Synthetic Biology Industrial Revolution, Social And Ethical Concerns

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***Abstract:-* The field of synthetic biology poses greater potentials with growing number of applications that can transform various sectors of the economy geared towards green technology. The potentials and essentials that synthetic biology poses in the pharmaceutical, agricultural, chemical production and energy sectors propose for better solutions to some of the greatest environmental challenges of our time, such as climate change due to global warming, water scarcity, pollution's and many others thus can be considered as the modern day epitome of disruptive innovations since it creates a new market and value network that will eventually disrupts an existing market and value network, displacing established market-leading firms, products, and alliances in biotechnology. Disruptive innovation was a term of art coined by Clayton Christensen, describes a process by which a product or service begins at the bottom of a market trend and then exponentially moves up ladder disrupting or displacing already established competitors in that particular field. According to the disruptive innovation theory not all innovations are disruptive, even if they are revolutionary. This review paper focuses on the potentials of the synthetic biology and emerging ethical concerns associated with innovative potentials of the emerging field of synthetic biology and why research institutions should focus more on synthetic biology as consortium of the modern advances in inventions and innovations and by examining the emerging global trends and problems, and looking for solutions and applications, it is affirmative that synthetic biology is a game-changing technology for the future since there are many exciting applications that directly address global needs in a fundamental way.**

***Keywords:* Synthetic Biology, biotechnology**

I. INTRODUCTION

The advances in technology has led to a new era of synthetic DNA which now allows scientist to develop organisms with novel functions, such as antibodies productions, this advancement has been collectively termed as the synthetic biology; a field which shares features with modern biotechnology and specifically builds on traditional molecular biology techniques to control the design, characterization and construction of biological parts, devices and systems. (1,6) Synthetic biology goes beyond traditional genetic engineering which typically involves the transfer of individual genes between cells, it actually involves the assembly of new sequences of DNA and even entire genomes. Synthetic biology provides tools for better exploration and understanding of the living organisms systems and can produce valuable products, such as drugs, fuels or raw materials for industrial production, by reducing the time, cost and complexity thus the field represents opportunities for a range of industries and future economic growth and job creation. In the world today, many countries are struggling to refurbish their cities by producing goods and services using renewable resources yet cities are exponentially swell with carbon emissions with the bulk of these emanates from solid and liquid fuels.(5) Scientific and economic interventions to curtail these emissions have been proposed for many years with little success along the way. Fortunately, synthetic biology offers effective means to implement sustainable manufacturing processes that can reduce cost of production.

Synthetic biology may be used to develop tests for various infections including antibiotic resistant strains in more affordable way. It is more of importance to note that synthetic biology will disruptively transform the pharmaceutical industries around the globe by alteration of the bacterial genes that produce antibiotics to generate potential new antibiotics.(2,4) The other disruptive innovative impacts of synthetic biology is on industries, key problems in industries revolve around raw materials supply, manufacturing costs, and the functionality of processed materials. Raw materials and manufacturing are costly, due to scarcity, energy, and capital requirements and they can be hazardous to workers and the environment. (7,23) Biological materials are inexpensive, abundant, and have novel functions, such as self-repair, with energy-efficiency and clean manufacturing.(9,20)It has already been demonstrated by the production of spider silk using engineered bacteria to create stronger textiles and many other applications to come. In manufacturing, biocatalysts are being developed for chemical production to replace the costly and environmentally unfriendly processes used today allthese shall disruptively innovate energy production sector.

