

## Challenges and Opportunities for Synthetic Biology in India

Singh V<sup>1\*</sup>, Jain R<sup>2</sup> and Dhar PK<sup>3</sup>

<sup>1</sup>Synth-Bio Group, Institute of Systems & Synthetic Biology, Université d'Évry Val d'Essonne, Genopole Campus 1, Batiment Genavenir 6, 5 rue Henri Desbruères, 91030 Évry, France

<sup>2</sup>UNESCO-IHE, Westvest 7, Delft, 2611 AX, The Netherlands

<sup>3</sup>Department of Life Sciences, Shiv Nadar University, Dadri, Gautam Budh Nagar, 203207, India

\*Corresponding author: Vijai Singh, Synth-Bio Group, Institute of Systems & Synthetic Biology Université d'Évry Val d'Essonne Genopole Campus 1, Batiment Genavenir 6, 5 rue Henri Desbruères, 91030 Évry, France, Tel: +33 169475381; Fax: +33 169474437; E-mail: vijaisingh15@gmail.com

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### Editorial

There is an unprecedented increase in the infectious, cancer, neurological and heredity diseases in humans worldwide. Food and energy scarcity are also a major concern. India is the second-most populous country with over 1.25 billion peoples in the world. Large number of Indian population do not have access to sufficient quantity of quality food, nutrients, drugs, vaccines, clean water – to name a few. Indian scientists are trying to tackle these challenges. However, simple conventional technologies are not sufficient to find solutions to these problems and a more modern approach is required.

Synthetic biology (SB) is a newly emerging area where engineering principles are applied in the biology. It is defined as “design and construction of new biological parts, devices, and systems, or re-design of existing, natural biological systems for useful purposes.”

Synthetic biology is a fast growing area where many discipline such as physics, chemistry, mathematics, engineering and computer science are applied together. It plays a key role in the improvement and establishment of synthetic gene networks and biosynthetic pathway for better understanding of cellular mechanisms. It is also helpful in sufficient production of valuable products for the prevention of diseases. An initial initiative of synthetic biology has been taken by American and European scientists who have designed a number of synthetic gene circuits by using synthetic genetic parts with well-defined functions. Recently, the groundbreaking research has been done by J.C. Venter and colleagues on the creation of first synthetic cell *Mycoplasma mycoides* JCVI-syn1.0. This experiment has proved that genomes can be designed in the computers which were further chemically synthesized and then created a new designer organism [1].

First synthetic genetic devices such as Repressilator [2] and Toggle switch [3] have been successfully designed and well-characterized in *Escherichia coli*. Later, Registry of Standard Biological Parts- MIT, USA (partsregistry.org) has established and standardized the genetic parts which are freely available to scientific community. In recent years, a number of synthetic genetic parts, device and circuit including promoter [4,5], regulatory proteins and RNAs [6-10], scaffolds [11], oscillators [2,12-14], riboregulators [15-18], riboswitches [19,20], toggle switch [3] and biologic gates [21-25] that have been successfully engineered and characterized in a wide range of hosts including mammals.

Though, globally research in synthetic biology and its application are on high priority, India is lagging behind in this field of research and an urgent need arises to promote and accelerate the synthetic biology research in India. It holds a key to solve many challenges such as food & energy scarcity and drugs against incurable diseases. Thus, initiative

should be taken by Indian scientists to design, construct and characterize the novel synthetic genetic parts, devices and circuits for reprogramming of cellular machinery with predictive function. These engineered organisms should be robust, fast, and efficient for production of value-added products for controlling the diseases. More recently in order to edit or correct the genome, CRISPR, a powerful tool which has been applied for genome editing of bacteria and archaea [26,27], zebrafish [28], *C. Elegans* [29] eukaryotes including human [30,31], should be used in development of new products using synthetic biology. It has also been used not only for controlling of pathogenic bacteria but also for cancer and genetic therapy [32,33].

Thus, we need to establish a national repository centre for synthetic genetic parts, device and circuits that should be easily accessible and can be used for designing and engineering of organisms with predictive properties. Ideally, all these genetic parts should be easily exchangeable and useful for production of any kinds of value added products or cell reprogramming or editing. India has also world-class research institutions with state-of-art infrastructure facility like IISc Bangalore, NCBS Bangalore, CCMB Hyderabad, IGIB New Delhi, CDRI Lucknow, NII New Delhi, AIIMS New Delhi, ICGEB New Delhi or new specialized synthetic biology centre. Indian funding agencies such as DST, DBT, ICAR, CSIR, DRDO and ICMR should also promote the synthetic biology research by making task force and prioritizing it as a major thrust area, research and innovation. The communal effort should be needed to promote and accelerate the synthetic biology research in India thus, we can also compete globally.

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