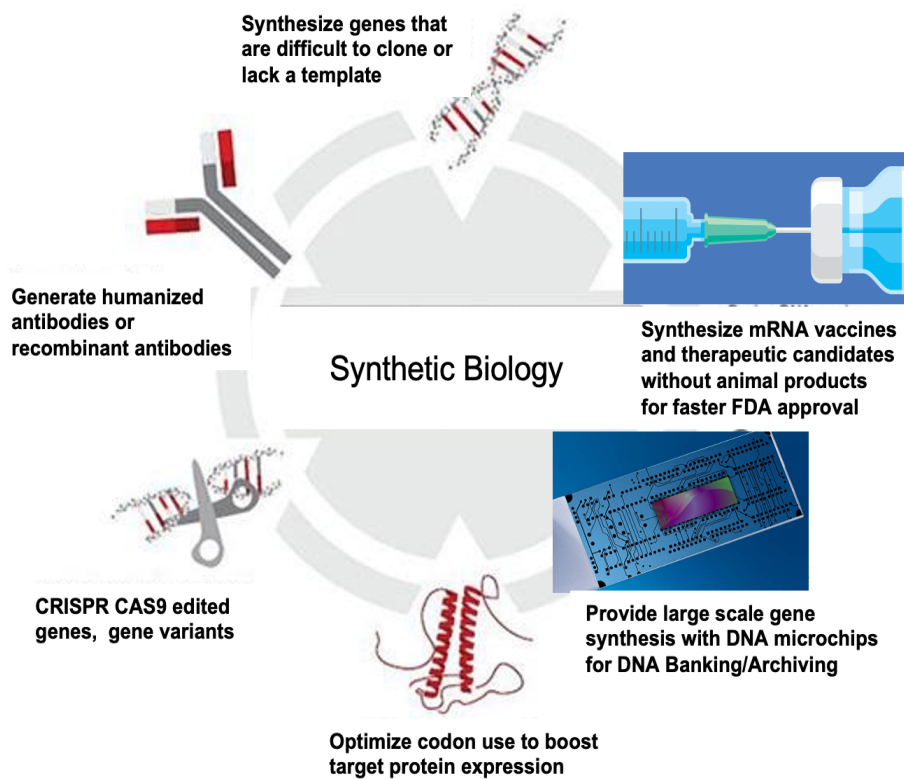


What Is Synthetic Biology and How It is Changing Our World

“The day might not be too long in the future when your personalized prescription will be emailed to you and printed at home”

In the realm of scientific innovation, synthetic biology stands as a cutting-edge field that has the potential to revolutionize various aspects of our lives. By combining biology, material science, chemistry, and computational sciences, synthetic biology aims to design and construct new biological parts, devices, and systems, paving the way for remarkable advancements. This blog post explores the concept of synthetic biology and its potential to reshape the world in terms of health, food production, and environmental sustainability. It also identifies potential bottlenecks that need to be solved to achieve the promise of synthetic biology



Healthcare

Synthetic biology holds immense promise for transforming the healthcare landscape and revolutionizing how therapeutics are discovered and manufactured. Harnessing the power of the body to protect and heal itself is becoming possible. Through genetic engineering and the principles of synthetic biology, scientists can manipulate organisms to create novel biopharmaceuticals, vaccines, and biotherapeutics. This opens up avenues for innovative disease diagnosis, treatment, and prevention strategies. It also provides the means for personalized

