China iGEM Online Meetup

会议手册

MAIN BROCHURE

Ailurus biotechnology

iGEM

CCiC Conference of China iGEMer Community

Biosysen The Bioware Company

Conference Agenda | 会议议程

Time	时间	Agenda	议程

2021年5月29日（29th May 2021）

9:00-9:30	Opening Ceremony 欢迎仪式
9:30-11:30	Presentation 项目分享：Manufacturing (FAFU_CHINA,Jiangnan_China, NJTech-China,NWU-CHINA-A, NWU-CHINA-B,ShanghaiTech_China, XJTU-China)
11:30-14:00	Lunch Break 午休
14:00-17:00	Presentation 项目分享：Health (BUCT,GA State SW jiaotong, HZAU-China,NJMU-China,NJU-China, SZPT-CHINA,SZU-China, LZU-CHINA,ZJU-China)

Conference Agenda | 会议议程

Time | 时间	Agenda | 议程
2021年5月30日（30th May 2021）	
9:30-11:30	Presentation 项目分享:Environment (CAU_China,CPU_CHINA,DUT_China, iBowu-China,Tongji_China, UESTC-China)
11:30-13:30	Lunch Break 午休
13:30-14:00	Lecture from CEO of Ailurus Biotech 赞助商致辞
14:00-16:00	Presentation 项目分享 (BS_United_China,Jilin_China,NEU-CHINA,OUC-China,SJTU-Software)
16:00-16:15	Leture from CCiC CCiC 致辞
16:15-16:30	Closing Ceremony 闭幕式

Content | 目录

School | 学校名称： Multiple schools 多所高中联队
Location | 地址： Beijing, Shanghai, Jiangsu, Sichuan
北京、上海、江苏、四川
Attending state | 参会状态： Presentation 展示
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The construction of genetic engineering bacteria by genetic element based on quorum sensing and the inhibitions of pathogenic microorganisms' virulence factor accumulation such as food contamination.

基于细菌群体响应的基因元件构建工程菌感应和抑制食品污染等致病微生物的毒力因子积累

Project brief: Food spoilage and contamination are always problems for humans as there is a large amount of harmful bacteria in the air, soil and water we contact with. Food contamination can be relatively alleviated by means of high temperature disinfection and plastic packaging. However, infections from contaminated food are still often reported. The key to the above problems is the accumulation of toxic and harmful substances such as endotoxins caused by bacterial growth during food processing, transportation and storage as well as the contamination of harmful pathogenic microorganisms. How to determine food freshness in a fast, effective, simple, safe and inexpensive way? How to simply and quickly control the accumulation of toxic and harmful substances in food preservation?

We use the principle of bacterial quorum sensing and synthetic biology technology to build engineering bacteria with detection and inhibition functions, aiming to establish a rating of food spoilage during storage and quantify the degree of food spoilage. Cooperating with the biological module that inhibits the synthesis of toxin, the bioactive protein that inhibits the accumulation of bacterial toxin can be prepared to delay and inhibit the process of food spoilage. This invention is expected to provide a reliable guarantee for the residents' health and food safety.

项目简介：食品的腐坏和污染一直困扰人类，我们接触的空气、土壤和水质中含有大量有害细菌，人们采用高温消毒和塑料包装等手段可一定程度缓解食品污染，但常有因食用污染的食品的感染的报道。导致上述问题的关键是食品在加工、运输和储存过程中的细菌生长以及有害病原微生物的污染会导致如内毒素等有毒有害物质积累。如何快速有效、简单、安全、廉价的方式来识别食物新鲜度？如何简单快速抑制食品保存中有毒有害物质的积累？

我们利用细菌的群体感应的原理和合成生物学技术，构建具有检测和抑制功能的工程细菌，旨在建立食品储存过程中变质的评级，量化食品腐坏的程度。配合抑制毒素合成的生物模块，可制备出抑制细菌毒素的积累生物活性蛋白，从而延缓和抑制食品变质过程。此发明创造有望对居民的人生健康和饮食安全提供可靠保障。

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Using fat to synthesis γ-Aminobutyric acid and 5-hydroxytryptophan in *Escherichia coli*

构建利用脂肪合成γ-氨基丁酸和5-羟基色氨酸的大肠杆菌

Project brief: Obesity and depression are common and serious problems. Globally, there are more than 650 million people suffering from it. Many people are under great pressure, tired at work, and their bodies are in a sub - health state for a long time, with their psychology in a depressed condition, which can easily bring about obesity. Aiming at helping people lose weight and relieve their emotions, we intend to construct an *E. coli* engineering bacterium that can be colonized in human intestinal tract. By using synthetic biological methods, the systems which can decompose fat and simultaneously synthesize γ-aminobutyric acid and 5-hydroxytryptophan, which can effectively relieve anxiety and improve physical condition, with decomposition products are constructed in this bacterium.

项目简介：肥胖和抑郁是一种常见又严重的问题，在全球，有超过6.5亿人受其折磨。很多人压力很大，工作劳累，身体长期处于亚健康状态，心理处于压抑状态，会产生肥胖。为了有效帮助人们减肥并舒缓情绪，我们打算开发一种可以定植在人体肠道内的大肠杆菌工程菌，利用合成生物学方法，在该菌中构建可以分解脂肪并用分解物合成γ-氨基丁酸和5-羟基色氨酸的合成系统，产生的这些物质能有效缓解焦虑情绪，改善身体状况。

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中国农业大学
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SSR：Saline-alkaline Soil Restorer
盐碱土修复师

Project brief: At present, the prevention and control of saline alkali soil is a worldwide problem which needs to be developed urgently, and biological control of it is a field which needs to be developed urgently as well. We are committed to finding a cost-effective biological treatment of saline alkali soil. We plan to transform *Corynebacterium glutamicum* to let it produce γ-Polyglutamic acid (γ-PGA) in soil. γ-PGA is an excellent water retaining agent, which can treat saline alkali soil by neutralization of acid and alkali, ion adsorption, nutrient activation, formation of soil aggregates, and interaction with plants. *Corynebacterium glutamicum* can produce glutamate by itself. It can synthesize and secrete γ-PGA by transferring related genes into it. Then put it into soil to treat saline alkali soil. In addition, we also plan to use salt and alkali differential expression promoters, and to modify RBS, start codon of the genome and other elements and methods to ensure the safety and further optimize the project.

