Newsletter | Part Version

XMU-China Credits

Sept.2016

Part Version

Dear all,
Here comes the Part Version for 2016 iGEM Newsletter.

For three years in a row, we have published a dozen Newsletters for iGEM competition. It is of great pleasure to announce that this year 46 teams from 21 countries and regions join us!

This year, we publish only one issue with two different versions: Part Version and Team Version.

This issue consists five parts:
Introduction, Human Practice, Collaboration, Discussion and Survey.

We acknowledge significant help, feedback and suggestions from the following forty-five teams (in alphabetical order):
Aachen, Aalto-Helsinki, AHUT, BGU_ISRAEL, BIT-China, Cardiff_Wales, CGU_Taiwan, Duesseldorf, Endinburgh_UG, EPFL, Evry, Freiburg, Groningen, Hannover, HUST, HokkaidoU_Japan, IIT_Kharagpur, Imperial_College, Jilin_China, Leiden, Manchester, NCTU_Formosa, OUC-China, Oxford, Peking, Peshawar, Pretoria_UP, Queens_Canada, SYSU-CHINA, SYSU-MEDICINE, Tec-Chihuahua, Tel-Hai, Tianjin, Tongji_Shanghai, UCAS, UCC_Ireland, UCL, UNIK_Copenhagen, UPO-Sevilla, UrbanTundra_Edmonton, USTC, Valencia_UPV, Vilnius-Lithuania, Washington and Westminster_UoW.

Many thanks to all of you for your generosity and contributions!
If there are any questions, please reach us at igemxmu@gmail.com

All the best! Cheer for the event!

XMU-China

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PART 1 INTRODUCTION

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Our project deals with the problem caused by Boric Acid in washing detergent. Boric Acid is listed as substance of very high concern according to ECHA. For example there is the suspicion that boric acid causes reproduction toxicity. However, it is still used in liquid washing detergents for stabilization of the proteases. Our idea is to replace boric acid and achieve the same control of activity and stabilization of the protease with another mechanism. The technique we want to use is called photocaging. In our case we want to use a photo-cleavable amino acid, that will be incorporated in the protein in a way that it will inhibite the protease through an extra protection group (“Photocage”). These groups can be cleaved off by irradiation of light with a specific wavelength and the original amino acid remains functional. The general idea is to connect the protection group with a commonly used amino acid which is added to the active site or other important site for the functionality of the enzyme. For example,

we replaced a serine in theoriginal sequence of the protease with a photocaged serine. Thanks to the additional protection group on the unnatural amino acid, the enzyme should remain inactive as long as there's no light shining on. Our intention is making the protease unable to fold correctly because of the additional size of this specific unnatural amino acid and its position in the protease. If we shine light on the it, the protease should become active again and fold correctly, since the large protection group is cleaved off and the original amino acid is revealed again.

For the incorporation of our unnatural amino acid we need a special tRNA which recognizes the least used stop codon UAG. UAG is used in exchange for a specific codon in the coding sequence of our protease where we want to put our unnatural amino acid in.

This tRNA needs an specific aminoacyl tRNA synthetase which attaches the appropriate amino acid onto its tRNA. This tRNA and Synthetase need to be an orthogonal pair, which means the Synthetase does not charge other tRNAs or the wrong one.

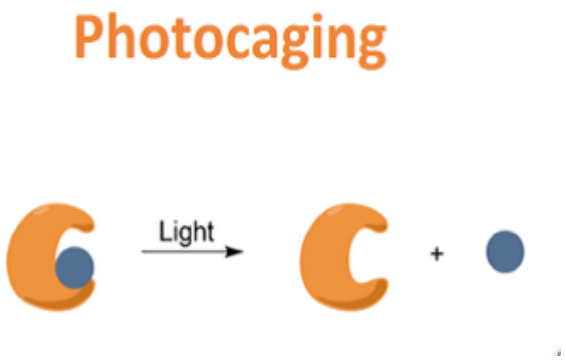
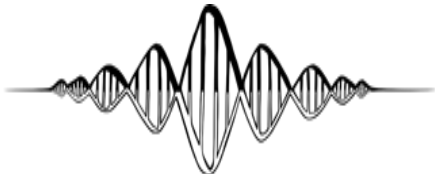


Figure 1.Mechanism of photocaging

OUR TEAM

We are the iGEM Team 2016 of the RWTH University in Aachen. Our team is composed of 16 students from Biology, Biotechnology, Computer Science and Biomedical Engineering. Like the past two iGEM teams of the RWTH University, we are also a very international team this year, our team members are from Germany, China and India.

Aalto-Helsinki



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Introducing MC Yeast

Our project this year is named "MC Yeast: Stress-based detection and enzymatic degradation of the cyanobacterial toxin microcystin." Our goal is to build a two-part system to detect and then degrade cyanobacterial toxins known as microcystins (MCs). Our detection system is based on the natural oxidative stress response of the yeast Saccharomyces cerevisiae. Exposure to MCs is linked to higher levels of oxidative stress, and we will couple this response to the expression of yellow fluorescent protein. Thus, fluorescence levels will indicate the amount of MCs present in a sample. To understand and validate our MC detection mechanism, we will also create mathematical and molecular models. For degrading the detected toxins, we are expressing and purifying the enzyme microcystinase (MlrA), which is naturally found in some gram-negative bacteria. The enzyme renders the MC harmless by modifying its structure.

How Aalto-Helsinki 2016 works

Even though we come from two different universities, from different fields of science and even from different countries, we have found a common tune. Our multidisciplinary team has many kinds of expertise and lots of knowledge; we have people from biology and modelling as well as those in between.

Our project has been divided into smaller subprojects with their own teams to make it easier to achieve our goals:

The research team has five members, responsible for the biological side of the project as well as knowing what is happening in the lab.

The modeling team of two is working their magic in order to provide more understanding of the biology behind our experiments.
The funding team has done an amazing job making sure that our team is able to participate to the Giant Jamboree as well as other iGEM meetings before that.

The design team is there to make sure that the visual side of our project is at least as good as the scientific.

Even though we have people in charge of each team, almost every one of us has done something in every subproject: even our mathematicians got to try out what it is like to work in a lab coat and nitrile gloves by making some liquid cultures.

Our team isn't only about hard work and long days at the office or at the lab. One of the most important things is our weekly tradition of choosing a Fun Master and a Cake Master. The Fun Master of the week is responsible for taking the team to do something fun together. So far, we've gone ziplining, hiking and room-escaping, just to name a few. The Cake Master is also vital: our weekly team meetings simply couldn't work if there wasn't any cake!

You can read more about our team members at *www.aaltohelsinki.com*.

Check also our blog about what is happening in Aalto-Helsinki: *http://blog.aaltohelsinki.com*.

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This year we chose to concentrate our efforts in environmental preservation in an attempt to counteract the ongoing and destructive results of pollution resulting from plastics. Plastic's chemical and physical attributes make it very hard to decompose. Consequently highly toxic waste is accumulating in alarming rates the whole world over. A plastic bottle will decompose in a period of an astonishing 500-700 years, with the slow decomposition rate deriving from the fact that plastic materials are synthetic and considerably new. Organisms have yet to develop an effective way to sustain themselves from those materials as a sole carbon source.

Today there are three main ways of disposing plastic waste:

Recycling - although awareness of recycling has increased considerably over the years, it remains an ineffective solution. Because there are only particular plastic types which are recyclable, plastic waste must be sorted manually, which is expensive and slow in comparison to manufacturing new materials.

Burying plastic waste - a slow degradation process accrues in which greenhouse gasses such as methane are emitted into the atmosphere and contribute to global warming. Furthermore toxic compounds are released into the soil and water sources that can affect public health. The areas in which plastic waste will not cause ecological damage are limited, and plastic disposal in the western world is declining.

Controlled combustion and incineration - If plastic waste is not incinerated and disposed of

properly, harmful amounts of toxins can be released and dispersed through the air or waterways.

Our solution – Biological Remediation

For many year scientists have tried to find ways to disintegrate plastic polymers. Some of the most promising research work tries to utilize microorganisms in order to degrade plastic, but they are often challenged by the slow rate of the process.

In our project we are trying to find a solution by means of experimental evolution and "intentional evolution," referring to genetic engineering and enzyme improvement by mutations. The goal of the research is to create a bacterium that could utilize plastic as a sole carbon source. In addition we hope to show a potential of making electrical energy by creating fuel cells based on the redox reactions taking place as part of the plastic degradation, forming a self-producing system.