medicine, e.g., creating individual cures for inherited and acquired diseases such as cancer. The ability to engineer organisms and their cellular machinery, through advancements in CRISPR methodology for instance, allows for the development of highly targeted and personalized medicine. By tailoring treatments based on an individual's genetic makeup, synthetic biology enables more effective and precise interventions, such as mRNA vaccines for cancer that have already shown their full potential in some cancers but have yet to be effective to treat solid tumors. Furthermore, synthetic biology has the potential to extend human longevity and improve quality of life by adding or repairing genes that become ineffective over time. Through regenerative medicine and tissue engineering, scientists are exploring the possibilities of growing artificial organs or repairing damaged tissues. This groundbreaking field offers hope for addressing chronic diseases, disabilities, and age-related degeneration by providing new approaches for rejuvenation and functional restoration. In the realm of diagnostics, synthetic biology plays a crucial role in developing highly sensitive and specific biosensors and in vitro diagnostics that eliminate false negatives. These diagnostic tools can detect and monitor diseases at their earliest stages, allowing for rapid and accurate diagnosis. Early detection significantly enhances the effectiveness of treatments and improves patient outcomes. Additionally, synthetic biology contributes to the production of diagnostic tools, making them more affordable and accessible to regions with limited resources or as permanent implants to provide continuous more effective bio-pharmaceutical doses. This accessibility empowers healthcare systems worldwide to provide better care and improve health outcomes on a global scale. The impact of synthetic biology in healthcare extends beyond individual patients. It holds the potential to transform public health initiatives and response strategies such as in the case of pandemics or endemic diseases. By leveraging synthetic biology techniques, researchers can develop more efficient and targeted vaccines against infectious diseases, aiding in disease prevention and control. This capability is particularly crucial in the face of emerging pathogens and global health challenges. In summary, synthetic biology's advancements in biopharmaceuticals, vaccines, biotherapeutics, personalized medicine, longevity, and diagnostics are set to change the world of health significantly. It offers innovative solutions that hold the potential to improve patient outcomes, extend human lifespan, and revolutionize disease prevention and control strategies. By harnessing the power of synthetic biology, we are moving closer to a future where healthcare is personalized, precise, accessible, and transformative for individuals and communities alike.

Food

The world's population is projected to reach nearly 10 billion by 2050, putting enormous pressure on global food production. Synthetic biology presents a solution by offering innovative approaches to enhance agricultural practices and food production. Through genetic engineering, crops can be modified to increase yield, enhance nutritional content, and improve resistance to pests, diseases, and environmental stressors. This can potentially address food scarcity and malnutrition in various parts of the world, particularly now when we are already experiencing the effects of climate change. Synthetic biology also enables the production of alternative food sources. By engineering microorganisms, it is possible to produce proteins, fats, and other essential nutrients without relying on traditional agriculture. This opens doors to sustainable and resource-efficient food production methods, such as lab-grown meat and microbial fermentation. Additionally, synthetic biology offers the potential to develop eco-friendly biopesticides and

biofertilizers, reducing the reliance on harmful chemical inputs and promoting environmentally friendly agricultural practices.

Environment

As the world faces pressing environmental challenges, synthetic biology offers innovative tools and strategies to address them. By harnessing the power of engineered microorganisms, synthetic biology can facilitate the production of biofuels as a renewable energy source. Biofuels generated through synthetic biology processes are more sustainable and emit fewer greenhouse gasses compared to fossil fuels, thereby mitigating climate change. Synthetic biology also contributes to environmental conservation by enabling bioremediation, the process of using organisms to remove pollutants from the environment. Engineered microbes can be designed to break down and eliminate harmful contaminants, such as oil spills and toxic chemicals, promoting the restoration of ecosystems and protecting biodiversity.

Digital Storage

The current limits of digital storage are primarily constrained by the physical and technological limitations of existing storage media, hard drives. Information on magnetic media degrades over time. Data centers regularly replace their hard drives every 4 to 5 years. It is estimated that the cost of replacement will cost over \$75 Billion per year by 2030. DNA's four-letter coding system allows for encoding digital information with incredibly high capacity. Although there are challenges to overcome, ongoing research and advancements in DNA synthesis and sequencing are gradually addressing these limitations, paving the way for DNA-based storage to revolutionize the field of digital storage in the future.

For long term archiving, 100 years or more, DNA-based storage technologies hold great promise as a potential solution. After all, DNA has been successfully sequenced, 10 times over, after 50,000 years from specimens of Neanderthals with errors on the order of 0.1% (due to modern day human contamination). It has been suggested that DNA can store around 215 petabytes (1 petabyte = 1 million gigabytes) per gram. Considering the estimated 64 zettabytes of data produced in 2020, we would need to convert this to petabytes (64 zettabytes = 64 million petabytes). Dividing this by the information density of DNA (215 petabytes per gram), we can calculate the amount of DNA needed to store this data to be around 300 kilograms. However, it's important to note that the conversion from digital data to DNA storage is complex and involves encoding schemes, error correction, and synthesis considerations, which may affect the final amount of DNA required. DNA's exceptional information density, environmental longevity, and chemical stability make it an attractive candidate for storing vast amounts of data over long periods of time. Given the accelerating speed of DNA sequencing it might be possible to read this DNA in real time in a few years.

