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Editorial

Editorial for "Special Issue on the 2019 and 2020 iGEM proceedings"

Synthetic biology comprises engineering design principles to build biological and biomimetic devices with versatile applicability. This Special Issue is composed of contributions with roots in the 2019 and 2020 international Genetically Engineered Machine (iGEM) competitions, and present platforms that enable the implementation of SynBio to bio-medicine, bio-remediation, and bio-materials.

The field of synthetic biology provides a vast and interdisciplinary engineering playground, where researchers harness a wide range of molecular building blocks and machinery to assemble devices that span from bio-engineered organisms displaying new and interesting functionalities [1] to synthetic-cell mimics able to coordinate bio-inspired behaviours [2]. SynBio is thus a versatile and comprehensive toolkit for novel technologies with a unique potential for societal impact.

The annual international Genetically Engineered Machine (iGEM) competition is a hands-on platform for students from various fields and disciplines to come together and address global issues with SynBio-solutions [3]. More than 3000 teams have competed over the past 17 years, demonstrating that engineering principles can be implemented to design and control biological functionalities. In its current format, iGEM aims to improve societal aspects relevant to local communities, and thus encourages young researchers all around the world to identify and tackle challenges critical to their region with practical synthetic biological devices and technologies. Therefore, aside from training various generations of synthetic biologists, iGEM has been shown to have a sustained industrial and academic output [4], alongside a growing and collaborative community [5].

In a collection of 12 articles, this Special Issue showcases the work of young researchers that participated in the 2019 and 2020 editions of iGEM. The authors present a variety of SynBio platforms put forward to advance the field in fronts that span from bio-sensing and therapeutics to bio-remediation and the development of novel and stable bio-materials.

Several contributions address issues with direct relevance to the biomedical space. Bae and Song performed protein engineering to develop cell-penetrating antibodies, reporting the characterisation of an effective and stable device with therapeutic potential [6]. In turn, Van de Steen et al. focused on the construction of drug delivery platforms, where encapsulin nano-compartments are re-purposed to enhance target recognition of biological agents, demonstrating successful identification and binding of cell-membrane receptors in breast cancer cells [7].

Palaniappan and collaborators focused on diagnosing cervical cancer with optimally-chosen biomarkers, developing a custom-built pipeline to construct detection circuits operated by toehold switches and microRNAs [8]. Similarly, Soudier et al. coupled toehold switches and cell-free expression platforms to detect the presence rosewood [9], introducing low-cost sensing and detection frameworks to prevent the trafficking of endangered species. Fang and co-workers proposed to couple the binding specificity of aptamers to the cleavage capabilities of CRISPR-Cas so to build devices for signal amplification, achieving protein detection useful in diagnosis methodologies [10].

In turn, Mai et al. exploited RNA interference (RNAi) circuits to impede the growth and development of the threatening plant *M. micrantha* [11], showcasing the herbicidal activity achieved by RNAi technologies.

With their strategy, Leong et al. proposed protein-based fire retardants with adhesive properties as coating materials, enabled by the engineering and expression of devices with fire-retarding capabilities [12]. Chen and collaborators reported the environmentally-friendly production of gardenia blue through the expression of heat-resistant proteins to aid the synthesis pathway [13], highlighting the potential of microbe-based strategies for the production of natural pigments.

On the other hand, Wang and co-workers presented a strategy to investigate *in silico* the morphologies of protein domains, introducing an online analysis suite for domain classification to enable new functionalities in protein engineering through shape identification [14]. Engel et al., in turn, proposed to improve the action and stability of therapeutic peptides by performing molecular docking, allowing them to identify *de novo* optimal D-peptides to target ligands of interest. Their proof-of-concept implementation enabled the successful identification of binders with pharmacological relevance [15].

Conversely, Steel and co-workers aimed their efforts to tackle the degradation of perfluorinated compounds (PFC) *via* bio-remediation, as enabled by the identification and engineering of PFC-degrading enzymes [16]. Similarly, Mo et al. worked on bio-engineering microorganisms to express and secrete recombinant laccases with confirmed degrading activity [17], thus helping in the degradation of Endocrine Disrupting chemicals from the environment.

Altogether, the contributions in this Special Issue showcase the prowess of synthetic biology to address a variety of societal necessities, and are a welcome addition to the arsenal of functionalities enabled by SynBio in the pursuit of novel, impactful, and applicative (bio) technologies.

Finally, at iGEM and Synthetic and Systems Biotechnology, we acknowledge and highly appreciate that the future of SynBio lies in the hands of high school, undergraduate, and over-graduate students. Indeed, our work aimed to provide a venue for young synthetic

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biologists to share and celebrate their work, while communicating with more senior colleagues and scientists that can guide them to better design, perform, and frame their research endeavours. We envision that, through efforts such as those invested in curating this Special Issue, a healthy and collaborative SynBio community can continue to support and motivate young researchers towards a better and sustainable future.

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