项目简介： 目前，盐碱地的防治是一个急需进展的世界性问题，生物防治更是一个急需发展的领域。我们致力于找到一种经济有效的生物治理盐碱地方案。我们拟通过改造谷氨酸棒杆菌，使其在土壤中生成γ-聚谷氨酸。γ-聚谷氨酸是优良的保水剂，可以通过酸碱中和、离子吸附、养分活化、形成土壤团聚体、与植物互作等多种途径改良盐碱地。土壤土著菌谷氨酸棒杆菌自身可以生产谷氨酸，通过向其中转入相关基因，可使谷氨酸棒杆菌具有合成并分泌γ-PGA的能力，将其制成菌剂投入土壤便可改善盐碱地。此外，我们还利用盐碱差异表达启动子，修改谷棒基因组RBS、起始密码子等元件和方法进行安全性的保证及项目的进一步优化。

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Construction of MnP-AAO-HFB1 composite system based on CRISPR/dCas9 programmable assembly technology for the oxidation of polyethylene plastic.
基于CRISPR/dCas9设计的可编程组装技术构建/合成氧化聚乙烯（PE）塑料的MnP-AAO-HFB1复合系统

Project brief: Exemplified by polyethylene, undegradable plastics have a degradation period of hundreds of years under natural conditions, causing severe environmental crisis worldwide. Manganese peroxidase (MnP) use hydrogen peroxide (H_2O_2) to produce high-redox-potential Mn^{3+}, possessing a PE-degrading potential. Our project takes MnP as our key PE-degrading enzyme, employs aryl alcohol oxidase (AAO) to provide H_2O_2 for MnP, and utilize Hydrophobin-1 (HFB1) to increase substrate accessibility, as well as combines SpyCatcher-SpyTag system with CRISPR/dCas9 system to anchor MnP, AAO and HFB1 onto one double-stranded DNA scaffold according to certain spatial order, distance and proportion. The final complex works as a molecular machine that can adhere and degrade PE in a green and swift way.

项目简介：以聚乙烯（PE)为代表的不可再生塑料，天然条件下降解周期长达数百年，在全球范围内造成了严重的环境污染。锰过氧化物酶(MnP)能够利用过氧化氢产生高氧化活性的Mn^{3+}，具有潜在的PE降解能力。本项目使用MnP作为降解PE的关键酶，使用芳醇氧化酶(AAO)为MnP提供过氧化氢，使用疏水蛋白HFB1增加底物可及性，结合SpyCatcher-SpyTag系统和CRISPR/dCas9系统，将MnP、AAO和HFB1按照一定的空间顺序、距离、比例结合到同一双链DNA上，构建出可附着并降解PE的分子机器。

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大连理工大学
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Capture and degradation of Microplastics in water
水体中微塑料的捕获与降解

Project brief: This project is committed to using *Chlorella* to solve the problem of micro plastic pollution in water, focusing on the capture and degradation of micro plastic (currently the degradation of plastic is PET). Microplastics are plastic particles less then 5mm, which widely exist in the natural environment and have a wide range of toxic effects on human beings, animals and plants, and even the natural environment. However, the treatment of microplastics is difficult and difficult to capture, especially in the key treatment links such as sewage sludge. There are many differences between the treatment of microplastics and traditional pollutants such as heavy metals. Another problem that can be ignored is that microplastics keep increasing year by year, and keep circulating in the natural environment; In the future, microplastics will bring us immeasurable challenges.

In the aspect of capturing microplastics, we use the quorum sensing system of bacteria to improve the biofilm production of *Chlorella vulgaris* by applying homoacylserline lactones (AHLs). We transform *Chlorella vulgaris* to autocrine AHLs and produce a large number of biofilms. Microalgae biofilm has a good adsorption capacity for microplastics, so as to capture microplastics in water.

For the degradation of microplastics, the genes of two important enzymes in the degradation process of PET microplastics were introduced into *Chlorella* to achieve the exocrine of degrading enzymes and the degradation of plastics. After modeling and analysis, the best degradation efficiency can be obtained by reasonably

connecting the two degradation enzymes.

Therefore, we use the Modular enzyme assembly technology to achieve the high and high effect of ligase complex. At present, PET is the main degradation object of the project, and a variety of plastic degradation enzymes can be added to build a variety of plastics degradation systems.

项目简介：本项目致力于利用小球藻解决水体中微塑料污染的问题，聚焦于对微塑料的捕获和降解（目前降解的塑料种类是PET）。微塑料是小于5mm的塑料微粒，在自然环境中广泛存在，对各种人类、动植物、乃至自然环境有广泛的毒害作用。但目前针对微塑料处理困难、难以捕获，特别是在污水污泥等关键处理环节中，微塑料这种新污染物与重金属等传统污染物的处理存在很多不一样的地方。另外一个不可忽略的问题是，微塑料保持着逐年增多的趋势，在自然环境中不断循环；在未来，微塑料带给我们的挑战不可估量。

捕获微塑料方面，我们借力与细菌的群体感应系统，利用外源施加高酰丝氨酸内酯(AHLs)能显著促进小球藻产生生物膜的特点，改造小球藻使其自分泌AHLs，自响应产生大量生物膜。而微藻生物膜对微塑料有良好的吸附性，从而达到在水体中捕获微塑料的目的。

降解微塑料方面，将PET微塑料降解过程中很重要的两种酶的基因导入小球藻，实现降解酶的外泌和塑料降解。经过建模分析，将两种降解酶合理连接可以获得最佳的降解效率，因此我们采用无骨架合成蛋白技术以实现连接酶复合体的高效表达与高效作用。项目目前以PET为主要降解对象，后续可以加入多种塑料降解酶，构建多种塑料降解体系。

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Construction of odor sachet with changing conditions based on genetic engineering
基于基因工程的方法构建条件变化气味香囊

Project brief: Chinese sachet has a history of thousand of years, and it is widely used in prevention, treatment and daily wear, but the common sachet has low odor efficiency and the utilization rate of aromatic alcohol is very low, which can not achieve the design effect. This year, we want to construct a cell factories to produce different aroma.

