Editorial

IET Synthetic Biology

To date, biological research has focused on the analysis of naturally evolved systems. These living systems are characterised by complexity, non-linearity and parallelism, often involving multicellular organisms with tens of thousands of genetically encoded components and possessing feedback-dominated mechanisms for self-organisation, reproduction and repair. They produce functional structures that are many orders of magnitude more complex than the most sophisticated man-made artefacts.

A formidable array of biochemical, biophysical and genetic techniques have been assembled for the description of biological systems, and this has given us methods for the comprehensive description of an organism's genome, gene expression patterns and metabolic activities. New imaging techniques allow non-invasive monitoring of biological activities and precise reconstruction of cellular and tissue architecture.

However, there is a general acceptance that the behaviour of complex biological systems cannot be derived purely from the properties of its component parts, and that description of the dynamic interactions within a system is required to encapsulate the behaviour of an entire system. This conception and the availability of large scale datasets from various 'omics' approaches has spawned the new field of systems biology, where computational tools are being harnessed for the numerical description and encapsulation of entire systems. This field is bringing together biologists, mathematicians and computer scientists, and providing a fertile source of new tools and approaches for describing and modelling biological systems. In addition, these developments provide tools for the design and modelling of novel artificial systems.

Recombinant DNA techniques were established in the early 1970s and have become increasingly capable since. Further, DNA synthesis techniques have become cheaper and ever-larger-scale assemblies of artificial genetic material are becoming feasible. For some years, scientists such as Tom Knight at MIT have realised that genes might be fashioned as modular building blocks for general-purpose use as genetic logic elements, and that the impending collision between new technologies for design and assembly of genetic systems will provide opportunities for a fundamental rethink in our approach to biology and its application.

Synthetic biology is the discipline that has resulted from this collision of new enabling technologies. Thus, recombinant DNA and improved DNA synthesis techniques provide the means of assembling new genetic systems, and computational approaches borrowed from systems biology provide tools for the design and modelling of artificial biological circuits. In addition however, the shift from analysis of naturally evolved biological systems to the construction of synthetic systems requires the recruitment of engineering principles to biology.

In principle, simple biological elements can be adopted as reusable components, which are well characterised and can be used for the construction of more complex devices and systems. This approach requires the application of engineering concepts such as modularity, reusability, abstraction and insulation from underlying detail. The reuse of modular components also facilitates software modelling, and work in the field is promoting parallel developments in computer software. New students and workers are coming into the field from very diverse areas, and need to come to grips with the nitty-gritty of unfamiliar biological systems, engineering tools and computer sciences. There is a growing demand for specialised coverage of this new field, including educational and review materials.

The Institution of Engineering and Technology (IET) was formed in 2006 after the merging of the Institution of Electrical Engineers (IEE) and the Institution of Incorporated Engineers (IIE) and now has more than 150,000 members worldwide. It is the largest professional engineering society in Europe and the second largest of its type in the world. The IET is a non-profit organisation that provides a wide range of services and information for technical research and education, including publication of a number of research journals. The IET has launched this new journal, *IET Synthetic Biology*, with the aim of supporting this growing new community. The journal will publish conventional research papers in synthetic biology in addition to providing a 'nuts and bolts' view of this new field, as well as review and educational materials. In particular, we wish to support the activities of young workers entering the synthetic biology field. Publication in *IET Synthetic Biology* will be free of page charges.

Synthetic biology is a very young and interdisciplinary field. In addition to conventional research and review articles, we see an important need for practical articles describing technical advances and innovative methods useful in synthetic biology. We will encourage submission of technical articles that might describe novel BioBrick components, construction techniques, characterisation of a new biological circuit, new software or a practical 'hands-on' guide to the construction of new instrumentation or a biological device. Further, we will provide a short report format which we hope will provide an easier avenue for publication by talented undergraduates in the field. We believe that this is needed in a field where the international Genetically Engineered Machine (iGEM) competition plays such a crucial role in recruiting and energising undergraduate students and faculty alike. In addition to the print journal, we are developing associated web resources. These will include a repository of online video resources, specialised review material and research tools for synthetic biology. For the early stages of the journal's development, published content will be freely available online as PDFs.

At this early stage of development in the field, we aim to publish thematic issues, with topical review content. We hope that central themes will provide a focus for new readers. This first issue is an example of this, where we are focusing on the activities of the last iGEM competition, the BioBrick repository and their impact on the field of synthetic biology. The iGEM competition has played a special role in the development of synthetic biology as a field. It has provided a platform for advocacy of the underlying engineering principles, for the development of an open repository of modular BioBricks and their worldwide distribution, and not least, the recruitment of many enthusiastic students directly into the field. It has provided the outline of new paradigm for biological teaching. Undergraduate teaching in biology has shifted away from a practical approach to cramming, as our knowledge of natural systems increases. In contrast, there is generally a much stronger emphasis on training in problem-solving skills for undergraduate engineering students. The iGEM competition mixes student engineers and biologists, and provides them with exciting challenges in scientific design, laboratory practice and project management, which are largely outside the normal undergraduate experience, and at the cutting edge of a new field. This issue contains an overview of the iGEM competition from James Brown, an iGEM 2005 team participant, iGEM 2006 student ambassador and iGEM 2007 team advisor. The issue also contains team reports from a wide variety of teams that participated in the last iGEM competition. We hope that this year's teams will also be encouraged to publish their team's efforts, and that this special *IET Synthetic Biology* iGEM issue will become an annual event.

For some of us, the growing application of engineering principles to biological design and construction marks a practical transition for biological research. For example, work in the physical sciences has been transformed completely over the last half century by the impact of human engineered constructs. Basic research on electronic phenomena and solid-state physics has given rise to new fields and entire industries devoted to microelectronics, optics and software development which dwarf their origins. One might expect a similar shift in biological research as synthetic biology begins to offer improved rational design and reprogramming of biological systems. If so, synthetic biology will contribute to future improvements in the microbial, plant and animal cell engineering that are clearly needed for the renewable technologies of the 21st century.

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