Remaining Unsolved Problems In Synthetic Biology

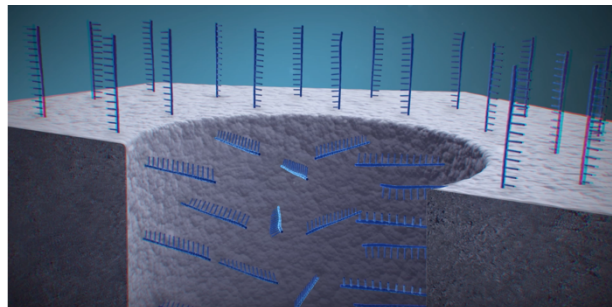
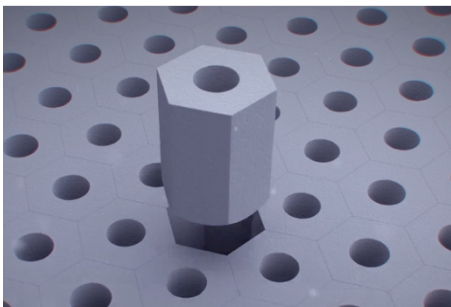
In the field of synthetic biology, several challenges persist despite significant advancements. Despite great advances in DNA sequencing we are still relying on chemical

methods developed nearly 50 years ago (Phosphoramidite chemistry), on materials invented in the early 20th century (controlled pore glass). Synthesizing long genes, typically exceeding 3000 bases, in preclinical quantities (nano to micromolar scales) remains a hurdle due to cost, time, and maintaining sequence fidelity during synthesis. Similarly, synthesizing RNA molecules of various sizes poses challenges, with RNA synthesis requiring additional considerations such as poor coupling (adding one more base) efficiencies, chemical stability and susceptibility to degradation. Achieving precise and efficient DNA ligation, crucial for complex genetic engineering, is an ongoing focus. Furthermore, the synthesis of DNA and RNA sequences containing palindromic regions encounters difficulties related to hairpin formation and secondary structures that standard amplification methods such as Plasmids are unable to resolve. Lastly, the synthesis of multiply modified RNA, with unnatural bases, remains a technical challenge, requiring innovative strategies for incorporating specific modifications at precise positions. Addressing these obstacles necessitates interdisciplinary collaborations and continuous advancements in synthesis techniques and automation, enzymology, chemical biology, and bioinformatics. Overcoming these challenges will expand the applications of synthetic biology, enabling complex genetic engineering and the development of novel solutions.