We have designed an exquisite gene circuit to optimize the metabolic flow, and we also want to modify the expression of the corresponding genes by using elements such as operons, so that the whole system can express different kind of flavor which combines various kinds of aroma substances under different physical or chemical stimuli.

In the end, we will use electronic nose to carry out quantitative analysis on different aroma substances under a series of experiments under different inducing conditions. On the basis of ensuring that the content of aroma substances will exceed the sensory threshold of human body, we will further optimize the dynamic expression of aroma substances, so as to achieve the design goal of microbial self-regulation of aroma.

项目简介：中国香囊已有上千年历史，在预防，治疗及日常的穿戴中广泛应用，但是普通的香囊具有气味低效性，芳香醇利用率极低，达不到实验设计的效果。本课题组今年的目标是构建一个细胞工厂来表达不同的香气。

我们设计了一个精妙的基因电路使代谢的流向达到最优解，我们还想要通过利用操纵子等元件来调整相应基因的表达，从而使整个系统在不同理化刺激之下表达出不同含量的香气组合。

我们将用电子鼻在一系列不同诱导条件的实验下对不同香味物质进行定量分析，在确保香味物质的含量都超过了人体感官阈值的基础上，进一步优化香味物质的动态表达，以实现微生物自我调节香味的设计目标。

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佐治亚州立大学 & 西南交通大学
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Heterologous expressed human follicle cell growth-related factors for the inhibition of hair loss

利用异源表达所得人毛囊细胞生长相关因子改善脱发

Project brief: Telogen effluvium is a hair disorder caused by acute or chronic stress. When a person undergoes prolonged stress, a certain percentage of anagen hair rapidly transitions to telogen effluvium, which causes diffuse hair loss. Androgenetic alopecia is an androgen-dependent genetic disorder in which the local scalp hair follicles have increased sensitivity to androgens, resulting in miniaturization of hair follicles and thinning of the hair shaft, causing hair loss. In this project, we want to investigate the pathways of Gas6 and platelet concentrated growth factor in promoting hair follicle cell proliferation. By expressing heterologous hair follicle cell growth-related proteins from *Pichia pastoris* or Chinese hamster ovary cell, and conducting tissue and animal experiments to explore novel delivery methods, we aimed at providing a new idea for inhibiting stressful and androgenic hair loss.

项目简介：休止期脱发是一种由急性或慢性压力引起的毛发疾病，当人长期处于压力之下，一定比例的生长期头发快速向休止期过渡，从而引起弥漫性脱发。雄激素源性脱发是一种雄激素依赖的遗传性疾病，患者局部头皮毛囊对雄激素的敏感性增加，导致毛囊微型化，毛干变细，引起脱发。本研究欲从GAS6蛋白通路和血小板浓缩生长因子促进毛囊细胞增殖的角度入手，以毕赤酵母或CHO细胞系为材料，通过异源表达毛囊细胞生长相关蛋白，同时开展相关组织、动物实验探究新型递送方式，为改善压力性、雄激素源性脱发提供新思路。

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A simple and early warning dual-function IBD detection system based on Nissle 1917

基于Nissle 1917的一个简便、早期预警双功能的IBD检测系统

Project brief: Inflammatory bowel disease is a common inflammatory disease that is zoonotic, which has the characteristics of not obvious early symptoms and complicated detection methods. Therefore, when a patient is diagnosed with IBD, the condition often becomes severe and this phenomenon is more common for pets. Therefore, we tried to develop a detection and report system for IBD from two aspects: simple detection and early warning. We envision that this system will be applied to pets first, that is, our engineered bacteria will be added to pet food. When bacteria enter a healthy intestine, they can secrete beneficial biomass. Once the early pathological response of IBD is detected by our bacteria, they will secrete a distinctive report odor while releasing small peptides that can delay the development of the disease. Eventually, the system of detection can be carried out and report the abnormal phenomenon in the early stage of pets suffering from IBD and the deterioration of the disease can be delayed.

项目简介： IBD是一种人畜共患的常见炎症性疾病，具有早期症状不明显，检测手段繁琐的特点。因此，当患者被确诊为IBD时，病情常趋于严重，且这种现象对于宠物更为普遍。于是，我们尝试从简便检测，早期预警两方面着手，开发一套针对IBD的检测报告系统。我们预想将该系统先行应用于宠物，即将工程菌添加至宠物食品中，当其进入健康的肠道后能够分泌益生物质，而一旦检测到IBD的早期病变反应，它们将另行分泌具显著特征的报告气味的同时释放延缓病情发展的小肽。最终实现在宠物患IBD的早期进行检测报告，并延缓病情的进一步恶化。

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Synthetic Biology pathway for active drug from herbal medicine: the case of synthesizing glycyrrhetinic acid
合成生物学合成路径获得中草药有效成分：合成甘草次酸

Project brief: Glycyrrhetinic acid (GA), a natural compound extracted from licorice is proved to have a range of therapeutic effects on cancer, ulcer, Alzheimer's, arthritis et cetera. GA is also approved as food additives due to its sweetness. Current method of extraction of GA from licorice is low-yield and complicated, so our project aims to achieve a cost-effective, and potentially large-scale production of GA, by converting the less effective prodrug Glycyrrhizic acid (GL), which has high concentrations up to 5% in licorice root, to the metabolically active form, GA, through the catalytic effects using the (βG). It has been reported that βG can be expressed in *E. coli* strains by the GusA gene. To achieve higher GA yield, We propose to 1) improve the yield of the enzyme βG by adjusting promoter strength and induction condition of GusA gene, 2) and to improve the catalytic efficacy of β-glucuronidase through optimizing fermentation conditions and to design cell free systems for enriched β-glucuronidase reactivity.