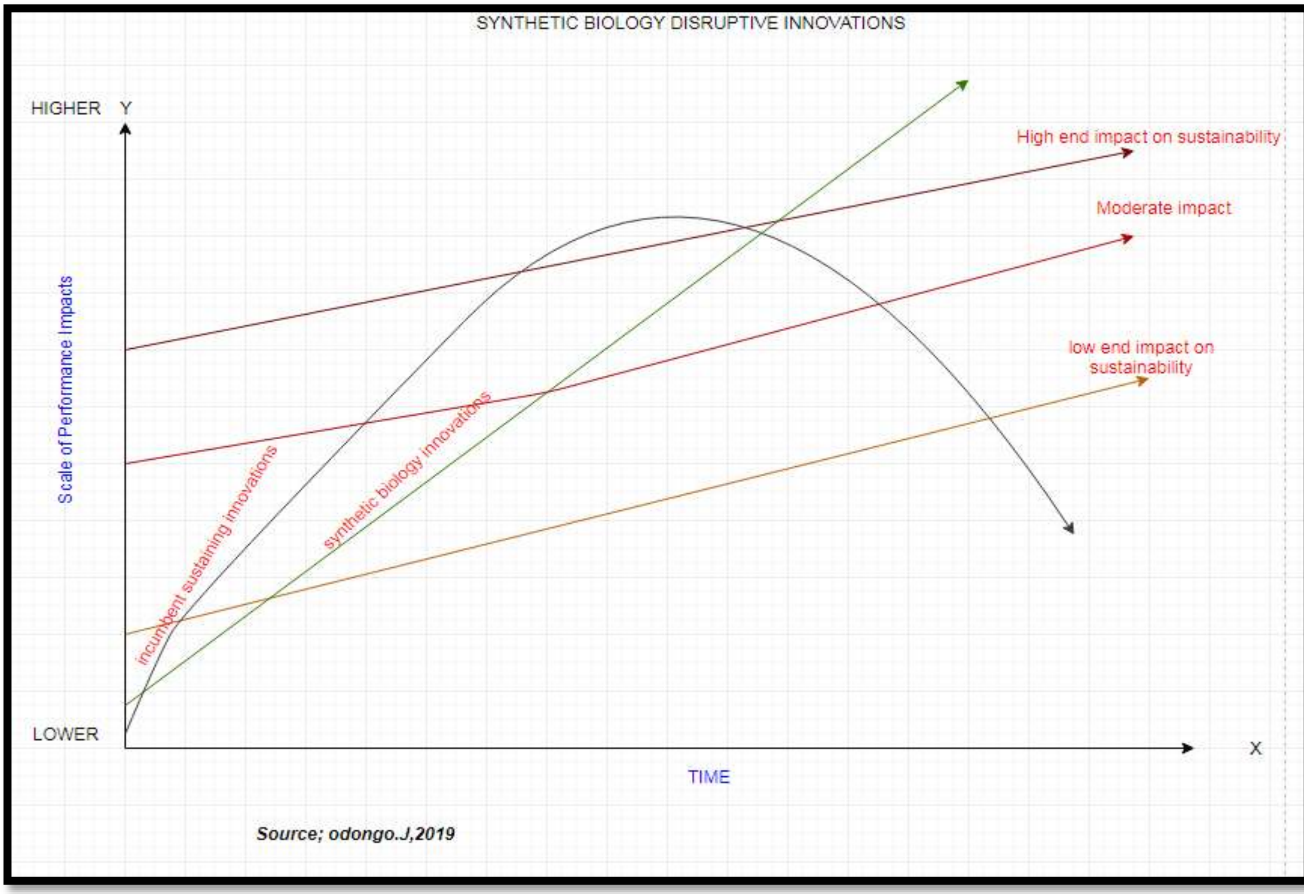

Figure 1; showing how synthetic biology innovations disrupt other dominant innovations

II. SYNTHETIC BIOLOGY CONCEPT

Basically we can define synthetic biology is the engineering of biology or biological systems by application of multi-disciplinary approaches to build artificial biological systems for production or research purpose, that can be illustrated from producing new food ingredients to molecules for treating cancer and may other like bio-remediation. This has been made possible by the advances made by scientist in reading and writing DNA and computational biology.

The synthetic biology is an interdisciplinary branch of biology and engineering. The subject combines various discipline from within these domains, such as the biotechnology, genetic engineering, molecular biology, molecular engineering, systems biology, biophysics, evolutionary engineering, computer engineering, electrical engineering, and control engineering. Synthetic biology applies these disciplines to build artificial biological systems.

Descriptions of synthetic biology depend on how the user approaches it as a biologist or an engineer. It was originally seen as a subset of biology but in recent years the role of electrical and chemical engineering has become more important for instance, one description designates synthetic biology as an emerging discipline that uses engineering principles to design and assemble biological components while other states it is a new emerging scientific field where ICT, biotechnology, and nanotechnology meet and strengthens each other thus the definition of synthetic biology is debated not only among natural scientists and engineers but also in the context of human science, arts and politics. The ultimate definitions of synthetic biology will take into account the dynamism and potential of synthetic biology which, if it achieves its potential, may change many aspects of how we live our lives.

The new era of genetic manipulation was initiated by the invention of the DNA as key to better understanding of cell development and specialization. Copying, editing, sequencing engineering, and synthesizing DNA and RNA (ribonucleic acid) all emerged from that discovery.

Biological parts in scientists' current inventory are capable of performing basic functions at the cellular level.(13,16) Examples include engineered biological circuits and oscillators. Synthetic biology involves programming microbes to behave in certain ways.

For example, bacteria can be engineered to glow when they detect certain molecules, and can be turned into tiny factories to produce chemicals. Microbes have an impact on health; the way they interact with animals is being ever more revealed by microbiology research. Scientists are now able to synthesize whole genomes, making it technically possible to build a microbe from scratch. This gives scientist huge opportunities to design them to do specific jobs, and we can also program in safety mechanisms."

