Synthetic Biology: Science of the inthinkable

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(During the 3rd BBIC (Biosafety and Biosecurity international conference), in Amman, 13-15 September 2011, I witnessed the most astonishing and elegant lecture by the pioneer in this field Dr. Andrew Hessel (1). A number of definitions have been given to the science of synthetic biology. It is a new area of biological research that combines science and engineering. It encompasses a variety of different approaches, methodologies and disciplines. Many comprehensive reviews on the subject are available [e.g. Benner and Simour (2)].

The title synthetic biology first appeared in the literature in 1980 (3) where Barbra Hobom used the term to describe bacteria that had been genetically engineered using recombinant DNA technology. Elowitz (4) had a model for how gene expression should work inside living cells. Biological systems are physical systems that are made up of chemicals. Around the turn of 20th century, the science chemistry went through a transition from studying natural chemicals to trying to design and build new chemicals. This transition led to the field of synthetic chemistry.

In 2000, the term synthetic biology was again introduced by Eric Kool and other speakers at the Annual Meeting of the American Chemical Society in San Francisco (5). Here, the term was used to describe the synthesis of unnatural organic molecules that function in living systems.

Engineers view biology as a technology-the systems of biotechnology or systems of biological engineering. The engineering of molecular circuits has been reviewed by Hasty et al.(6).

Synthetic biology will benefit from better models of how biological molecules bind to substrates and catalyze reactions. How DNA encodes the information needed to specify the cell and how multi-component integrated systems behave. Recently, multi-scale models of gene regulatory networks have been developed that focus on synthetic biology application.

Precise and accurate quantitative measurements of biological systems are crucial to improving understanding of biology. Such measurements often help to elucidate how biological systems work and provide the basis for model construction and evaluation. To read some accounts of synthetic biology, the ability to manipulate life seems restricted only by imagination. Researchers might soon program

cells to produce vast quantities of biofuel from renewable sources or to sense the presence of toxins, or to release precise quantities of insulin as body needs. All visions inspired by the idea that biologists can extend genetic engineering to be more like the engineering of any hardware. It is legitimate to say that synthetic biology is «moving from reading the genetic code to writing it «.

In the Watson-Crick model (7), nucleotide pairs contribute independently to the stability of a duplex. Although some diversity in nucleic acid structure and function is not captured by such simple rules, most molecular biologists only use this diversity occasionally. The elegance of the Watson and Crick model has caused most molecular biologists to overlook the chemical peculiarity of such rules. The power of the Watson-Crick rules was nevertheless sufficient to lead to complacency by most of those who learned the double helix structure. Molecular recognition in DNA was a < solved problem>.

In 1980>s, some synthetic biologists began to wonder whether DNA and RNA were the only molecular structures that could support genetics. Other biologists, seeking technological goals, attempted to replace molecules in the DNA structure to create DNA analogues that would, for example, passively enter the cells, but could still support the < A pairs with T, G pairs with C < rule, with the aim of disrupting the performance of intracellular nucleic acids in a sequence-specific < antisense < way.

Applications of synthetic biology:

1. New biological production techniques for existing or novel biological materials and chemicals.
2. New and improved diagnostics, drugs and vaccines.
3. Biosensors and nanotechnology.
4. Bi0-remedication tools to process contaminants.
5. The final goal is to produce synthetic cells (in human about 200 types of cells exist).

Opposition to synthesis biology by civil society groups has been led by certain teams for no synthetic organisms to be released from the laboratory. In 2006, 38 civil society organizations raises questions for ethics, biosecurity and biosafety involvement of stack-holders and intellectual property (10, 11). An initiative for self-regulation has been proposed by the International Association Synthetic biology (12), that suggests some specific measures to be implemented by the synthetic biology industry, especially DNA synthesis c ompanies.

« we comprehensively reviewed the developing field of synthetic biology to understand both into potential rewards and risks « said Dr. Amy Gutman, the commission chair and president of the university of Pensylvania.

A major goal of synthetic biology is to develop a deeper understanding of biological design as Schmidt et.al. (11) initially sought to design integrated gene circuit (see 6). As a

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result of all efforts done by various scientific groups starting from the « surgery of genes « to the redesigning of life (or redesigning of the molecules of life), reaching to the artificial genetic system which can be replicated by enzymes, scientists had created five-synthetic cells was a profoundly significant point in human history !! (8, 12).

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