In order to achieve our goal, different courses of action were chosen:

(i) An Organism Evolution Approach – One of our approaches is to use an organism which has adapted into "finding a solution" to use plastic, and try to improve that "solution" using methods such as experimental evolution and serial passaging. We have chosen to improve a bacteria that was found to degrade polyethylene called Rhodococcus ruber.

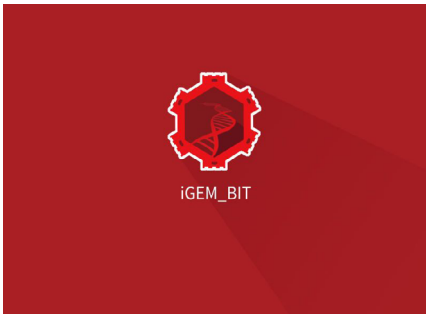
(ii) A Protein Engineering Approach – Another approach we have adopted, is the engineering of a protein. We chose an enzyme that was found to be one of the most efficient enzymes in breaking down PET polymers into degradable substrates, this enzyme is called LC-cutinase. Based on the enzymes structure that was solved, we have chosen to use a rational mutagenesis approach for our experiment. After the process was completed we have ended up with 4 different variants other than the WT. These mutations are expected to improve the enzymes activity.

(iii) Genetic Engineering of Metabolic Pathways – we will modify two metabolic pathways using engineered enzymatic cascades which lead to two products, terephthalate and ethylene glycol resulting from the biocatalysis of PET by LC-cutinase. While the terephthalate will be used to produce succinyl co-A and acetyl co-A, the ethylene glycol will be transformed into malate by using a metabolic pathway that already exists in E. coli. This way, our engineered bacteria of choice, Pseudomonas putida, will degrade PET and will transform the electrons released from PET degradation into energy by using PET as the carbon source.

(iv) Microbial Fuel Cells - Since PET is a polymer that contains high energy bonds in its carbon-carbon bonds, excess energy released by our engineered microorganisms from carbon-carbon bond degradation will

be harnessed and utilized in microbial fuel cells devices, this way plastic biodegradation will be converted into energy.

BIT



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In a short time, and provide patients with reference significance testing data, and the testing costs can be drastically reduced alleviate the contradiction of medical treatment system. In recent years, breast cancer has become one of the highest incidental cancer. Many patients missed the best diagnosis and treatment time and them made patients lost their lives. Studies have shown that when we have breast cancer, the expression degree of microRNA-21 and microRNA-155 in the human body will be significantly higher than the normal human body. Based on the above background, this project applies the artificial designed biological system to realize the detection of expression levels of microRNA (associated with breast cancer) in the serum environment, the concrete realization method is: Detect microRNA expression level in the serum samples through the engineering bacteria(directional transformed) , the higher microRNA expression degree can produce green fluorescent protein, then using miniaturized signal hardware to detect fluorescence, and through the mathematical modeling of the model to calculate microRNA expression level. Finally deduce the theoretical diagnosis to user and this project is a real-time inspection system for breast cancer detection.

OUR TEAM

Team BIT is a passionate team which is composed of 19 undergraduate students with different majors. With the shared interest in synthetic biology, we gather together and want to make a difference in this field. The team is supervised by Prof. Deng Yulin, Prof. Li Xiaoqiong, Prof. Lv Xuefei and Dr. Quan Zhenzhen. We are excited to share what we are doing with leading universities and students around the world.

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We will assess the viability of a novel bioluminescence detection system for point-of-care diagnostic testing. In our proposed system, a Streptococcus pyogenes dCas9 isoform codon optimised for Escherichia coli is fused to the N-or C-terminal fragments of a thermostable pH-tolerant Pyrophorus plagiopthalamus luciferase (LUC). We aim to coexpress guideRNAs to target these chimeric dCas9-LUC proteins to adjacent DNA sequences. This will enable the reconstitution of luciferase activity and subsequent bioluminescence in the presence of luciferin. This light output constitutes a signal for detection of any targeted DNA sequence and is extremely adaptable, dependent on access to the target sequence. We plan to undertake a proof of concept study of this system using gRNAs targeted to the E.coli 16S rRNA locus, aiming to describe both the effective output of this system in vitro, and the optimum distance between gRNA targets. Finally an important aspect of this study will be to investigate the feasibility of this diagnostic system as a clinical test, potentially using cell-free components.

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Leijuvant :
A revolutionary Choice of Vaccine Helper

- What is the context of this research?

Leishmania, a trypanosomatid protozoan, are aerobic organisms, relying on oxidative phosphorylation, but are defective in the synthesis of heme. The genetic deficiency of heme biosynthesis in Leishmania makes it possible to produce transgenic mutants (DT), which are inducible with delta-aminolevulinate (ALA) for accumulation of uroporphyrin I (URO) as an endogenous photosensitizer. Another photosensitizer, PC, will also be loaded exogenously. After URO and PC are illuminated by specific wavelength of light, double inactivation will kill Leishmania thoroughly with proven effectiveness. Professor Kwang Poo Chang established the double photo Inactivation system of the Leishmania and validated its possibility as a cancer vaccine.

- What is the significance of this project?

Vaccine provides active adaptive immunity to a particular disease and most commonly used vaccines can be part into two big categories, live attenuated and inactivated vaccines. An inactivated vaccine consists of pathogens which are grown under controlled condition to kept them non-infectious and then killed to completely remove its infectiousness. Since inactivated pathogens tend to induce a weaker immune response than live ones, immunologic adjuvants are required to provide an effective immune response against the inactivated pathogens. Here we aim to introduce an effective, save and pathogen specific adjuvant.

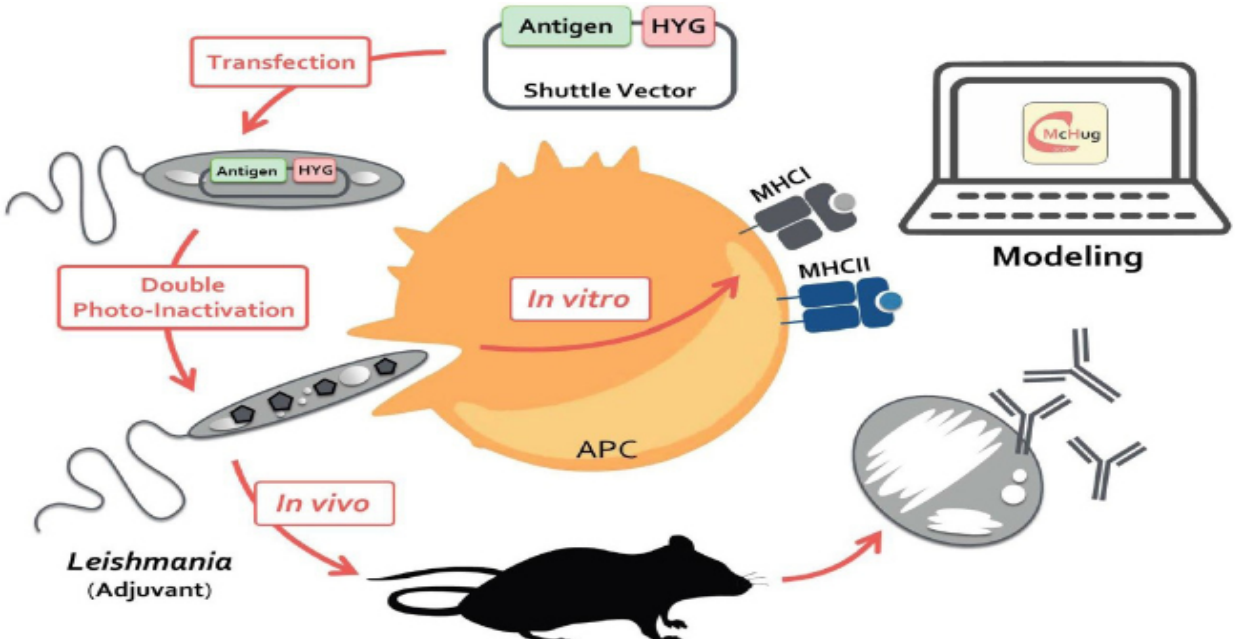
- What are the goals of the project?

Leishmania possess the advantages as a potential vaccine adjuvant, such as antigen presenting cells

(APCs) recruitment, pattern recognition receptors (PRRs) activation, inflammasome activation and activation of MHC-presenting pathway. Genetically-engineered Leishmania that can be inactivated by light exposure acts as a safe carrier to deliver specific antigens to the APCs for T cells and humoral response. Based on this concept, we established a new model system to generate antigen-specific Leishmania adjuvant--Leijuvant. We will perform several experiments to check if it is a potential vaccine adjuvant.

