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A team of local secondary school students create a winning device that can remove copper ions from water, writes **Nicola Chan**

Improving the system

Back in 2015, the discovery of lead in a public estate's drinking water sparked concerns over the effects of water pollution on people's health. Inspired by the incident, 39 students from five local secondary schools teamed up to create a device that could lower the copper-ion concentration in aquaponics - raising both aquatic animals and cultivating plants in the same water.

A similar project was previously done by a group of seniors in 2016, but the secondary students from the joint school alliance, Hong Kong JSS, wanted to improve upon it. This time around, they used genetically modified E. coli - a bacteria commonly found in human and animal intestines - to absorb copper ions in aquaponics. Although copper - which is present in water in the form of ions - is a nutrient for humans, excessive intake can lead to health problems.

In early November, 30 of the members flew in Boston in the United States to present their idea at the International Genetically Engineered Machine Competition, an annual worldwide event that gathers young biology talents across the globe and their innovative solutions to everyday problems.

The team's experimental design and findings made them the first secondary school in Hong Kong to win a gold medal.

Young Post sat down with three of the team members last week to learn more about their project.

"We've taken a lot of water samples from different aquaponic systems, from which we detected a high concentration of copper," says team leader Yoyo Yip Sze-man, 16.

They chose to fix this problem for their project because they already had access to something that could help them detect and measure the amount of copper in water, said the Po Leung Kuk Celine Ho Yam Tong College student.

She adds that they hoped the technology they came up with could be used to remove other heavy metal pollutants found in water.

The students from PLK Celine Ho Yam Tong College, United Christian College (Kowloon East), Yan Oi Tong Tin Ka Ping Secondary School, Pentecostal School, and St Teresa Secondary School split up into school teams led by their respective biology teachers.

Some were in charge of developing, testing and evaluating their hypotheses, while others took to the street to raise awareness of the hazards of water contaminated with heavy metals, and surveyed different people in the aquaponics industry.

The team discovered that E. coli could better absorb copper if they either increase its copper binding proteins, or get rid of the genes that export copper. In light of this discovery, they then developed their bacteria copper absorption device (B-cad) that incorporated the two types of genetically modified bacteria.

We took a lot of water samples from different aquaponic systems, and detected a high concentration of copper

The B-cad has artificial tubes that can take in copper ions, while not letting the E. coli out. The resulting device is able to remove 25-55 per cent of the copper in a aquaponic system with 5-15mg/L copper ion in 48 hours.

"After consulting fish owners and potential users of the device, we added a cage around the tubes[] to prevent them from being bitten off which could potentially die if the b[] leaked to their habitats," says Yoyo.

Oscar Lam Ho-him from Pentec[] School was responsible for collecti[] from the stakeholders, analysing t[] and promoting their initiative. Bes[] to several stakeholders, the 16-ye[] admitted feeling nervous when pr[] his team's ideas at the iGEM compe[]

"I was worried that I might not [] answer the audience's questions. B[] worked out," the 16-year-old said.

When asked what their most re[] challenge was, Jasmine Yu Oi-ni, [] the many times she and her team[] stay in school until 8pm.

"Because our experimental res[] always what we expected, we [had] the same experiment - which take[] hours to complete - after school a[] to four times in total," said the Yan Ka Ping student.

"The journey was quite distress[]

Looking back, though, both Jas[] Yoyo are grateful to have overcom[] challenges that they came across.

"We got a great sense of satisfaction when we finally succeeded in the end," explains Yoyo.

成報 2019年11月12日

港中學國際基因工程生物機械競賽首奪金

【本報港聞部報道】一年一度的國際性合成生物科學界賽事「國際遺傳工程機器設計競賽」（iGEM）日前在美國波士頓舉行，結果由仁愛堂田家炳中學、滙基書院（東九龍）、五旬節中學、保良局何蔭棠中學及德蘭中學組成的Hong Kong JSS聯校隊伍，於比賽中奪得金獎殊榮，是這項比賽歷來第一次由來自香港的中學隊伍奪金。

iGEM比賽重視以合成生物學方法解決本地問題，要求參賽隊伍以一至兩年時間進行科研工作，以基因工程方法解決一個當地社會的問題。比賽不單止會評審研究項目的科學質素，更會要求參賽者以工程及數學模型概念去製造產品及以商業和人文角度去對社會大眾進行推廣及教育工作。現時多間國際生物科技企業，例如Gingko Biowork、Benchling、Opentrons等，均是當年iGEM參賽隊伍並以參賽項目起家。

證研究項目達世界級水平

iGEM每年來自40多個國家超過300隊隊伍參賽，比賽分有研究院、本科生及高中三個組別。參賽隊伍主要來自大學隊伍，包括哈佛大學、麻省理工學院（MIT）、牛津大學及史坦福大學等世界一流學府，而高中組別亦不乏世界知名中學參加。不論組別，每個研究項目均會有最少六名具有博士學歷的科學家作為評審。

評審範圍包括，研究的詳細報告網頁（Team wiki）；部件資料庫（Part registry）的資料；20分鐘台上演講；以及海報展覽及多個答問環節。評審小組最後會就項目的質素及隊伍的表現作出評級，如果達到一定標準便可得到金銀銅的獎項。金獎為三級中最高級別，證明研究項目已達到世界級水平。

香港於2016年首次有中學隊伍參加iGEM比賽。今年，由仁愛堂田家炳中學、滙基書院（東九龍）、五旬節中學、保良局何蔭棠中學及德蘭中學組成的Hong Kong JSS聯校隊伍，於比賽中奪得金獎殊榮，成為iGEM歷史中首次有香港中學隊伍奪金，證明香港中學生的能力可以達