Nanopec

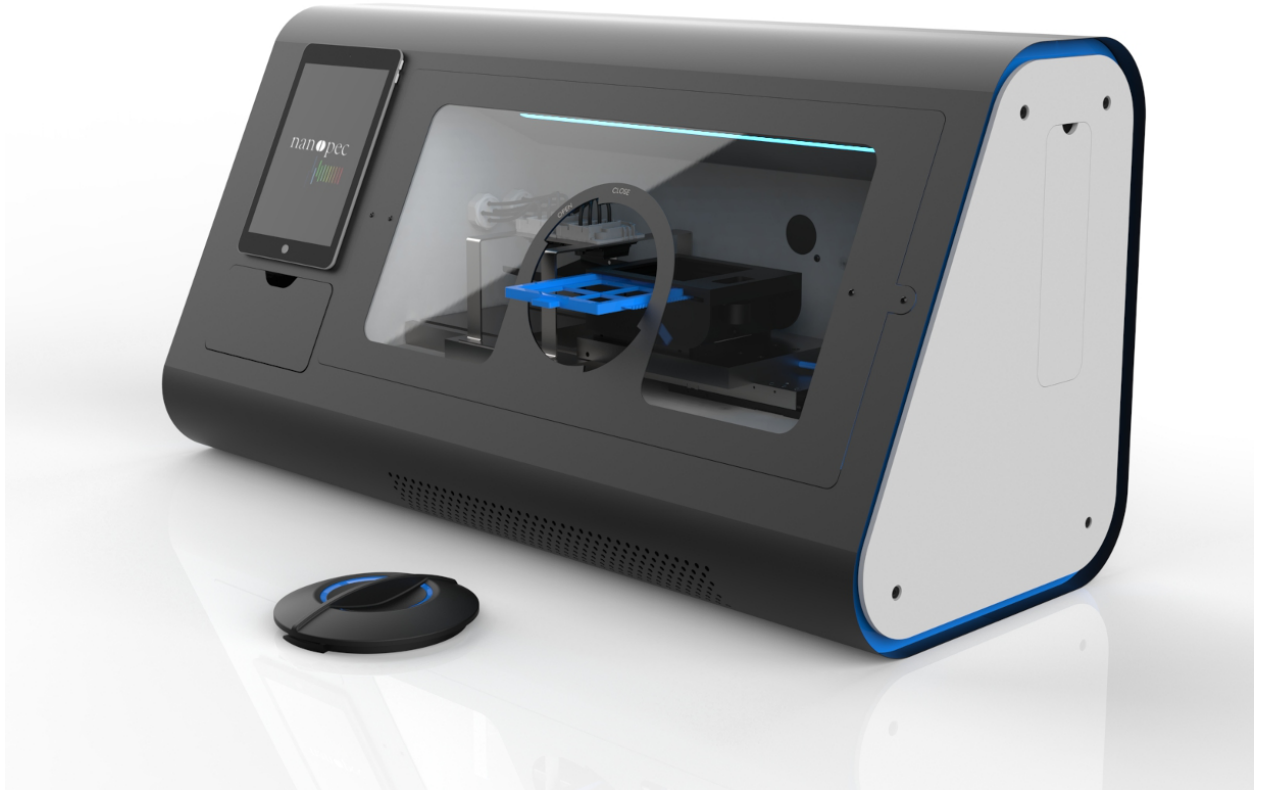
Synthetic biology holds immense potential to transform the world in various domains, particularly in health, food production, and environmental sustainability. By leveraging the principles of biology, engineering, and computation, this emerging field offers innovative solutions to pressing global challenges. With ongoing advancements, synthetic biology has the capacity to improve healthcare outcomes, address food scarcity, and promote eco-friendly practices. However, as with any emerging technology, it is crucial to consider ethical, social, and regulatory aspects to ensure responsible and equitable deployment. With careful implementation, synthetic biology has the capacity to usher in a brighter future for humanity and the planet.

Nanopec's goal is to realize the full potential of synthetic biology to protect, to heal, and to improve the quality and length of our lives. Nanopec has been using DNAREax, a nano-porous ceramic film, in order to transform the synthetic biology market. Examples of this include DNAREax to boost the production of DNA by 400 fold over silicon chips for banking purposes and biological therapeutics.



Nanopec is able to create preclinical amounts of cell and animal free DNA overnight. This DNA has no risk of cell/DNA contamination, thus leading to undesirable immunological reactions,

it does not use E. coli, mammalian cells, or bovine serum, and there is sufficient product yield to run preclinical tests at nano to micro-molar amounts directly from the synthesis without needed amplification or fermentation. DNAREax is the proper 'paper' to make DNA, to print precisely and in pre-clinical amounts DNA and RNA. Simultaneously Nanopec is working on a prototype DNA & RNA synthesizer to achieve the goal of creating 100 variants of a gene comparable to the spike protein for SARS-Cov2.



Nanopec's goal is to improve, sustain, and prolong life by increasing availability of DNA and RNA, speed up the cycle and lower the cost for discovering more effective and less toxic biopharmaceuticals, finding profitability in smaller patient groups leading eventually to personalized medicine. With the use of its proprietary nano-structured ceramics and surface chemical modifications Nanopec enables the field of synthetic biology to change our lives. The day might not be too long in the future when your personalized prescription will be emailed to you and printed at home.