Here we aim to design an E.coli-Leishmania shuttle vector constructed under biobrick standards to provide a standardized shuttle vector for our ownexperiment and for others' future application.

To test the efficiency of the antibody immune response of the photo-inactivated Leishmania as a vaccine adjuvant, we will co-inject ova recombinant protein and photo-inactivated Leishmania that is genetically modified to present OVA protein into mouse. Serum will be collected every 5 days after the second injection to test the antibody immune response with Anti-OVA ELISA. The outcome will be compare to the of Alum adjuvant.



OUR TEAM

Our team consists of 12 members majoring in biomedical science and electronic engineering to represent CGU participating in iGEM. We are resourceful, thriving on challenge, and eager leaners. Everyone brings what he or she has learned into full play.

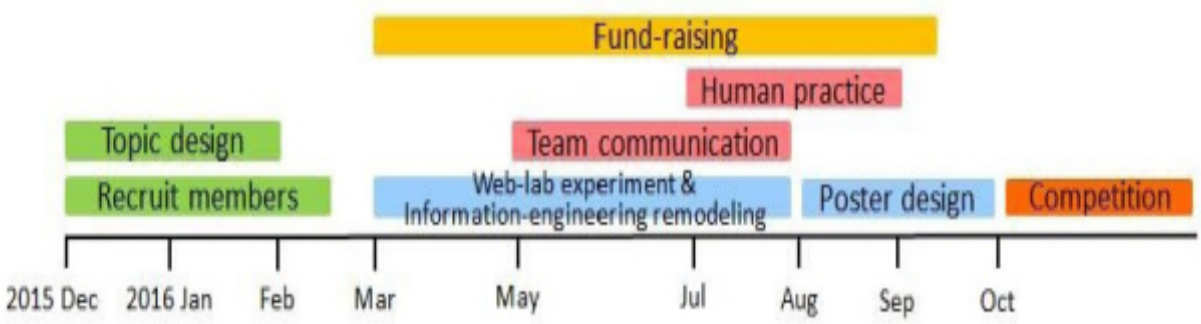
After interdisciplinary brainstorm, we hope to contribute to the society and world by developing a new adjuvant delivery way during the iGEM project. We also expect to communicate with other teams and, through science, build up a friendship with lots of iGEMers!

Motivation and Goal

1. Promote worldwide visibility of CGU and Taiwan.
2. Make some impact to the world through our efforts in the iGEM project.
3. Expand our horizon and evaluate our competitiveness.
4. Innovate new thoughts, ways, and product through interdisciplinary practicing.
5. Win the gold metal and special awards to further verify the value of our concept.

The following is our brief progress of team. We have communicated with over 20 teams, designed questions, participated in Science Carnival, and designed questionnaire to survey public acceptance of our concept for human practice, built up a software for modeling, and carried out experiments. And we are going to visit the vaccine industry and institution for further discussion of our project. All of us expect to make some difference toward society and world in this summer.

Progressive Plan



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BabblED

– The DNA Typewriter

Building a modular system to encode information in DNA.

We aim to develop a modular system for encoding any unit of information, into DNA. We will prove the validity of our concept by encoding Ogden's Basic English (a collection of 850¬1,000 words that can be used to express most concepts in the English language). Each encoded word; a BabbleBrick, will be stored in a different Phytobrick. Sentence assembly and unidirectionality is ensured by the stepwise addition of BabbleBricks that have alternating types of sticky ends; this prevents repeats and minimizes the occurrence of missing words. The whole sentence construct, or BabbleBlock can be melted off for easy retrieval and assembled back into a PhytoBrick for storage. Since the value that is assigned to each BabbleBrick is arbitrary, each one can be reused with any library or language. In this way, our encoding and assembly method can be optimized for many types of data. Furthermore, using a variety of error correction and encryption techniques we will provide an exceptionally secure and high fidelity storage medium.

OUR TEAM

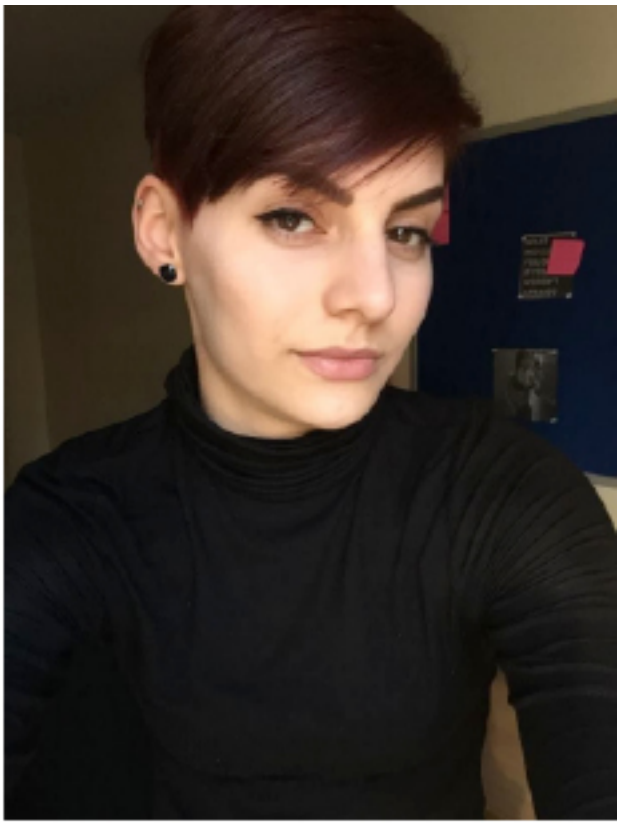
Nikita Lazaroo
I am a 2nd year Psychology student from Australia, with a strong interest in biology and cognitive science. In my spare time I enjoy kickboxing, cooking and travelling. I am enthusiastic about participating in iGEM and exploring the field of synthetic biology as they are both aimed towards the advancement of biology as an interdisciplinary science that is accessible by all. The potential for iGEM projects to provide solutions for complex social issues is what initially drew me to the competition, and I'm thrilled to be a part of the Edinburgh team.

Petar Iliev (aka Pepy)
I am a 2nd year Biological Chemistry student and in my spare time I do kickboxing and listen to exuberant music. I am from Bulgaria and I enjoy socialising, dancing and hiking. I am passionate about iGEM, because synthetic biology is a field where nature is utilised to complement itself and great ideas make a huge impact.

Brendan Largey
I am second year Biochemistry student from New York. In my spare time I enjoy restoring antique furniture, teaching dance, and making use of the Oxford comma. I also enjoy playing the violin and other instruments, and can bake a mean kartoshka. I have been enjoying every moment with the team so far and love interacting with such a diverse group of individuals.

Catalina Rotaru
I am a 2nd year Computer Science student from Romania and I am deeply interested in computer security and cryptography. In my spare time, I enjoy boxing, dancing, learning russian and watching CSI series. I am very excited to be taking part in such a massive engineering competition. iGEM represents the challenge to find solutions to worldwide problems. Moreover, it brings people of different backgrounds together to exchange knowledge and experience.

Azzurra Laura De Pace
I am a 2nd year Biology student from Italy. I am very interested in Epigenetics and personalized medicine. In my spare time I love reading books outdoors and cooking. I am very happy to be part of the Edinburgh iGEM team. Taking part in the iGEM competition gives students the chance to re-interpret nature through the power of synthetic biology.



Freddie Starkey
I am a second year Informatics student from Aberdeenshire. My main interests are in Bioinformatics and Artificial Life. I enjoy Nordic Skiing and Kayaking in my spare time as well as being a massive Doctor Who fan. I am excited to have the opportunity to work in the wet lab for a change during iGEM as well as to contribute to a project with such large real world applications.

Patrick Lim

I am a second year Molecular Genetics student from Bristol. I do a bit of programming and writing and am very excited to be helping out with Edinburgh iGEM. When I am not working with the team I do gardening at a hospice. During my time here I have learned a lot about science and have become a big fan of falafel wraps despite being skeptical at first.

