Introduction

Community building in synthetic biology

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Synthetic biology can be summarized as a field of research dedicated to the design of biological parts, systems, and devices across multiple length scales.[1] There are three main classes of motivation behind this endeavor: (i) to make new types of biology that can ultimately be used in industrial/technological/medicinal applications,[2] (ii) exploiting an "understanding by building" approach as a tool to increase our understanding of fundamental processes in Nature,[3] and (iii) to gain insights into questions relating to the origin of life, and how molecular building blocks come together to enable life.[4]

Synthetic biology can be approached from two opposing directions. The top-down approach involves starting with living systems and re-engineering them using molecular biology and genetic/metabolic engineering techniques with a view to introducing new user-defined functions. The bottom-up approach involves starting from a molecular level and working up, generating ever more complex cell-mimetic constructs. There are increasing efforts to combine approaches by fusing living engineered cells and synthetic cells together, whether as part of a hybrid system,[5,6] or through engineering communication routes between the two.[7]

By definition, the boundaries of this field are blurry, with what does and does not count as synthetic biology often a topic of debate. What is accepted, however, is that it is a discipline that spans and bridges multiple disciplines, bringing together molecular scientists, engineers, medics, computer scientists, and biologists. Computational scientists may model engineered biomolecular structures[8] and mathematicians may design biological networks.[9] Chemists may use principles of molecular self-assembly to generate synthetic cells from the bottom-up,[10] whereas biochemical engineers might re-engineer living systems for useful purposes in industrial biotechnology.[11] However, it is only by combining approaches, pooling knowledge, and using synergistic expertise that the true potential of the field be realized.

The scale of the challenges undertaken within synthetic biology means successfully realizing its potential relies on building communities. Indeed, synthetic biology has a proud tradition of building community-based initiatives, with several having sprung up in recent years, each catering to different sections of the synthetic biology landscape. The prime example of this is the annual International Genetically Engineered Machine (iGEM) competition, where young scientists develop new biological systems over a summer, and aims to promote systematic, open and transparent development of tools for synthetic biology. This community, comprised mostly of undergraduates and their host labs, has increased from 31 members to 5400 members in the space of 13 years. Related activities include the BioBrick project, an open registry of standardized biological parts used in the assembly of synthetic biology devices. To date, over 20,000 parts are included in the registry. With such efforts, together with the assortment of formal and informal academic networks that have sprung up in the US, Europe and the UK, community has been a defining feature of the synthetic biology ecosystem that is only increasing. Although most networks have focused on top-down approaches, bottom-up synthetic biology centers and institutes are increasingly being forged, including Build-a-Cell, BaSyC, and MaxSynBio. In parallel, community-operated prototyping workshops such as hackspaces have moved into synthetic biology with over one hundred biohackspaces now registered on DIYBIO.org. Excitingly, these are opening up the field not only to academics but also to general members of the public.

It is in the context of these wider community-building efforts that we, together with our academic partners, launched fabriCELL: a pan-London network of researchers working in bottom-up artificial cell fabrication. This serves as a vehicle to leverage our collective expertise, establish collaborations, engage with industry, and interact with the public, acting as a focal point around which artificial cell activities are organized. For this effort to succeed, a healthy pipeline of young academics must exist to support long-term growth of the area. It is for this reason that a host of postgraduate Centres for Doctoral Training exploring synthetic biology themes have been established in the UK and elsewhere. fabriCELL works closely with existing doctoral training schemes. These include the Centre for Doctoral Training in Chemical Biology (funded by the Engineering and Physical

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Sciences Research Council) at Imperial College London, which trains physical scientists to develop new molecular tools and technologies for the study of biological systems including artificial cells, and the Cellular Bionics Doctoral Scholarship Programme (funded by the Leverhulme Trust), which explores the interface between living and non-living systems on cellular length-scales.

As synthetic biology matures, there is an increasing need for communities such as these to build bridges with related disciplines, especially as the real world applications of the technology become more pronounced. One area which is expected to have the largest impact is in Experimental Biology and Medicine. Engineered cells, synthetic cells, and novel biomolecules have long been touted as being new avenue in therapeutics, and the interaction between these engineered species and biological systems an area of active research. For this reason, the journal Experimental Biology and Medicine, having been established in 1903 and being one of the oldest journals of its kind, is launching a synthetic biology as a new category.

This thematic issue is the first contribution to the journal category, adding to the journal's heritage of exploring cutting edge aspects of the life sciences. The issue contains articles that cover the wide synthetic biology spectrum, including plant synthetic biology,[12] protocell research,[13] artificial cell therapeutic agents,[14] cell-free synthesis and protein reconstitution in cell-mimics,[15] and topography design of synthetic cell membranes.[16] The editors of this issue hope that it be of value both for experiments in bottom-up and top-down synthetic biology, as well to general Experimental Biology and Medicine readers.

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