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基因改造大腸桿菌濾重金屬 研製細菌過濾器

港5中學聯手 iGEM首奪金

香港年輕一代具備驚人的科研潛能，以創意研究項目揚威國際。由本港5所中學學生組成的聯校隊伍「Hong Kong JSS」，透過研究對大腸桿菌進行基因改造，增加其吸收重金屬的能力並首創出低成本的細菌過濾器「B-CAD」，本月成功

■5校共30多名學生的聯校隊伍在「國際遺傳工程機器設計競賽（iGEM）2019」奪金。

…世界級。

…生」啟發

…地少人多，「魚菜共…受歡迎的情況，發現…現重金屬累積超標的…定對大腸桿菌進行基…能吸附重金屬的生…菌的金屬硫蛋白…度表達，及將排走重…sF）基因敲除，從而…菌吸收重金屬的能…隊伍更製造了一個首…CAD」，並於實驗證…成本去降低魚菜共生…屬水平。

隊員之一的仁愛堂田家炳中學學生余安怡表示，參加iGEM的經驗讓她學會很多關於基因工程和科學研究的知識，從中獲益良多；而赴美參賽交流，見識到世界各地年輕一代的科研實力，高興能走出香港放眼世界，可以推動自己進步。

該校帶隊老師、生物科科主任劉博提到，香港過去被指過度注重考試操練及背誦，於培訓學生科學探究能力及科學素養（Science literacy）方面較為落後，他認為，iGEM賽事可讓學生體驗真正科學家在研究中運用跨學科的知識及能力的過程，是非常難得的經驗，而同學在參賽後對科學的興趣及能力有明顯提升，可見活動有助學生發揮所長，及激勵他們追求更高的層次，收穫甚豐。

細菌吸銅機 過濾重金屬

基因改造增「吸金力」 淨化食水消除污染

明報 2019.11.11

中學聯校隊伍國際基因工程賽奪金

仁愛堂田家炳中學、匯基書院（東九龍）、五旬節中學、保良局何蔭棠中學及德蘭中學組成的Hong Kong JSS聯校隊伍，於…

星島日報 2019.11.18

改菌「勁吸金」港生揚威國際

改造桿菌基因濾重金屬 iGEM首見港中學隊伍奪金

香港文匯報訊（記者 高鈺）香港年輕一代具備驚人的科研潛能，以創意研究項目揚威國際。由本港5所中學學生組成的聯校隊伍「Hong Kong JSS」，透過研究對大腸桿菌進行基因改造，增加其吸收重金屬的能力並首創出低成本的細菌過濾器「B-CAD」，本月成功於全球最大型的合成生物科學國際比賽「國際遺傳工程機器設計競賽（iGEM）2019」奪得金獎殊榮，更是iGEM歷史中首次有香港中學隊伍奪金，為港爭光。

今年度的iGEM在11月初於美國波士頓舉行，共有來自四十多個國家與地區逾300支隊伍參賽，分有研究院、本科生及高中三個組別，吸引世界各地知名大學及中學參加。競賽重視以基因工程及合成生物學方法，解決本地社會問題，除了項目的科學質素外，評審亦會要求參加者以工程及數學模型概念去製造產品，及從人文角度進行社會大眾的推廣及教育工作。

赴美參賽證研究達世界級

香港於2016年首次有中學隊伍參加iGEM，而今年由仁愛堂田家炳中學、滙基書院（東九龍）、五旬節中學、保良局何蔭棠中學及德蘭中學5校三十多名學生組成的「Hong Kong JSS」聯校隊伍，於田家炳基金資助部分費用下，以基因改造大腸桿菌過濾水中重金屬的項目赴美參賽。

其網頁報告、現場台上演講、海報展覽及答問環節表現，成功獲評審小組頒最高級別的金獎，說明研究水平達到世界級。

低成本降魚菜共生重金屬

港生們因應香港地少人多，「魚菜共生」耕種方法近年日受歡迎的情況，發現「魚菜共生」經常出現重金屬累積超標的問題。研究隊伍遂決定對大腸桿菌進行基因改造，以將其變成能吸附重金屬的生物，他們讓大腸桿菌的金屬硫蛋白（metallothionein）過度表達，及將排走重金屬的運輸蛋白（cusF）基因敲除，從而成功大幅增加大腸桿菌吸收重金屬的能力。基於有關成果，隊伍更製造了一個首創的細菌過濾器「B-CAD」，並於實驗證明「B-CAD」能以低成本去降低魚菜共生系統中，水裡面的重金屬水平。

隊員之一的仁愛堂田家炳中學學生余安怡表示，參加iGEM的經驗讓她學會很多關於基因工程和科學研究的知識，從中獲益良多；而赴美參賽交流，見識到世界各地年輕一代的科研實力，認識到個人的渺小但亦能走出香港放眼世界，更有推動力讓自己進步。

該校帶隊老師、生物科科主任劉博則提到，香港過去被指過度注重考試操練及背誦，於培訓學生科學探究能力及科學素養（Science literacy）方面較為落後，他認為，iGEM賽事可讓學生體驗真正科學家在研究中運用跨學科的知識及能力的過程，是非常難得的經驗，而同學在參賽後對科學的興趣及能力有明顯提升，可見活動有助學生發揮所長，及激勵他們追求更高的層次，收穫甚豐。

■Hong Kong JSS 聯校隊伍於iGEM比賽場地合照。 受訪者供圖

成員還要考試 研