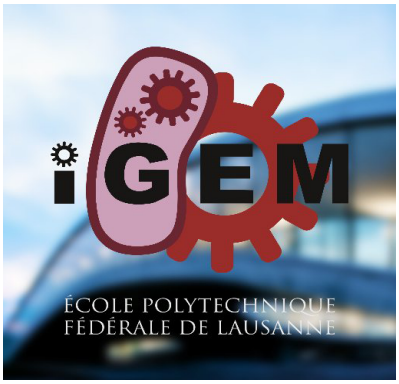
Rosie Maddock

I am a third year Biology student from Aberdeenshire. I am interested in biochemistry with a particular interest in disease research. In my spare time I play judo, go to the gym, and love to cook. I am really excited to be part of iGEM because it provides so many people the opportunity to develop and explore their synthetic biology ideas. The flexibility with iGEM projects allows input from different subject area backgrounds, which gives rise to many exciting lines of research.

Alexandra Bisia

I am a student from Crete, Greece, who just finished her second year of studies in developmental biology. I am keenly interested in foreign languages, exploring the beautiful city I study in. It's an incredible experience being part of the Edinburgh iGEM team, as the competition has given us the opportunity to push back the boundaries of biology and apply our ideas to create novel solutions to current problems. I have also become familiar with different subjects and interdisciplinary collaboration, which I believe to be the future of research.

EPFL



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CRISPR-Cas9 has already revolutionized synthetic biology. To build upon this development we aim to implement digital-like circuits in yeast using a CRISPR-associated RNA scaffold system (Zalatan et al, 20151). Furthermore, a recently published study unveiled Cello, a modular program automating the design of artificial transcriptional circuits in E. coli (Nielsen et al, 20162). As a proof of concept we will modify Cello to use our dCas9 transistors in yeast for a so-called half-adder system, using AND and XOR gates, that we can experimentally assess. With this approach we aim to pave the way for even more complex biological circuits in yeasts.

CRISPR/dCas9 use until now

The conventional method of using the CRISPR dCas9 system in the construction of biological circuits is to fuse dCas9 to VP64, an activation unit, in order to activate or repress gene expression. With this system, only one effector protein can be used, meaning that an activator or repressor will have to fill both roles functionally, its action being determined by its placement on the DNA. For example, a gene may be repressed by an activator-fused dCas9 purely through steric hindrance by placing dCas9 on the gene.

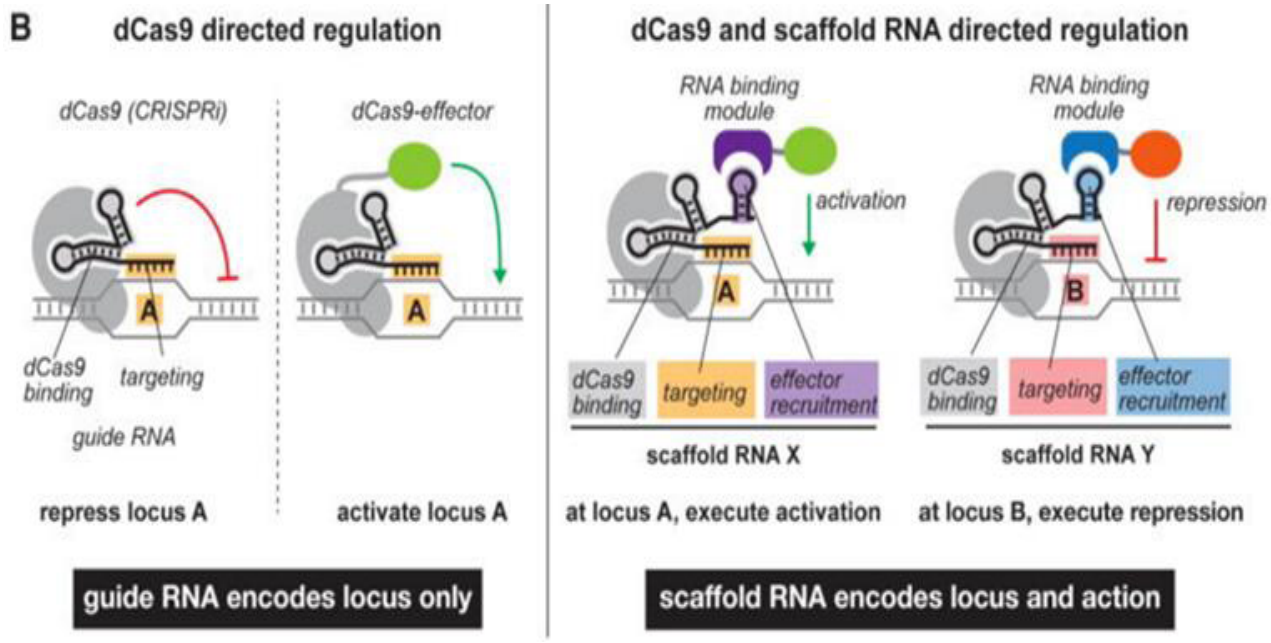
What's new with our approach ?

One of the novel aspects of our system, with respect to the "classical" dCas9 based DNA circuit, is that the effector proteins are recruited by a scaffold guide RNA (scRNA) through an RNA binding module.
In our system, the guide RNA bound to dCas9 serves both as a targeting sequence and an effector protein recruitment element. Contrary to the conventional system, this allows us tohave both transcriptional

activators and repressors in the same system. In addition, it has been shown that the activator VP64 was more effective when bound to the scaffold gRNA than when fused to dCas9 directly (Zalatan et al., 2015). Interestingly, the scaffold allows us to target two different effectors to the same DNA target, allowing the combination of different repressors, activators, or even activators and repressors together.

To go further

With the creation of our transistors, it will be possible to construct any logic gate, such as XOR, AND and NOR. By concatenation of these gates we can construct complex biological circuits, which could be used as biosensors or detection methods for diseases or substances. They could even act in coordination with circuits naturally present in organisms and react to external factors producing different proteins as a response.



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Our objective for iGEM 2016, is to produce a significant amount of PLA solely through a biological way by engineering Pseudomonas putida.

PLA bioproduction presents several benefits compared to chemical synthesis: it uses simple carbon sources and it is inexpensive. On the other hand, P. putida is a safe organism reported to be efficient for polymerization, which gives advantages over other possible chassis. By modificating its metabolic pathways, we aim to improve PLA biosynthesis yields in a sustainable manner, and to determine the usability of our bioplastic by manufacturing a vesicle for drug delivery.

What is the PLA?

PLA, or Poly-Lactic Acid, is a totally biodegradable polymer and a thermoplastic. It's currently used as food packaging but also in other applications such as the sutures in surgery.
PLA has a lot of advantages. Indeed, it is considered that a bottle composed of PLA takes 80 days to be disintegrated instead of 1000 years for a classic plastic bottle. Moreover, PLA has good optic qualities such as transparence and brilliance, good properties for protection against oils and gases (O2 and CO2) allowing it to be an intermediate for different mass market polymers and an alternative to current plastics.

Key figures

- 280 million tons: it's the average amount of plastic produced each year worldwide (which represents 8,880 kilograms per second)
- 1,000 years: it's the average lifespan of a plastic bottle

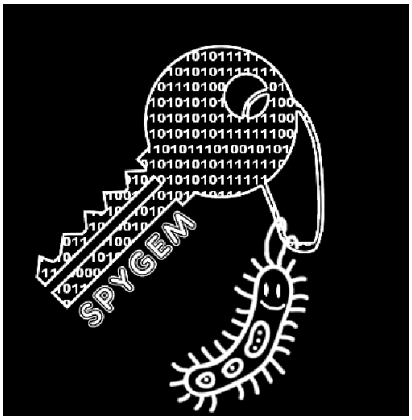
- Up to 450 years: it's the time needed for the degradation of a plastic bag in the environment.

For these reasons, our team thought about working on a biological alternative to the plastic: the PLA!

OUR TEAM

We are 12 students from different nationality and different backgrounds (biology, biochemistry genetic, bioinformatics and law) from the University of Evry Val d'Essonne (France) and we are helped by two advisors.

Groningen



igemgroningen2016

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In 2002, the amount of information stored digitally had eclipsed information stored in analog format for the first time . Just five years later, only 6% of the world's data was still analog . In 2015, an estimated 2,500,000,000,000 megabytes of new data were created every day, and this number is growing at an increasing rate . It is not surprising that data breaches orchestrated by hackers are on the rise as well. Financial and legal records, military and government documents, these are examples of important information that must be preserved for a long time, but could cause great damage in the wrong hands. We have become a civilization dependent on information, and this information must be stored somewhere. As a result, we are faced with two problems: where do we store all of our data, and how do we keep it safe?

