

Chui's Student Excellence Scheme Ho Wing Hing Talent Fund

HKU iGEM 2018 Project Report

With the generous support from Chui's Student Excellence Scheme Ho Wing Hing Talent Fund, HKU iGEM team 2018 represented the University at The International Genetically Engineered Machine (iGEM) Competition Giant Jamboree in Boston, MA from 24th to 28th October 2018.

HKU iGEM team 2018 was initiated by students from the disciplines of medicine, science, engineering and business in February 2018, under the guidance of Dr. Julian Tanner from the School of Biomedical Sciences, Faculty of Medicine and Professor Alice Wong from the Faculty of Science. At the Boston Giant Jamboree, the team presented project 'ETHERNO: E coli-synthesized Therapeutic Nanostructures', which was awarded Gold Medal and a nomination for Best Part Collection Award.

The International Genetically Engineered Machine Competition 2018 comprised of two elements: laboratory research and human practices. This project deepened our scientific knowledge, team building skills and communication skills. The following is a summary of the laboratory research and human practices conducted in this project.

Laboratory research

Our project stems from a method of DNA nanostructures genetic encoding and self-assembly in living bacteria described by Elbaz et al. (2016). Despite its demonstration of successful in-vivo nanostructure production, the nanostructure produced does not have any function. We designed new DNA sequences to be operated in a DNA nanostructure production system named ETHERNO (E. coli-synthesized Therapeutic Nanostructures).

Our Nano Drug Carriers are composed entirely of DNA, which is non-toxic and degradable inside human cells. The Nano Drug Carriers are designed as tetrahedrons to facilitate cell entry. Previous studies have shown that three-dimensional DNA nanostructure enter mammalian cells more efficiently than two-dimensional AS1411 or linear structures. Functional DNA sequences can be conveniently added to the 4 vertices of the tetrahedron to achieve oligonucleotide delivery or cell antigen binding, enhancing the effect of the drug.

Achievements

In this project, we successfully designed and constructed 2 DNA nanostructures: NDC and NDC-AS, demonstrated their therapeutic effects on MCF-7 breast cancer cell line, and synthesized them by operating genetic circuits in E. coli DH5alpha. Mathematical models were also constructed to characterize the drug loading and release properties of our originally designed DNA nanostructures.

1. Nano Drug Carriers and Nano Drug Carrier-AS1411 facilitated doxorubicin cell entry visualized under fluorescence microscope.

2. Nano Drug Carriers and Nano Drug Carrier-AS1411 efficiently released an anti-miRNA DNA oligo in the presence of RNA inputs, as visualized on poly-acrylamide gel electrophoresis (PAGE)
3. ETHERNO DNA nanostructure production system synthesized component strands of NDC and NDC-AS
4. Submitted parts formed tetrahedral nanostructures visible under transmission electron microscope.

In terms of personal development, this project helped us to grasp common laboratory techniques and understanding the logic flow of biomedical research. It provided us an opportunity to learn how to think of science critically and thoroughly, which is essential to our development in academia.

Human Practices

Secondary School iGEM Team Mentorship

We mentored the HK_HCY_LFC team, which compose of two different secondary school, Tsuen Wan Public Ho Chuen Yiu Memorial College (HCY) and Po Leung Kuk Laws Foundation College (PLKLFC). It was a precious opportunity for us to sharpen our communication skills and establish our professional network.

With the HK_HCY_LFC team choosing DNA nanostructure as the topic, HKU iGEM team provides help in different aspects. Starting from early February, students from HKU iGEM team started to educate and give insights to the HK_HCY_LFC team students, in setting up their project.

With the kickstart of the lab session in July, the HKU iGEM team assisted the experimental design, and monitored the lab sessions in order to troubleshoot and educate. In day to day laboratory sessions, the HKU iGEM team members taught the students different laboratory skills, precautions, as well as guide students to analyze the results for the experiments.

Interview with Molecular Pathologist Dr. Ruth Lau

Dr Ruth Lau, a molecular pathologist from Yan Chai Hospital, mentioned that complete elimination of drug resistance will be a long way to achieve while at present, target therapy and immunotherapy are popular ways of treating drug resistance. In her opinions, it is an innovative idea for us to build a unique nanostructure as vehicle which deliver drugs to specifically target unique cancer tumour cells of a patient. This would allow a great potential of developing effective, personalised treatment with lower side-effects.

Shenzhen iGEM EurAsian Meetup 24-26th July

During 24- 26th July, our team and other 21 teams have gathered in Shenzhen to share our designs and progress in the past few months. We actively exchanged ideas and joined in various workshops, making new friends and learning from each other. We also had a fruitful time in a 10-minutes oral presentation and poster session which we gained useful suggestions to improve our design and show our content in a much lively and systematic way.

The 51st Joint School Science Exhibition

The 51st Joint School Science Exhibition (JSSE), held from 22nd to 27th August 2018 in the Hong Kong Central Library, provided a valuable opportunity to share knowledge and inspire people from all walks of life.

The project showcased by the HKU iGEM team concerned the use of DNA as a nano drug carrier for specific drug delivery in cancer treatment. With folding DNA origami craft as an introduction, we have successfully piqued the public's interest and educated them with the basic knowledge about DNA structures and functions, as well as the diverse diagnostic, therapeutic and other interesting applications of nanotechnology. Our project in breast cancer therapy has attracted not only the attention of many enthusiastic school students pursuing STEM education, but also attracted the curious minds of numerous working adults who expressed the actual need to optimize current cancer treatments.

Photo of HKU iGEM team 2018 presenting the project poster at the Giant Jamboree in Boston.