项目简介： 甘草次酸是一种从甘草中提取的极有药用价值的成分，对癌症，溃疡，阿兹海默症，关节炎都有一定的疗效。同时GA也被用来做天然甜味剂。现有提取GA的方法产量低并且繁琐，因此我们的项目致力于达成一个低成本的大规模生产方式。用β-葡萄糖醛酸酶将在甘草中有高达5%含量的甘草酸催化成更有效的GA。βG可以在大肠杆菌中被GusA基因表达出来。我们希望通过下面两个方面去达到高产量，1) 通过改变启动子的强度调控GusA的表达来提高βG的产量，2) 改变发酵条件和构建无细胞系统提高βG的效率。

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Save Coral Reefs at risks: Synthesize an eco-friendly sunscreen by *S. cerevisiae*
利用酿酒酵母合成环境友好型防晒霜来保护受到白化威胁的珊瑚礁

Project brief: Every year, the splendid view of coral reef attracts people all around the world. However, to protect from UV damage, around 14,000 tons of sunscreen containing chemical compounds with a broad-spectrum UV coverage, such as oxybenzone and octinoxate, is washed into the oceans and seas annually, causing bleaching and a variety of pathologies to corals. As an ecosystem carrying a quarter of living species in the ocean, the bleaching of coral reefs can further lead to the extinction of marine organisms. Our project aims at engineering *S. cerevisiae* to produce a natural sunscreen compound gadusol by introducing 2 genes from zebrafish (EEVS and MT-Ox).We hope to produce an eco-friendly sunscreen using the yeast extract containing gadusol to replace the traditional sunscreens, protect the marine ecology and build a better world.

项目简介： 珊瑚礁景区每年都吸引了世界各地的旅客前来观光。然而，前来观光的旅客为了抵御景区强烈的紫外线，会使用大量含有广谱防晒物质——羟苯甲酮与甲氧基肉桂酸辛酯的化学防晒霜，每年约有14,000吨防晒霜因此被冲刷至海洋当中，导致了珊瑚白化与一系列珊瑚疾病。作为承载了25%海洋生物的生态系统，珊瑚礁的白化会进一步引起海洋生物的灭绝以及生态系统的崩溃。我们的项目致力于通过导入EEVS与MT-Ox两段来源于斑马鱼的基因来改造酿酒酵母，使其成为可以生产斑马鱼来源的天然紫外吸收剂统的化学防晒霜，保护珊瑚礁以及海洋gadusol的微型防晒霜生产工厂，利用酵母提取物进一步生产出生物防晒霜，替代传生态系统。

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Mosquiet: Dynamic regulation strategy based *Escherichia coli* biological acid production device to lure and kill mosquitoes
基于动态调控策略的大肠杆菌生物产酸诱蚊杀蚊装置

Project brief: In addition to the annoying itching caused by mosquito bites, blood-sucking female mosquitoes are responsible for the transmission of Dengue Fever, Malaria, Yellow Fever, Japanese Encephalitis and many other diseases, seriously affecting living standard and public health of human beings. However, the commonly used insecticide, mosquito repellent and chemical mosquito attractant still have some defects, such as irritation to human body, environmental pollution, drug resistance and so on. This project intents to construct a mosquito-lured-and-killing device based on an auto-regulating *Escherichia coli* production system of L-lactic acid and acetic acid to lure blood-sucking female mosquitoes, by using the idea and basic elements of synthetic biology for dual dynamic regulation of both quorum sensing and acid response of key genes.

项目简介：除了夏天蚊子叮咬引起的恼人的瘙痒之外，吸血的雌蚊会导致登革热、疟疾、黄热病、日本脑炎等其他多种疾病的传播，严重影响全世界人类的生活质量与生命健康。而当前常用的杀蚊剂、驱蚊剂、化学诱蚊剂等都有一定缺陷，如对人体的刺激性、环境污染、抗药性的产生等。本项目拟通过采用合成生物学思路和基本元件对关键基因进行群感和酸响应双重动态调控，构建基于能够自动调控L-乳酸、乙酸产量以诱蚊的大肠杆菌菌株的诱蚊灭蚊装置。

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Targeted inhibition of SARS-CoV-2 infection based on CRISPR-Cas13 system
基于CRISPR-Cas13系统靶向抑制SARS-CoV-2感染

Project brief: The novel coronavirus SARS-CoV-2 leads to a sustained outbreak of COVID-19. Traditional vaccines and drugs lag behind, but the potential of CRISPR-Cas13d for pan-coronavirus protection provides a new strategy to replace them. We construct CRISPR-Cas13d system through bioinformatics screening. A preventive antiviral strategy in human cells is developed by using specific crRNA-mediated Cas13d protein to degrade the coding RNA of receptor protein ACE2.

项目简介： 新型冠状病毒SARS-CoV-2导致COVID-19持续爆发，传统的疫苗和药物治疗具有滞后性，CRISPR-Cas13d进行泛冠状病毒保护的潜力提供了替代传统药物或疫苗的新策略。本项目通过生物信息学筛选构建CRISPR-Cas13d系统，利用特异crRNA介导的Cas13d蛋白靶向降解受体蛋白ACE2的编码RNA，进而开发了一种人类细胞中的预防性抗病毒策略。

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Multivirus Detector: Using PmrCAB system and quorum sensing, and building a hardware to achieve multivirus detection.

利用PmrCAB系统和群体感应系统，构建硬件实现多病毒检测

Project brief: Over the years, we have suffered from different kinds of corona-viruses, such as MERS, SARS-CoV-2 and so on. At present, the detection methods of these viruses are becoming mature, but prediction or detection systems for multiple corona-viruses is uncommon.

Our project intends to construct an engineering bacteria to detect MERS-CoV, Hcov-229E and SARS-CoV-2 at the same time. First, we used PmrCAB system to detect corona-virus protein. Then we used the quorum sensing system based on LuxI / LuxR in *E. coli* and added HRP amplifier in order to amplify the signal. Finally, theses three kinds of engineering bacteria are put in the same device to realize the multi virus detection in environment.