Storage of data in DNA has been proposed as early as the 1960's, but has only recently become a hot topic. This is in part due to the ever-growing demand for data storage, as well as advancements in DNA synthesis and sequencing technologies. Our goal is to create a system for long-term data storage and data transfer which cannot be hacked by digital means. Digital methods of encrypting information and converting it into binary code are well established, and data storage in DNA has already been demonstrated. Our project combines these two approaches by first converting information into binary code, encrypting it, and then storing it safely in DNA. Additional measures based on molecular biology will prevent unauthorized access, ensuring the safety of the stored information.

Our system will be useful for the kind of information that should be stored and transferred in a very secure manner, but does not have to be accessed quickly (within seconds). It will be possible to obtain

the message in about 24-48 hours, however, this timeframe is likely to be reduced as new sequencing technologies are developed. For example, this system could be used to store patent and prototype information, genealogical records, legal and financial records, banking account details, login data or even top secret government documents. Given the stability and compactness of DNA, our system could also be adapted to serve as a time capsule for human knowledge.

Advantages of data storage in spore DNA

DNA is a far more stable data storage medium compared to magnetic and optical media, remaining intact for at least 700,000 years at -4°C. Even in harsh environments, DNA has a half-life of over 500 years. In contrast, current storage technology lasts only up to 30 years.

Spores are extremely resistant to aging, radiation, heat, and chemical damage. A viable spore-forming Bacillus strain was isolated from 250 million year old salt crystals.

The densest data storage medium commercially available today can hold up to 10 GB/mm3. DNA has a data storage density of up to 109 GB/mm3, 8 orders of magnitude higher.

Conservative estimates predict that based on global memory demand, the amount of silicon (required for flash memory) is expected to exceed silicon supply by 2040.

DNA storage will soon become a cheaper alternative for data storage as DNA synthesis and sequencing costs drop. It is estimated to become a cost-effective method for long-term data storage within approximately ten years Data storage in DNA is more environmentally friendly than currently used digital data storage. In 2015, 416.2 terawatt hours of electricity were used by data centers worldwide. This is higher than the annual power consumption of the entire UK[10], and is responsible for approximately 2% of global greenhouse emissions, rivalling the airline industry.

Data stored in DNA cannot be hacked by digital means.

DNA data storage is an apocalypse-proof technology because DNA will be relevant to future civilizations. As long as intelligent DNA-based life exists, there will be compelling reasons to study and manipulate DNA.

Our approach

We use a layered approach with a combination of digital and biological security measures to ensure the information can only be accessed by the intended recipient. The first layer is digital encryption. The information is encrypted with the Advanced Encryption Standard (AES) algorithm, converted into a DNA sequence and integrated in the genomic DNA of Bacillus subtilis, a safe, thoroughly

categorized organism capable of sporulation. The binary data obtained after encryption will be encoded into DNA according to the following logic: since DNA consists of four nucleotides namely T, A, C, and G, every nucleotide will represent a binary pair (combination of a 0 and a 1).The T will be represented as 01, A as 10, C as 00 and G as 11 sporulation. The binary data obtained after encryption will be encoded into DNA according to the following logic: since DNA consists of four nucleotides namely T, A, C, and G, every nucleotide will represent a binary pair (combination of a 0 and a 1).The T will be represented as 01, A as 10, C as 00 and G as 11 into two different Bacillus strains and are protected from unauthorized access with additional security layers.

Once the message and key are encoded in Bacillus DNA, the cells are cultured in a sporulation-promoting medium. Bacterial spores are among the most resistant biological entities currently known, and thus represent an ideal substrate for long-term data storage. The spores containing the encrypted message and key are freeze-dried and embedded in separate filter papers (or any other porous material) for storage and transfer, along with a spiropyran-ciprofloxacin conjugate. The biological activity of this photoswitchable antibiotic is very low when the spiropyran photoswitch is in its stable closed form, but increases dramatically after irradiation with a specific wavelength of light (in our case, 365 nm) which brings the photoswitch into a less stable, open form. When the light source is removed, the compound slowly reverts back to its biologically inactive state. Irradiation with other wavelengths also results in deactivation. The strains carrying the message and key (which possess resistance to the antibiotic) are mixed with numerous decoy spores when brought onto the carrier material. The decoy spores are not resistant, and do not contain any encrypted information.

When the intended recipients want to access the stored data, they place the filter paper with key carrying spores and antibiotic in a culture medium, and irradiate it with the activating wavelength of light. This wavelength must be known by the recipient beforehand. The activated antibiotic kills the decoys but not our key carrying strain. After culturing, their DNA is sequenced and the key is found. The key contains information necessary to culture the message carrying strain, and to decrypt the message. Without activation, all the spores germinate and grow, including the decoys. This makes it impossible to find the key by sequencing. Once the key is obtained, the message carrying strain can be cultured. Their DNA is then sequenced and the message can be decrypted.

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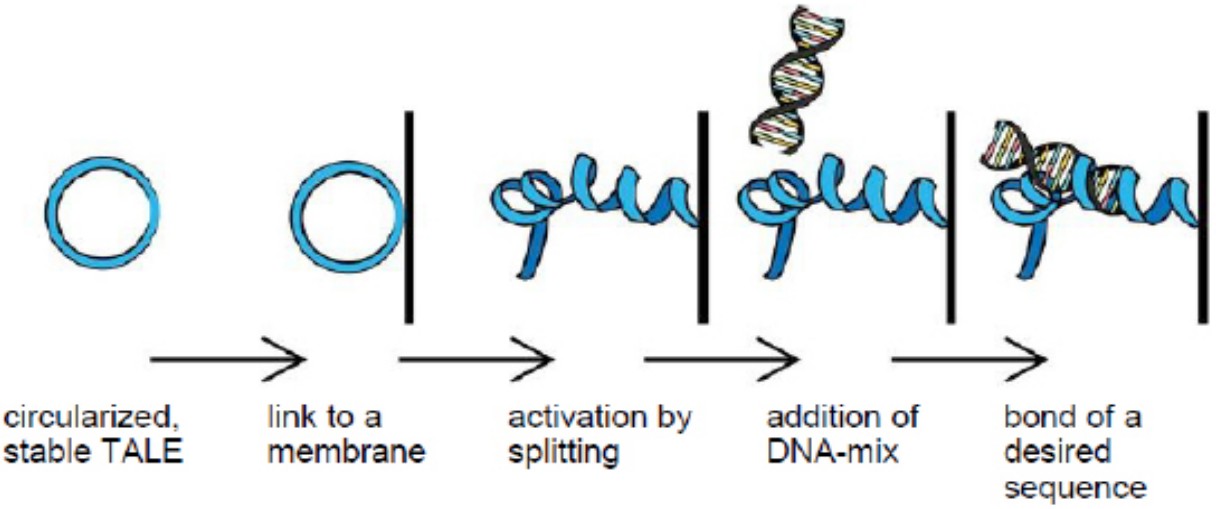
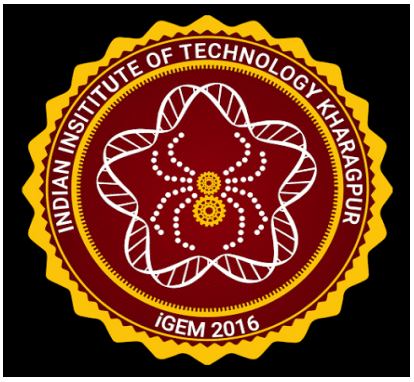
The vision to modify genomic DNA at any specific site has become reality by genome editing.
Scientists can now specifically cut DNA. Two cheap and easy strategies have been proven to be useful approaches: Crispr-Cas9 and TALEN.
This is exactly where we want to step in. We chose to work with TALE proteins that can be designed in a way that they recognize a changeable, but defined DNA sequence without further molecule classes like unstable RNA.

Typically, TALE proteins can be combined with various effector enzymes (e.g. restriction enzymes) which can carry out the desired operation. Nevertheless, the use of these systems is restricted to in vivo applications, since the enzymes are not stable in vitro. Proteases can attack and destroy the link between amino acids, which form the protein.

