today. Medical writing became a dynamic and demanding profession as governments and the public became more involved in medicine and health. It required a combination of critical thinking, scientific knowledge, and communication skills to inform and educate the public about the latest news, trends, and controversies in medicine. The diversification of the role continued into the 2000s and morphed into the significant role medical writers play today.

Modern-day biotechnology and medical writing

The dawn of the 21st century brought forth another transformative era in biotechnology. In 2006, Andrew Fire and Craig Mello were awarded the prestigious Nobel Prize in Physiology or Medicine.[18] The distinguished recognition was for their ground-breaking discovery of RNA interference (RNAi). This mechanism had profound implications in the realm of genetics, as it provided a means to silence gene expression using small RNA molecules.[18] Their discovery of RNAi added a new dimension to the understanding and manipulation of genetic material and the development of personalised medicine, further propelling biotechnology into previously uncharted territories. In a revolutionary stride in 2008, J. Craig Venter and his team accomplished a feat that was once thought to be science fiction – they synthesised an artificial bacterial genome and transplanted it into a recipient cell.[2] This remarkable achievement created the first synthetic life form, an event that not only marked a significant milestone in the field of biotechnology, but also sparked discussions about the possibilities and ethical implications of synthetic biology.



In 2010, Jennifer Doudna and Emmanuelle Charpentier made a breakthrough discovery with the CRISPR-Cas9 system – a formidable tool that revolutionised genome editing by enabling precise alterations in DNA sequences.[2] This ground-breaking technology was leveraged in 2013 when Feng Zhang and his team reported the first successful application of CRISPR-Cas9 for genome editing in mammalian cells.[19]



The rapid development and potential applications of this technology, however, soon stirred a global dialogue around the ethical and societal implications of genetic modification, especially in humans. There was even talk of bringing back the woolly mammoth by cloning preserved thigh bones.[20] Reflecting this, the International Summit on Human Gene Editing[21] was convened in 2015 to deliberate on the ethical and social dimensions of using CRISPR-Cas9 for modifying human embryos. However, in 2018, He Jiankui sent shockwaves through the scientific community and the world with a startling announcement. He stated that he had successfully created the world's first gene-edited human babies using the ground-breaking CRISPR-Cas9 technology.[22] This significant achievement sparked a firestorm of global controversy and widespread condemnation, challenging the ethical boundaries of biotechnology like never before. The incident served as a stark reminder of the immense responsibility that accompanies the power of genome editing, and the urgent need for regulation in this rapidly evolving field.

Only a few years later, there was an industry-defining moment in 2020. An unprecedented achievement allowed the FDA to approve the first COVID-19 vaccines developed using the innovative messenger RNA (mRNA) technology.[23] This technology instructs cells to produce a viral protein that triggers an immune response, a significant leap in vaccine development. It reflected the culmination of over 10,000 years of biotechnological advancement, highlighting the power of biotechnology in confronting global health crises. It marked a beacon of hope amid a global pandemic and highlighted the potential of biotechnology, not only as a tool for progress, but as a weapon in safeguarding humanity's future.

Conclusion

In reflecting on biotechnology's history, it is evident that the human desire to harness life's tools to solve complex problems has been both a blessing and a curse. This journey has given rise to phenomenal advancements; anyone now working with monoclonal antibodies and other therapeutic biotechnology products are now working with genetically-modified organisms! However, this journey has recently showed some darker sides. Such moments serve as stark reminders of the perils of unrestricted scientific exploration and the future of biotechnology. However, it is equally important to remember that every stumble is a step forward on the path of learning. Medical writers have played a crucial role in this journey by critically articulating data about biotechnology. They have helped to further advance the field and get drugs developed. Their ability to communicate complex scientific information in an accessible and comprehensible manner has been vital in bridging the gap between the scientific community and the public and fostering a deeper understanding of biotechnology and its impact on humanity.

My definition of biotechnology is with all its potential and challenges: Biotechnology is an intrinsic part of our existence – woven into the fabric of our lives, our society, and indeed, our very world. The ongoing journey of biotechnology is not merely about mastering life's mechanisms, but also about evolving our understanding of ethical practices.

Acknowledgements

Thank you to the following colleagues at Morula Health: Philip Burridge, Jed McKenzie, Tara Quinn, and Jayshwini Sanghani for their contributions.

Disclaimers

The opinions expressed in this article are the author's own and not necessarily shared by their employer or EMWA.

Disclosures and conflicts of interest

The author declares no conflicts of interest.

Data availability statement

N/A

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