项目简介：数年来，我们遭受了MERS，SARS-CoV-2等不同冠状病毒的侵害，当前对这些病毒的检测手段也趋于成熟，然而基于多种冠状病毒的检测甚至预测的系统却不常见。

本项目拟构建对MERS-CoV、HCoV-229E、SARS-CoV-2三种冠状病毒实现检测的工程菌。选用PmrCAB系统对冠状病毒蛋白进行检测，使用大肠杆菌内的基于LuxI/LuxR的群体感应系统，并加入hrp放大器以放大信号；最终将三种工程菌置于同一装置中实现对环境中的多病毒检测。

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Treatment of autism with engineering probiotics
基于工程益生菌治疗自闭症

Project brief:

Autism spectrum disorders (ASDs) are neurodevelopmental disorders diagnosed in early childhood. They present with varying degrees of dysfunction. Intervention and support for ASDs should be individual, multidimensional and multidisciplinary, bringing severe financial burden on both families and the society.

Our project attempted to construct engineering probiotics to lend a helping hand to “star children” and their family.

项目简介： 自闭症谱系障碍(ASD)是一种儿童早期神经发育疾病，表现为不同程度的功能障碍。儿童自闭症为家庭和社会带来了沉重的经济负担。我们的项目试图通过构建工程益生菌来帮助“来自星星的孩子”。

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Saving Rose Plan : Design and Construction of Synthetic Microalgae-Yeast Consortia for Biosynthesis of Phenylethanol
拯救玫瑰：苯乙醇生物合成人工混菌体系的构建及调控

Project brief: Phenylethanol is a kind of rose-scented aromatic alcohol, which is widely used in cosmetics, food and medicine and has great market value. At present, there are three ways to obtain phenylethanol, namely physical extraction, chemical synthesis and biological synthesis.

Saccharomyces cerevisiae has the characteristics of small volume, fast reproduction, much absorption, fast transformation, strong adaptability, etc. The products produced by *Saccharomyces cerevisiae* are relatively pure with low cost and high efficiency, and the quality meets international standards. In addition, using L-phenylalanine as substrate can greatly increase the yield of phenylethanol produced by *Saccharomyces cerevisiae*, so it can be considered to use Saccharomyces cerevisiae to biosynthesis phenylethanol. This project intends to produce phenylethanol by constructing a phenylacetaldehyde synthase (PAAS) system based on *Saccharomyces cerevisiae* and use basic elements of synthetic biology, such as promoters, for fine regulation of key genes, and to construct a yeast-microalgae interaction system in the later stage.

项目简介：苯乙醇是一种玫瑰花香的芳香醇，其广泛应用于化妆品、食品、医药中，有着巨大的市场价值。目前，获得苯乙醇的途径一般有三种，分别是物理萃取、化学合成和生物合成。

酿酒酵母具有体积小、繁殖快、吸收多、转化快、适应强等特点，生产产品较纯且成本低、周期短、效率高，质量符合国际标准。此外，以L-苯丙氨酸作为底物可以使酿酒酵母苯乙醇的产量得到大幅提高，因此可以考虑利用酿酒酵母生物合成苯乙醇。本项目拟通过构建基于酿酒酵母的苯乙醛合成酶(paas)系统生产苯乙醇并采用合成生物学基本元件如启动子对关键基因进行精细调控，并在后期构建酵母-微藻互作体系。

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Targeted therapy of asthma by self-assembled small interfering RNA *in vivo*
体内自组装的小干扰RNA系统用于治疗哮喘

Project brief: Asthma is a common chronic disease of the respiratory system. At present, the common drugs used to treat asthma include β-receptor agonists and glucocorticoids. However, some investigations have shown that patients' poor compliance with drugs will lead to frequent recurrence of asthma, which is very unfavorable to the control of the disease. Since the symptoms of asthma are induced by type 2 inflammation to a large extent, we plan to use RNAi technology to inhibit the expression of related proteins, so as to inhibit inflammation and relieve asthma. Our project designs are as follows: We intend to transfection mouse bronchial epithelial cells by liposome atomization with minicircle DNA (mcDNA). These mcDNAs will encode siRNAs of GATA3 and TSLP, respectively; and the siRNAs will be secreted extracellular through exosomes, targeting the corresponding genes to achieve the inhibitory effect of inflammation.

项目简介：哮喘是一种常见的呼吸系统慢性疾病，目前常见的用于治疗哮喘的药物有β受体激动剂和糖皮质激素。但是，有调查表面患者对药物的依从性不佳，这会导致哮喘经常性的复发，对病情的控制是很不利的。由于哮喘的症状有相当程度是由2型炎症反应所诱导，故而我们拟采用RNAi的技术抑制相关蛋白的表达，以抑制炎症、从而缓解哮喘。我们具体设计思路如下：我们拟采取用minicircle DNA(mcDNA)以脂质体雾化的方式转染小鼠的支气管上皮细胞，这些mcDNA将会分别编码GATA3和TSLP的siRNA，后者会通过外泌体的方式分泌到胞外，靶向相应的基因达到抑制炎症的作用。

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Construction of the *Escherichia coli* two cell system for monarch violet dye production

构建大肠杆菌双细胞系统生产帝王紫染料

Project brief: Tyrian purple, also known as, 6,6-dibromoindigo, is a kind of natural pigment with a long history of production and application, which was always been preferred by the royal. In addition to its value in history and culture, as a kind of novel biocompatible semiconductor it also receive much attention. However, due to natural yield little, difficulty in chemosynthesis and the potential pollution, its high yield production hasn't been realized. Therefore, we plan to implement a two-cell reaction by spatiotemporally separating the two consecutive procedures of the production, so that the enzyme in tyrian purple metabolic pathway could achieve its highest efficiency. Moreover, we can choose some gene expression regulatory parts to improve the high-yield and high-purity dual cell system.