To circumvent these problems, we aim to stabilize TALEN via circularization of the protein. This modification should increase the stability of the protein and enables us to use it in vitro. To circularize the protein, we use linkers that bind both ends of the protein together. Combined with an effector domain, we want to establish a new type of recombinant protein that we call "TALebot". Our approach will permit many new applications for these proteins.
In the following, we will test our "TALebot" for stability against heat, acid and storage. Hopefully, we can enable the use of TALE proteins for in vitro modification or aimed cutting of DNA in a cell-free environment.
Furthermore, we plan to immobilize a specially designed "TALebot" onto a membrane and link a desired DNA sequence. With this technique, we image new applications like the detection of carcinogenic virus DNA form blood plasma or a one-step-purification of plasmids from bacteria solutions.


circularized, stable TALE
link to a membrane
activation by splitting
addition of DNA-mix
bond of a desired sequence

IIT_Kharagpur



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Silkotron: A genetically engineered machine for efficient production and export of spider silk

Our arena for this year's idea hunt was the use of available parts in its registry and past ideas. This was because it would take a bigger budget and higher expertise to create new parts and also the funding organization required us to use the previous parts only. Needless to say, there was only gold and diamonds and more inspiration to find in the old records. So, this year, our aim is to have a fast and efficient production of spider silk using the synthetic biology model bacteria E.coli.

Spider silk is a very versatile material having its applications in various industries like medical, engineering, clothing, biomedical to name a few. But the spider silk cultivation is a very slow and cumbersome process. Our idea aims at synthesizing recombinant spider silk protein and produce it extracellularly in our model bacteria E.coli, the main motive behind it being mass production of spider silk through rapid multiplication of bacteria. For the project, we are making two constructs to express silk outside the cell, all parts of which are already available in the parts registry. We also aim at developing a novel detection system using FRET dye pairs. This system will primarily be used in monitoring and modelling the cleavage activity of HIV protease used for selective cleavage and controlled release of the silk protein. CFP and YFP will be used as FRET dye pairs. The idea of cleavage and release of HIV protease followed by cleavage and release of silk protein described above will be tested by the FRET based assay.

We aim at synthesizing recombinant spider silk

protein (MaSp2) in E.coli and anchoring it to the outer cell membrane, followed by the cleavage of the same using an HIV1 aspartyl protease. The silk protein will be fused to a fragment of OmpA protein that will display it on the outer surface of E.coli. An HIV protease cleavage site will be introduced between the OmpA fragment and the silk protein assembly. A second construct containing the cleavage site and the HIV protease will be fused to the OmpA fragment. Induction of the second protein construct will initiate cleavage by the protease in cis that will release the protease and allow it to cleave in trans and release the spider silk protein. We also aim at developing a novel detection system using FRET dye pairs. This system will primarily be used in monitoring and modelling the cleavage activity of the HIV protease used for selective cleavage and controlled release of the silk protein. CFP and YFP will be used as FRET dye pairs. The idea of cleavage and release of HIV protease followed by cleavage and release of silk protein described above will be tested by the FRET based assay.

The construct containing the MaSp2 protein will contain OmpA, HIV1 cleavage site, MaSp 2E. An HIV protease cleavage site will be introduced between the OmpA fragment and the silk protein assembly. A second construct containing the HIV protease will be similar to the silk construct, the only difference being replacement of the MaSp2 gene with the HIV protease gene. The FRET system using CFP and YFP will be used as FRET dye pairs.

OUR TEAM

We are an 17 member team consisting of third and fourth year undergraduate students who look after different tasks of the project including wetlab, public policy, conducting surveys, keeping track of the updates . Our seniors who were a part of the team last year are our guides. Our team has two young and dynamic PIs as well.

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In nature, microorganisms live together and cooperate to accomplish complex tasks. As synthetic biology advances, the field will transition from engineering unicellular systems to multicellular systems. Products from complex genetic circuits that were previously too burdensome for a single cell will be split between specialized populations. It is difficult in co-cultures to ensure the stable coexistence of different cell types over time. Current co-culture technology suffers from its inability to accomplish this, making it unpopular in the scientific community.

This year we are developing a system called Genetically Engineered Artificial Ratio (GEAR) to control population ratios in microbial consortia. GEAR is composed of three distinct modules: communication, comparison, and growth regulation. The communication module will feature a bi-directional communication system composed of orthogonal quorum sensing systems. The presence of quorum molecules in the cytoplasm will activate the transcription of the RNA molecules. If the correct population ratio has been achieved, equal amounts of sense and antisense RNA will be produced, which sequester each other and prevent activation of the growth regulatory module. The growth regulatory module produces growth repressing proteins that aim to slow division of the cell, to achieve the desired ratio. In the future, we envision our GEAR system being used for distributed multicellular biocomputing, bioprocessing, and microbiome engineering.

Here are some need-to-know facts about Imperial's 2016 team:

- Biggest Challenge: Not boiling cell cultures in the incubator.
- Members who have to leave by 5 to get to their coven meetings: 4.

- Team Communication Strategy: Open lines of communication are important. We believe gifs, vines, and interpretive dances are better than words and talking.
- Days since last seance: 10.
- Ideal Collaboration: A team which also enjoys long walks on the beach and candlelit dinners.
- Things We Understand About iGEM: Synthetic biology is exciting, GFP will verify anything, and building a wiki is insane.
- Supermodel Alter-Egos Present On The Team: Karlie Kloss, Kendall Jenner, Bar Refaeli, Gisele Bundchen, Naomi Campbell, Cara Delevigne, Adriana Lima, Priyanka Chopra, Gigi Hadid, Alexa Chung, Tiffany Trump, and Coco Rocha.

OUR TEAM

Our team is composed of 12 members. Half of our team comes from the faculty of natural sciences, the other half come from the department of bioengineering at Imperial. Our chosen disciplines span from biochemistry to biomedical engineering.

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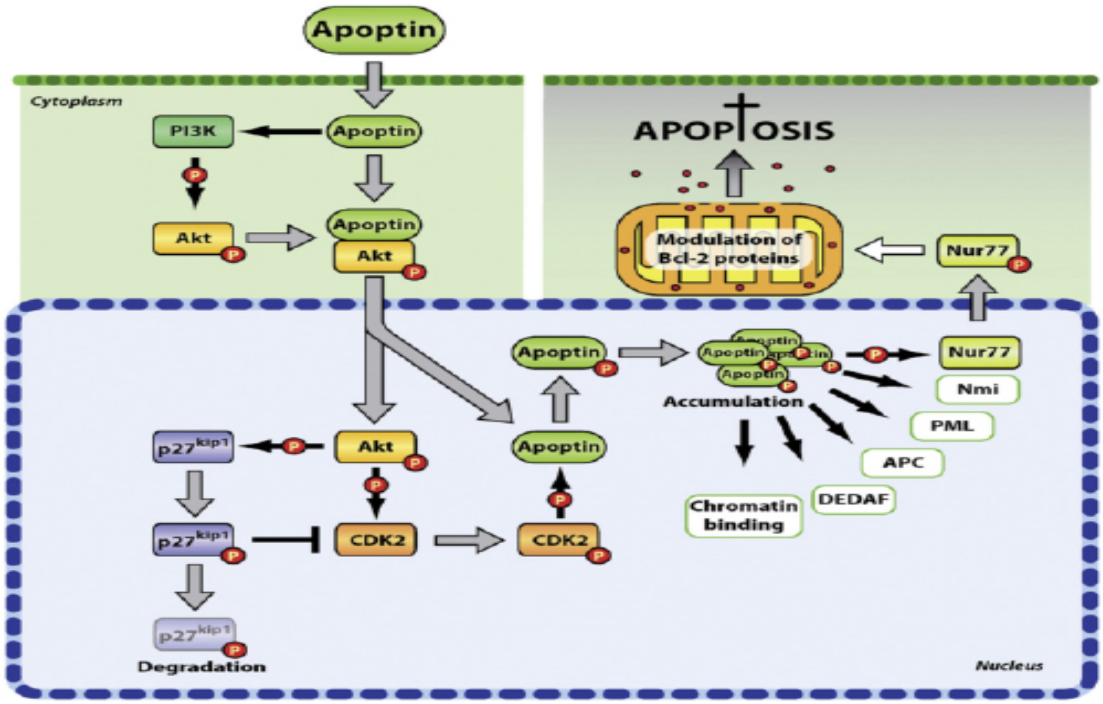
Solid tumor cells can be considered as harmful mutants in the ecosystem in human body. We therefore propose a novel approach to eliminate tumor cells. Bifidobacterium has been proved to be non-immunogenic to human body, and has the ability to settle in hypoxic regions, such as solid tumors, preferentially. First of all, we plan to construct a recombinant plasmid that consists of DNA replication origins and related genes from pMB-1 and pUC18. In addition, we will clone HU (a Bifidobacterium promoter) and TAT-apoptin gene with a N-terminal secretion signal peptide into this recombinant plasmid. Apoptin is a small protein that can induce tumor-specific cell apoptosis independent of p53. Thus it specifically kills tumor cells while leaving normal cells largely unaffected. TAT is a protein with a transduction domain named PTD that has the ability to help apoptin to transduce though cell membrane. Additionally, we plan to use two other signal peptides, Tmp-1 and Sec-2, to ensure the secretion of apoptin. This plasmid can be amplified both in E. coli. and Bifidobacterium, and apoptin can be expressed specifically in Bifidobacterium. With the help of signal peptide and TAT, apoptin can be secreted by Bifidobacterium and be transdced into solid tumor cells successfully to achieve the ability of killing tumor cells. Moreover, we will inject Bifidobacterium into tumor-bearing mice, and simulate the distribution and association of Bifidobacterium with tumor cells using ecological competition models. After the tumor-killing ability of this recombinant plasmid is proven, we will focus on enhancing the biosafety of our system through modifying the HU promoter activity to regulate the apoptin expression and applying a conditional regulatory mechanism to restrict the proliferation of Bifidobacterium.