III. SAFETY AND ETHICAL PROSPECTS

Many issues have been drawn between the early development of recombinant DNA technology in the 1970s and now the synthetic biology. A number of key ethical and social issues raised by the technology have been debated, including:

3.1 Uncontrolled Release

One of the main aims of synthetic biology is the creation of artificial microorganism such as bacteria, which may have utility in the production of energy and bioremediation. (22) However, such a prospect raises concerns about their accidental release into the environment, as by their very nature such biological machines could evolve, proliferate and produce unexpected interactions that might alter the ecosystem. A number of measures are being proposed or adopted to ensure adequate biological control, including: engineering bacteria to be dependent on nutrients with limited availability; and integration of self-destructive mechanisms or methodologies in case the population density of the particular organism become too great.

3.2 Bioterrorism

The ability of synthetic biology to produce known, modified or new microorganisms designed to be hostile to humans is a major concern, and has been demonstrated by the synthesis of the polio virus and the pandemic Spanish Flu virus of 1918. A major challenge in this respect is the availability of the effective controls over commercial DNA synthesis. (19)A number of proposals have been made by both scientific groups and government agencies to address the dual use (military/civilian) nature of synthetic genomics, including: controls over commercial DNA synthesis and public research.

3.3 Patenting and the Creation of Monopolies

The drive to create a microorganism that can turn biomass into fuels such as ethanol or hydrogen is a major focus of research, which has prompted a concern that patenting may lead to the creation of commercial monopolies or inhibit basic research.

3.4 Trade and Global Justice

Perhaps the biggest success in synthetic biology to date has been in the production of terpenoids for the manufacture of the antimalarial medicine artemisinin, a drug that holds significant promise for worldwide malaria victims. However, there are concerns that synthetic artemisinin would ensure that no local production of natural Artemisia could be sustained in developing countries, thereby maintaining the discrepancy of wealth and health between rich and poor nations.

3.5 Creating Artificial Life

One of the most potent promises of synthetic biology is the creation of 'artificial life'. This has provoked fears about scientists 'playing God' and raises philosophical and religious concerns about the nature of life and the process of creation. It has been suggested that a stable definition of 'life' is impossible and that synthetic biologists are confused over what life is, where it begins and particularly, how complex it must be. (13,14)In response a number of scientists have proposed a modified version of Turing's test for life imitation. However, it is unclear whether these moves to undermine lay concepts of life will ameliorate deeper fears about the blurring of the boundary between the artificial and the natural world.

IV. CONCLUSION

From the previous chapters it has been illustrated clearly that the disruptive innovation potential benefits of synthetic biology are immense, including interventions to grave challenges of our time such as global warming, environmental degradation and human diseases despite all these potentials the greater concern is on dual- application of the technology that means the misuse of the technology to pose a threat to public health or National security. It's worth mentioning that duel-application or use is not only restricted to synthetic biology for instance vehicles can also be used to kill people, however the biggest concerns here is synthetic biology can be applied for example to make dangerous pathogens more transmissible or lethal raising the spectra of bioterrorism thus this call for a rigorous, robust and predictable designs, public engagement and a modern ethical framework for continued success of synthetic biology. There also may be potential or perceived risk due to deliberate or accidental damage, thus it is absolutely necessary to gather information about these risks and devise most appropriate biosafety strategies to minimize such risks

Researchers need to focus particularly on the safety and ethical concerns and tries to facilitate a socially acceptable development that is a win-win scenario for gaining public confidence. We need no to forget our past experiences especially in the field of genetically modified crops this will help to engage all the parties in the best proactive devoid of fragmentary discussion that will contribute to the community by supplementing genuine biosafety and bioethics aspects.

It is vital to recognize the importance of maintaining public legitimacy and support. In order to achieve this, scientific research must not get too far ahead of public attitudes and potential applications should demonstrate clear social benefits. Furthermore, the potential benefits of the technology must not be overhyped for this risks both creating excessive public anxiety and unrealistic hopes.

Partnership with civil society groups, social scientists and ethicists should be pursued as a highly effective way of understanding critical issues, engaging with publics and winning support for emerging scientific fields. Experiments in upstream engagement and public consultation should be undertaken to provide a valuable channel for helping negotiate the boundaries of what is socially acceptable science.

A robust governance framework must be in place before the applications of synthetic biology are realized. This will require a thorough review of existing controls and regulations, and the development of new measures, particularly relating to biosafety, environmental release and biosecurity. Research and funding agencies have an important role, not only in terms of funding the best science, but also in steering and shaping the field. Thus research can be undertaken in a way that ensures ongoing public support and realizes the potential social and economic benefits of these powerful technologies, whilst controlling risks in a way that reassures both the public and the scientific community.

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