项目简介：帝王紫，即6,6-二溴靛蓝，是拥有悠久生产与应用历史的天然染料，历史上一直为统治阶级所钟爱，除其承载的历史文化价值外，帝王紫作为新型生物相容性导体，在半导体材料中也倍受瞩目。但由于其天然产量少，化学合成困难且存在环境污染，迄今未能实现高产。本项目拟采用双细胞系统，进行生产时空分离，以达到帝王紫代谢通路中相关酶的最高利用效率，并严格筛选基因表达调控原件，构建帝王紫高纯度，高产量双细胞体系。

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Ginsenoside：Based on the expression of b-glucosidase in *Pichia pastoris* and the deglycosylation of Rb1, the transformation pathway and yield of ginsenoside were optimized.

基于在毕赤酵母中表达B-葡萄糖苷酶并用于Rb1的去糖基化，优化人参皂苷转化的路径与产量

Project brief: Ginsenoside, as an effective component of ginseng, has a variety of pharmacological activities. Among them, ginsenoside CK has been studied for its excellent biological activities such as anti-diabetes, anti-tumor, anti-inflammatory and anti-aging. however, CK almost does not exist in natural ginseng, and can be produced by enzymatic transformation of PPD type ginsenoside Rb1. In order to improve the production of CK, our team intends to express b-glucosidase in *Pichia pastoris* and use it for the deglycosylation of RB1 and the production of CK.

项目简介：人参皂苷作为人参的有效成分，具有多种药理活性。其中，人参皂苷CK因其具有抗糖尿病，抗肿瘤，抗炎，抗衰老等出色的生物活性而被研究，然而，CK在天然人参中几乎不存在，可由PPD型主要人参皂苷Rb1通过酶促转化产生，为了提高CK产量，我们队伍打算在毕赤酵母中表达B-葡萄糖苷酶并用于Rb1的去糖基化和CK的生产。

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Fluorescence-activated RNA aptamer, CRISPRi and strand replacement reactions based whole cell biosensor for antibiotic detection

基于荧光激活RNA适配体，CRISPRi与链置换反应的高性能全细胞生物传感器以检测抗生素

Project brief: Due to the large-scale use of antibiotics, environmental pollution and food residues have posed a great threat to the ecological environment as well as human health. Therefore, this project aims to design a series of high-performance whole cell biosensors (WCBs) to detect antibiotics. To overcome the common limits of WCBs, a fluorescence-activated RNA aptamer is used as the output signal to increase the response speed, and it is hoped that the signal-noise ratio and dynamic range of the sensor can be improved by the NIMPLY logic gate gene circuit composed of CRISPRi and strand replacement reactions.

项目简介：由于抗生素的大规模使用，其造成的环境污染和食品残留问题对生态环境与健康安全已造成了威胁，故本项目以四环素类和大环内酯类抗生素为例，设计了高性能的全细胞生物传感器用以检测抗生素。为克服WCBs常见的各种限制，本项目将一种荧光激活RNA适配体作为输出信号以增加传感器响应速度，并希望通过由CRISPRi和链置换反应组成的NIMPLY逻辑门基因线路提高传感器的信噪比(signal-noise ratio)和动态范围。

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Stress sensitive biodegradable pharmaceutical cell-laden adhesive hydrogel for fracture repair

应力敏感的以细胞为骨架的生物可降解可释药粘性水凝胶用于骨折修复

Project brief: Hydrogels are excellent materials for 4biomedical applications because of their good biocompatibility, predictable degradation rate, adjustable mechanical properties and good elasticity. Current fracture repair materials lack fine regulatory elements, such as ideal material degradability and accurate drug release control, etc. This project designed a new type of cell-laden hydrogel-based material, whose functions include the Piezo-based stress sensitive control system of material degradation and drug release, so as to realize the phased-changeable material strength and drug release in the recovery period of patients and achieve the purpose of individualized precision medicine. At the same time, the hydrogel-based material is coated with mussel-like proteins to increase the material's strength and ensure a tight bond to the fracture site.

项目简介： 水凝胶因其良好的生物相容性、可预测的降解率、可调节的力学性能和良好的弹性而成为生物医学应用的优良材料。目前的骨折修复材料缺乏较精细的可调控元件，例如材料的可降解性，释药控制等。本项目设计了一种以细胞为结构骨架的新型水凝胶材料，其功能包括基于Piezo的压感调控材料降解与药物缓释系统，实现患者骨折恢复期的阶段性材料强度改变和药物释放，达到个体化精准医疗的目的。同时，水凝胶外覆盖有贻贝黏蛋白，增加材料强度并保证材料与骨折处的紧密结合。

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Platform of DNA Computation
DNA计算平台

Project brief: The current DNA computation and its application are still in the laboratory stage, which is difficult to apply DNA computation for researchers without rich professional knowledge. This project aims to build a comprehensive dynamic DNA computing work platform to assist scientific researchers in accelerating the progress of research. This platform integrates bioinformatics analysis, machine learning models and molecular dynamics simulation to achieve design guidance and predictive simulation of dynamic DNA computation sequences. It can be applied to low-cost, non-invasive, and conventional early cancer screening.

项目简介： 目前，DNA计算及其运用还处于实验室阶段，如果没有丰富的专业知识很难完成DNA计算的设计及结果展示。本项目旨在构建一个综合的动态DNA计算工作平台，协助科研工作者加快科研进程。此平台融合生物信息学分析，机器学习模型，分子动力学模拟三大模块实现动态DNA计算序列的设计指导和预测模拟，可以应用于面向低成本、无侵入性和常规的早期癌症筛查。

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Engineered *Acetobacter xylostella* to work on *P.aeruginosa* infection and wound repair in burn treatment

改造木醋杆菌用于烧伤治疗中铜绿假单胞菌的感染和创面修复

Project brief: Infection remains the most common cause of morbidity and mortality in burn patients. *Pseudomonas aeruginosa* is among the leading causes of nosocomial infection primarily because it is intrinsically resistant to many antibiotics and antimicrobials. This year our team is working on *P.aeruginosa* infection and wound repair in burn treatment. Using principles of synthetic biology, we genetically modified *Acetobacter xylostella* to kill *P. aeruginosa* specifically through the production and release of chimeric bacteriocin SE protein and the immune protein. Moreover, the production of cellulose in the engineered *Acetobacter xylostella* was regulated by blue light, which can further prevent infection of other bacteria and promote wound repair.