Experimental schematic diagram

OUR TEAM

Jilin_China team is a team that has fourteen undergraduates from four different majors and six teachers as PI, secondary PI, instructors and advisors. Especially, professor Yongge Wu and Dr. Xin Hu provide us with excellent supports of lab equipment and academic consults. All members are from the School of Life Science at Jilin University.

Leiden

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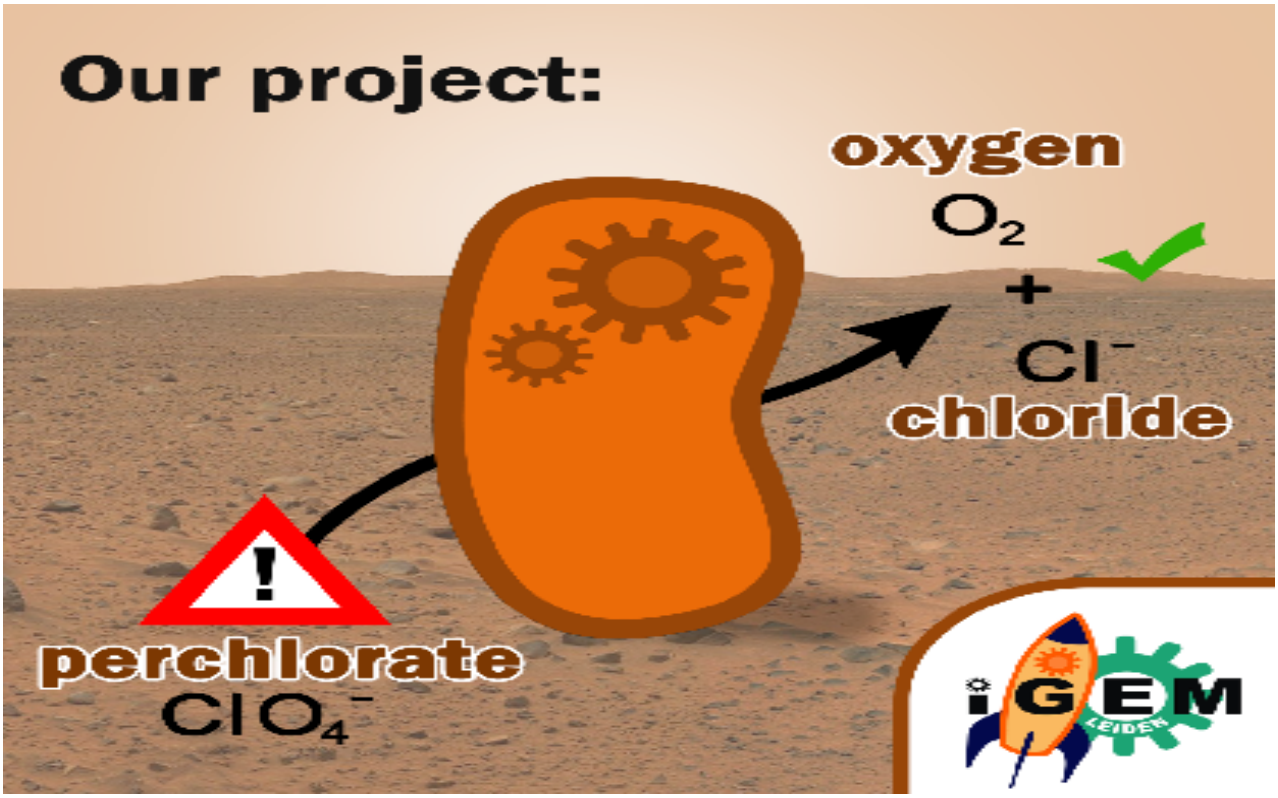
For the first year, Leiden University from the Netherlands participates with a team of its own in the iGEM competition – with a killer application for synthetic biology!

E. colonizer: gardening on Mars!

Have you ever thought of building a garden on Mars? Perchlorate (ClO4-) contamination of groundwater, surface water and food supplies is a widely spread hazard for the environment and our health on earth. However, it poses even a larger challenge when colonizing our neighbour planet Mars. Martian soil contains 0.5 - 1% perchlorate, which therefore needs to be remediated in order to cultivate edible crops.

The Leiden iGEM team will equip the bacterium Escherichia coli with the tools to convert the toxic perchlorate into chloride and oxygen (!) by introducing a set of codon-optimized genes from Dechloromonas aromatica, encoding for the perchlorate reductase complex and chlorite dismutase. In this way, the system can be much better understood, used in faster growing bacteria than the original ones and therefore optimized for use on a larger scale.

Besides, we will study E. coli's gene expression under Martian gravity (0.38g) using a Random Positioning Machine, to make sure that our system will function in a bioreactor on Mars and find gravity-dependent genetic elements. Altogether, our system is widely applicable to remove perchlorate from contaminated soils on earth, while also being highly useful for future Mars expeditions. So collect your seeds, rake, shovel and watering can and join our mission to Mars!



OUR TEAM

Our team consists of 13 highly enthusiastic and ambitious students with a broad variation of backgrounds: biology, life science & technology, stat-istics, physics, mathematics, astronomy and science based business, with bachelor as well as master students.

Peking

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Uranium, a heavy metal element, is weakly radioactive and poses a threat to both the environment and human health. A person can be exposed to uranium by inhaling dust in the air or by ingesting contaminated water and food. Long-term exposure to uranium increases the risk of various diseases and health issues including cancer, kidney problems and immune system damage. Uranium has become more commonplace due to nuclear accidents (the Chernobyl Accident, the Fukushima Daiichi nuclear power plant Explosion), uranium mining and the development of depleted uranium weapons.

To alleviate these problems, the Peking iGEM team aims to construct a novel functional biological material, which can absorb uranyl ion with the employment of a specific uranium-binding protein. This novel material has numerous promising characteristics such as high specificity, high efficiency, self-assembly and self-reproduction. With some modification, the design can be applied to deal with uranyl ion in polluted water and soil, demonstrating its impressive potential. We believe that the material can effectively solve the increasingly serious uranium pollution in the near future.

OUR TEAM

The team of Peking iGEM 2016 consists of 15 students of various majors including biology, medicine and physics. Although the majority of the members are sophomores, they are creative and willing to learn. Over the past six months, Peking iGEM 2016 has become a professional and passionate team with the help of the leaders and instructors.

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Our project Watts-Aptamer aims to Design and construct an optimized photo-bioelectrochemical cell using an RNA aptamer synthetic biology strategy.

The world population consumes approximately 3500 kWh/y/capita, increasing the demand for clean alternative energy. Recent improvements of photo-bioelectrochemical cells (PBEC), which harness electrons from photosynthesis to generate electricity, include synthetic attachment of chloroplast thylakoids to graphene electrodes. However, current attachment techniques require costly chemically synthesized linkers and PBECs are not yet efficient enough for industrial energy generation. In this project, DNA aptamers were designed and evaluated as low-cost biological linkers to tether plant photosystem II (PSII) complexes to graphene foam electrodes. Systematic Evolution of Ligands by EXponential enrichment (SELEX), together with software developed by team Heidelberg 2015 (MAWS and JAWS) were used to develop PSII- and graphene-binding DNA aptamer candidates. This project aims to improve the attachment and orientation of the PSII complex to the graphene electrode for higher electron transfer efficiency, and serves as a prototype for the in planta expression of RNA aptamers for self-assembling thylakoid attachment.

We are also looking into improving a part in the registry that has been submitted by another team. A project description video will also be available on YouTube soon.

