Viewpoint

No, synthetic biologists are not 'playing God'

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Synthetic biology is a field of biological research in which interest has burgeoned over the past decade. The turning point that launched synthetic biology research was the completion of the Human Genome Project (HGP) in 2003. With the availability of our genetic code (sequence of chemical base pairs that make up the human DNA), we can now use these data to yield greater understanding of the inner mechanisms of our biological systems. Using synthetic biology, we could potentially not only achieve better diagnosis and treatment of human diseases, but also solve problems like rising food market and global energy needs [1]. Synthetic biology is aimed at the rational design, construction, modeling, testing, and debugging of biological entities to make up a functional organism that can carry out designed, predictable tasks. A major part of the research in synthetic biology involves making and creating new genes and genetic devices. Scientific knowledge in biology has drastically advanced over the years that now give the ability to create new synthetic organisms. This possibility has sparked a huge debate about synthetic biologists taking over the role of creationists by 'playing God'.

With the advent of recombinant DNA technology from the early 1970s, genetic engineering has evolved as a 'cut and paste' technology where genes can be added or deleted in the genome [2]. On the other hand, synthetic biology starts with designing the sequences on a computer (also known as the bottom-up approach); employing chemical nucleotides of Adenine, Thymine, Guanine, and Cytosine-strung together by DNA synthesizers depending on the DNA sequence fed into the machine. Synthesized pieces of DNA are then assembled together to form new functional genetic devices. These functional genetic devices can then be inserted into host organisms to carry out predictable tasks. Thus predictable outputs are translated into solutions that will help solve real world problems: cut down carbon emissions, produce green energy fuels, treat diseases and, a host of other biotechnological applications. The ability to reprogram and redesign natural biology in order to produce tailored bioprocesses with predictive outcomes prospects more than what conventional biotechnology has given us [3].

Researchers in the field of genetic engineering are not surprised by the emergence of synthetic biology and believe that it is a natural progression in fundamental biology [3]. Biological research has reached a landmark phase where yield of knowledge has been more profound than what was known several decades ago, hence facilitating the construction of synthetic micro-organisms. On a historical and philosophical perspective, it has been opined that synthetic biology is the most recent and unexceptional off-shoots, from what humans have started many millennia ago, for instance; subsistence farming [4]. Ever since the agricultural revolution that involved selective breeding techniques to grow high-yielding crops, man has tweaked nature for his needs and thus the manipulation of nature is not new [5]. A major controversial issue is that synthetic biologists are trying to override and eventually substitute nature with synthetic biology which tends to usurp the boundaries between man and nature. Here, it begs to question the concept of nature. Who decides what nature is? Who has the moral authority to decide and preach on the concept of nature in the first place? [5] In simple terms, nature encompasses plants, animals, the environment, and other characteristics of the earth, as opposed to humans or human creations. From an ethical perspective, nature as a whole has an inherent value in itself. Any human endeavor that disregards it is morally questionable. But does conducting synthetic biology really disparage nature? [6] It is to be noted that scientists often turn to nature and the so-called 'new design' are entirely or minor variations of what exists in nature already. This definitely means that synthetic biologists do place nature on a pedestal and are inspired by nature itself. The construction of synthetic micro-organisms is merely the creation of more additions, albeit man-made, to the existing natural world. These additions do not diminish the concept of nature or its inherent value, which in any case of absence or presence of synthetic biological organisms will not (and need not) be diminished by human creativity.

An ethical concern is whether synthetic biological products have an intrinsic value that is inherent in all natural products and organisms as prevalent in the environment [7]. Critics of synthetic biology have also contended that creation of synthetic microorganisms leads to devaluing or undermining the specialness of life. The vitalist theory that supports the idea of a 'vital force' that is necessary for living organisms has been disproved by experiments conducted by the research scientists at the J. Craig Venter™ Institute. The transfer of synthetic *Mycoplasma mycoides* genome made from four chemicals of nucleotides A, G, C and T, into a natural host of *Mycoplasma capricolum,* followed by the replication of the synthetic genome in the host, proves that it is the DNA that drives the information system in a microorganism and not the 'élan vital' as believed by the vitalism theorists [8]. Although the vitalist theory is disproved, it does not deprive micro-organisms (natu-

ral or synthetic) of their inherent value based on the biocentric ethical standpoint that all micro-organisms have an intrinsic value as they are living beings [7].

The fact that using synthetic biology, scientists can create biological entities different from those found in nature thereby giving them the ability to potentially build any organism has led to dubbing synthetic biologists as allegedly 'playing God'. The notion of "playing God" is not preached by the scientists but is often used by journalists and media personnel as a catch-phrase in conventional and modern media. At present, a Google search of two keywords "synthetic biology" and "playing God" yields 35,700 results. This media onslaught has been on the rise since the creation of the first synthetic cell in 2010 by researchers at J. Craig Venter™ Institute at La Holla, in Maryland. But, what does the notion of "playing God" mean? To create life – to make life out of nothing – is considered as an act of God. No man can create life from scratch or absolutely nothing. Moreover, Venter's 'synthetic' genome sequence was designed based on a natural genome and chemically synthesized using chemical nucleotides of A, T, G, and C which in by itself does not constitute a living being or exhibit any properties – reproduction and evolution – of one [6]. In order for it to work, the synthetic genome had to be inserted into an existing natural framework – a microbial chassis – after which it started to replicate. In this sense, synthetic biologists are not playing God. Progress in scientific knowledge does not gift any scientist with the ability to be 'God' – an entity often conceived as someone with the absolute knowledge of the universe, ability to create anything with no restraints at all. Scientists have constraints such as insufficient knowledge of biology, material immaturity as with biological building blocks to construct synthetic systems and, even limited funding – all of which clearly unwarrants tagging them as 'playing God'.

Like with any new technology, synthetic biology also needs to be scrutinized for potential risks to public safety and the environment. Creating new sets of genes and organisms through human invention may lead to fears of environmental pollution and potential use as bioweapons. Scientists have taken the first steps to tackle this by designing micro-organisms that have built-in 'genetic firewalls' allowing the growth only in lab/artificial conditions to achieve bio-containment. At the same time, the research immaturity and the underlying complexity involved in synthetic biology, currently makes it difficult and ambiguous to appropriately carry out risk assessment. This concern is being addressed by scientists, policy makers and regulators in the same lines as dealt with genetic engineering and recombinant DNA technology decades ago.

The language used to deploy scientific advances into the public space has an effect on public opinion about synthetic biology. News that are based on poor scientific knowledge may misinform the public and lead it to misunderstand the technology. The newness, strangeness and transgression that characterize some new technologies – like synthetic biology – can lead to a public reaction against the development of this technology. In such an atmosphere, it is imperative that proper, well-informed scientific discussions are open to the public so that these exchanges spur rational thinking and can act as a catalyst to help develop educated opinions about synthetic biology. With the advent of synthetic biology, it is most likely that Synthetically Modified Organisms (SMOs) will become a part of our future. Sooner or later, there will be a phase of universal acceptance of SMOs that will impact our lifes in a high degree. We embark on an era that will witness a deluge of genomic technologies and set sail for the next cycle of the Kondratieff waves in technology and economic development: 'Geno-technology'. As synthetic biologists redesign biology to innovate genomic technologies, their ambitious goal is to preserve humanity and life on this planet. In this regard, they are certainly not 'playing God'.

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