项目简介： 感染是烧伤患者发病和死亡最常见的原因。铜绿假单胞菌是医院感染的主要原因之一是因为它对许多抗生素和抗菌剂存在耐药性。今年我们团队致力于烧伤治疗中铜绿假单胞菌的感染和创面修复。运用合成生物学的原理，我们对木醋杆菌进行改造通过生产和释放嵌合细菌素SE蛋白和免疫蛋白来杀死铜绿假单胞菌。此外，在工程菌木醋杆菌中用蓝光调节纤维素的生产，可以进一步阻止其他细菌的感染以及促进伤口的修复。

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Cocktail therapy: Specific to multiple potential targets of inflammatory bowel disease through genetically modified engineered bacteria
针对炎症性肠病的多个潜在靶点通过基因改造的工程菌进行“鸡尾酒式”治疗

Project brief: Inflammatory bowel disease (IBD) is a kind of chronic intestinal inflammation with many characteristics including long onset cycle, limited curative effect, easy to relapse and potential risks in causing cancer, the disease has a great impact on the quality of patients’ life. At the same time, the world currently has more than 10 million people suffering from IBD and other related diseases, so the application prospects of related products are broad.

After screening out multiple targets that have been proven effective for IBD treatment, We develop our cocktail therapy for IBD (especially UC) patients target on above reasons by using genetically modified engineered bacteria, in the form of enteric-coated capsules or fermented yogurt. As the final product, we also use bio-information methods to assist in the detection and tracking of patient feces, and adjust the ratio of bacteria in a timely manner.

At the level of public awareness, we will adopt multiple channels for publicity, popularizing knowledge about IBD diseases, in order to raise the public’s awareness of IBD.

项目简介：炎症性肠病有以下难点， 发病周期长，很难彻底根治，容易反复发作而且有潜在的癌变风险，患病对患者的生活质量造成很大的影响，同时，目前全世界有超过1000万人患有IBD以及相关疾病，相关产品应用前景广阔。

我们目标利用基因改造的工程菌，在已被证实有效的靶点中筛选出多个对因肠道菌群失衡的IBD(UC患者)进行“鸡尾酒式”疗法，以肠溶胶囊或发酵酸奶等形式作为最终产品，同时利用生信手段进行患者粪便的辅助检测、跟踪，及时调整菌种配比。

在公众认知层面，我们会采取多种渠道进行宣传，普及IBD疾病的相关知识，补齐公众对IBD的认知缺失。

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Detection and Degradation of Stench produced by Wet Garbage
湿垃圾恶臭气体的检测与处理

Project brief: The "Regulations of Shanghai Municipality on the Management of Domestic Waste" have been implemented for nearly two years. With the promotion and implementation of waste sorting measures, the amount of wet garbage separation in Shanghai has been increasing. Wet garbage will produce stench gas during the stacking and transportation, which will affect the health and quality of life of residents. Considering that ammonia and hydrogen sulfide are the main odor generated by wet garbage, we try to construct sensing and oxidation pathways of these two gases in *E. coli*. We hope to realize a detection and degradation system for hydrogen sulfide and ammonia using synthetic biology.

项目简介： 《上海市生活垃圾管理条例》已执行了接近两年。随着垃圾分类措施的推广与实施，上海市湿垃圾分出量不断增大。湿垃圾在堆放和运输的过程中会产生恶臭气体，影响居民的身体健康与生活质量。考虑到湿垃圾腐烂产生的臭气以氨气和硫化氢为主，我们尝试在大肠杆菌中构建硫化氢与氨气的感受与氧化通路。我们希望借助合成生物学的工具实现一个硫化氢与氨气的检测与处理系统。

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To Realize In-situ Regeneration of Office Waste Paper: Recombinant expression of deinking enzyme and a new kind of surface-display cellulosome system in *Pichia pastoris*

毕赤酵母重组表达脱墨酶和新型纤维小体系统实现办公室废纸的原地再生

Project brief: CEPI (Confederation of European Paper industries) has reported that the recycling rate of office waste paper (OWP) is dramatically low (12.9%) in Europe though this kind of paper has high value to regenerate. We find that cellulase, xylanase, lipase and laccase will allow biodeinking to occur, by disposing of fibers to eliminate adhesive ink particles to help the ink detach from the waste paper. In our project, we designed a new surface assembly of a functional cellulosome by using a synthetic yeast consortium, *Pichia pastoris*. The secreted cellulase and xylanase are docked onto the displayed scaffolding in a highly organized manner, resulting in the assembly of a functional cellulosome on the yeast surface.

项目简介： 欧洲造纸工业联合会称目前欧洲办公废纸的回收率极低(12.9%)，尽管该类纸拥有很高的再生价值。本项目旨在重组毕赤酵母，使其分泌纤维素酶，木聚糖酶，脂肪酶和漆酶并通过表面展示纤维小体系统提高其脱墨效率。该四种酶可剪切与粉墨相连的纤维以帮助墨水从废纸上分离而使生物脱墨发生。其中纤维素酶和木聚糖酶会以高度组织化的方式结合在重组毕赤酵母表面展示的支架上。

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Efficient biosynthesis of tryptophan
色氨酸的高效生物合成

Project brief: Tryptophan is an essential amino acid, which can be used as a food additive to improve insomnia, depression and other mental problems. This project intends to use synthetic biology methods to construct a controllable gene circuit for efficient tryptophan synthesis in *E. coli*, based on the bistable control system. By designing corresponding culture and fermentation devices, control systems and separation systems, this project provides a possible solution to achieve the efficient production and convenient application of tryptophan at home.

项目简介： 色氨酸为一种人体必需氨基酸，可以作为一种食品添加剂，改善失眠、抑郁等精神问题。本项目拟利用合成生物学方法，在大肠杆菌体内构建以双稳态调控系统为核心的、可调控的色氨酸高效合成基因电路，并通过设计对应的发酵培养装置、控制系统、分离系统，实现色氨酸的家用化高效生产与便捷运用。

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Liver Guard: Precise therapy of hepatocellular carcinoma based on engineered oncolytic adenovirus

肝卫士: 基于增强型溶瘤腺病毒的特异性肝癌靶向治疗

Project brief: Oncolytic virus (OV) is a promising method to treat hepatocellular carcinoma, yet it has not been widely used clinically due to low infection efficiency, insufficient specificity, compromised intertumoral transmission and etc. Our project designed a genetically modified adenovirus using synthetic biology approach to overcome current problems with oncolytic virus. We also enables engineered adenovirus to escape from immunity trap with immunocamouflage, which increases the titre of viral infection. It is highly hoped that our project can give a new insight into precise oncolytic treatment of HCC.

项目简介： 溶瘤病毒疗法是目前治疗癌症的新途径，但由于感染效率低、特异性不足、瘤内传播障碍等问题而未在临床上得到广泛应用。本项目通过对腺病毒进行合成生物学改造，增强病毒对肝癌细胞的特异性侵染、复制及瘤内传播，并加入免疫伪装机制，减少由于机体免疫造成的溶瘤病毒清除，实现原发性肝癌高效靶向治疗，为癌症的精准治疗提供科学依据。

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Design a gut microbe to prevent diarrhea-related dehydration
设计一种肠道微生物以防止腹泻相关的脱水

Project brief: In the world, diarrhea is a very serious problem. Diarrhea is responsible for 11% of deaths among children under the age of 5 due to poor sanitation and difficult access to clean water. At the same time, diarrhea is also a symptom caused by many diseases that seriously affects the quality of human life. Among them, dehydration is one of the main causes of diarrhea-related deaths. Therefore, we plan to design a beneficial engineered microorganism that can help diarrhea patients maintain moisture and kill pathogenic bacteria. This microorganism will colonize the human intestines to achieve the functions we expect.

项目简介： 在世界范围内，腹泻是一个十分严峻的问题。由于恶劣的卫生条件和难以获得的清洁引用水，有11%的5岁以下儿童死亡病例是由腹泻导致的。同时，腹泻也是多种疾病产生的严重影响人类生活质量的症状。其中，脱水是导致腹泻相关死亡的主要原因之一，因此我们计划设计一种可以帮助腹泻患者保持水分并且杀灭病原菌的有益工程微生物。这种微生物将会定植到人体的肠道内，以实现我们所期待的功能。

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Acne treatment with engineered bacteria
利用工程菌进行痤疮治疗

Project brief: Acne is a common skin disease. Generally speaking, acne is related to pores being blocked by oil and the proliferation of *Propionibacterium* acnes in such anaerobic environment. Our project aims at dealing with acne caused by factors above and hopes to develop a drug for acne treatment with convenience and less side effects.

Firstly, we engineer our bacteria to give them a stronger ability to break down fatty acids, thus unblock the pores and destroy the anaerobic environment. At the same time, they can compete with *Propionibacterium* acnes for fatty acids. Secondly, our engineering bacteria will secrete bacteriocin which is able to kill *Propionibacterium* acnes directly. In order to ensure the precise synthesis and secretion of bacteriocin, we add fatty acid-sensitive promoters to control the expression of bacteriocin gene. What's more, we hope to further optimize the strength of the promoters by directed evolution.

In terms of safety, we will prevent environmental pollution or other safety threats by using nutritionally deficient engineered bacteria.

项目简介：痤疮是一种常见的皮肤病，多见于青少年，一般来说，痤疮和毛孔被油脂堵塞、痤疮丙酸杆菌在这种厌氧环境下大量增殖有关，我们的项目针对这种因素引发的痤疮、希望开发出一种副作用更小更方便的药物治疗痤疮。

一方面，我们的工程菌有更强的分解脂肪酸的能力，可以将被堵塞的毛孔疏通，破坏痤疮丙酸杆菌生活的厌氧环境，同时与痤疮丙酸杆菌竞争作为营养来源的脂肪酸，另一方面，我们的工程菌可以分泌能针对性杀灭痤疮丙酸杆菌的细菌素。同时，为了保证杀灭物质的精确合成与分泌，我们在细菌素前加了脂肪酸敏感型启动子，而且我们希望通过定向进化的方式进一步优化启动子的功能。

在安全方面，我们希望通过使用营养缺陷型的工程菌，防止其污染环境或者造成其他安全威胁。

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Bacteriophages were modified with CRISPR/ Cas and a bistable system was established by cell-free system for quantitative detection of bacteria
利用CRISPR/CAS改造噬菌体并通过Cell-free系统构建双稳态系统进行细菌的定量检测

Project brief: Vibrio parahaemolyticus（VP）is widely distributed, mainly exists in sea water and aquatic products. The detection rate of Vibrio parahaemolyticus in the coastal sea water of East China is 47.5%~66.5%, and the average carrying rate of Marine fish and shrimp is 45.6%~48.7%, which can be as high as 90% in summer. It takes a long time to detect Vibrio parahaemolyticus under the existing methods, and there is a quantitative requirement for the detection of this bacterium according to the national standard. Our project is to use edited phages containing specific protein-coding genes to infect and lyse Vibrio parahaemolyticus (VP) and release the transfected exogenous protein, which can then activate downstream cell-free gene circuit and generate visual signal.

The purpose of phages in our project is to specifically identify bacteria. The downstream circuit outputs binary signals indicating the VP concentration meets the national standard (100MPN/g) or not. Moreover, we have designed several preliminary experiments to verify our thoughts so far.

项目简介：副溶血性弧菌分布极广，主要存在于海水和水产品中，我国华东地区沿岸的海水的副溶血性弧菌检出率为47.5%~66.5%，海产鱼虾的平均带菌率为45.6%~48.7%，夏季可高达90%以上。现有手段下检测副溶血性弧菌需要较长时间,且根据国家标准该细菌的检测存在定量需求。

我们的项目是利用CRISPR技术编辑过的含有特定蛋白编码基因的噬菌体感染和裂解细菌，释放转染的外源蛋白，激活下游的细胞游离基因回路，产生视觉信号。在我们的项目中，噬菌体的目的是特异性识别细菌。下行电路输出指示VP浓度是否符合国家标准(100MPN/g)的二进制信号。