OUR TEAM

The Pretoria_UP IGEM team was first established in 2015 as part of the Forest Molecular Genetics (FMG)

research group of the University of Pretoria. The team has since grown to have 11 students in different study disciplines under the supervision of an instructor and advisors who are experts in their respective fields in 2016.

WattsAptamer

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UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

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Instructor

Prof Zander Myburg
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Dr Tjaart Kruger
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Dr Eshchar Mizrachi
Advisor

2016 TEAM MEMBERS

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Advisor

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The current drug market is dominated by drugs of biosynthetic origin. Greater than 70% of these essential compounds are commonly found in the bacterial kingdom and a significant portion are produced by nonribosomal peptide synthetases (NRPS). NRPS are large multimodular enzymes that create a variety of structurally and functionally diverse peptides. NRPS have catalytic domains to carry out these functions such as condensation domains (C) to couple amino acids together, adenylation domains (A) to activate amino acids, peptide carrier proteins (PCP) which use a thiol arm to swing the substrates between active sites, and the last domain is a thioesterase domain (TE) which facilitates product release.

These large synthetases are composed of a string of modules where each module is responsible for the addition of one amino acid to a growing peptide chain. These amazing cellular machines produce only one major product through efficient enzymatic steps. The shortcoming is that often times the products are cyclic and thus hard to reproduce through total chemical synthesis. Therefore, it is difficult to optimize potential drug leads.

We will be constructing a pipeline that will allow us to modify NRPS products which are difficult to synthetize.
The pipeline will consist of 3 phases:

- Creating a robust tagging system to visualize the production of NRPS compounds.
- Modifying domains through genetic and protein engineering in order to change their substrate specificity and append additional modifications onto the substrate.
- Develop a homologous recombination system which takes advantage of conserved sequences in NRPS domains to construct novel pathways.

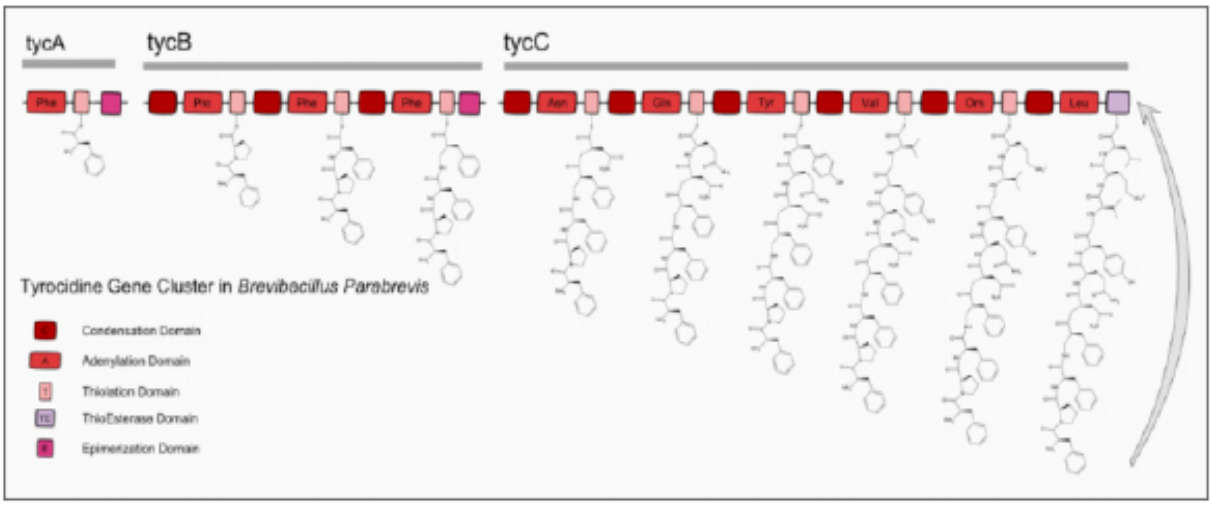

Figure 1. Tyrocidine gene cluster containing C, A, T, TE catalytic domains. Epimerization domains change L amino acids into D amino acids The final product is a head to tail cyclized peptide which has anti¬bacterial properties. Unfortunately, it is also hemolytic.

Phase 1: Tagging

Indigoidine is a NRPS product that is produced by a single module and produces a brilliant blue colour when it dimerizes. In 2013, Heidelberg's iGEM team demonstrated that it was possible to use the IndC module which produces indigoidine and couple it to a valine module to form a dipeptide which dimerizes to produce a blue colour. Strangely, no paper was published on the ability to tag NRPS products leading one to be skeptical of their work. The most likely explanation was that they had failed to engineer the robustness of the IndC module and were unable to tag larger preceding peptides which were sterically bulky.

Indigoidine dimerizes through a non¬enzymatic reaction to produce a blue pigment. A cyclized glutamine that is oxidized triggers the dimerization event. Evidence for this dimerization mechanism can be found if one looks at another NRPS product known as Padanamide B. Padanamide B contains a cyclized glutamine as its final amino acid but lacks an oxidation domain hence the cyclized glutamine cannot be oxidized. Without the oxidation of the cyclized glutamine, no dimerization event occurs in padanamide B while indigoidine is able to dimerize. This lead us to another interesting observation. The mechanism of glutamine cyclization in IndC was proposed to occur through oxidation of glutamine which forced its cyclization, but padanamide lacks an oxidation domain. Therefore, one can conclude that it is the TE domain that is responsible for its cyclization (Figure 2).

We aim to demonstrate that the oxidation domain oxidizes the cyclized product rather than glutamine to induce dimerization.Given that this is true, one would then be able to modify the specificity of the oxidation domain through protein and genetic

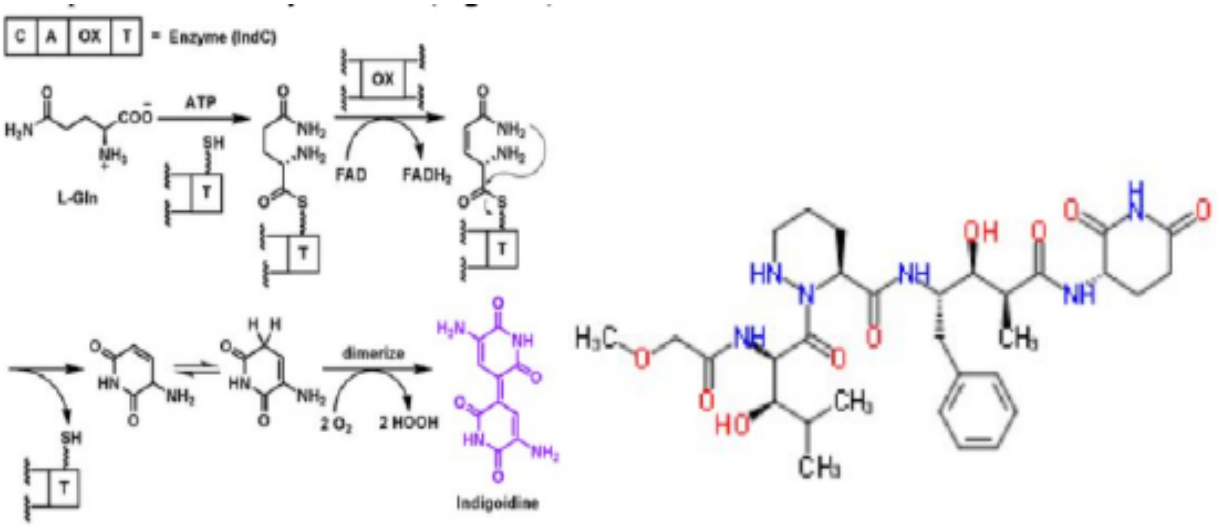

Figure 2. (Left) one of the proposed mechanisms for indigoidine synthesis. Oxidation occurs first then cyclization, opposite of what we suggested. (Right) Padanamide B structure, the final amino acid is the unoxidized version of cyclized glutamine.

engineering to visually label any preceding peptide sequence. The visualization of NRPS products will allow us to carry out high throughput screening of small peptide production which is essential for Phase 2.

Phase 2: Module Modification

While previous research shows that one can swap out whole modules in NRPS gene clusters its extent is limited since production of the biologically active product is greatly diminished. Instead research suggests that adenylation domain substrate specificity is not as robust as once believed. Stachelhaus et al. were able to demonstrate that there are ten residues on the adenylation domain which dictate substrate specificity. Taking both preceding statements into consideration it has been shown that through genome engineering it is possible to change the specificity of adenylation domains to incorporate different compounds. This bypasses the pitfall of low compound yield due to whole module swapping.

Changing adenylation domain specificity is a huge step towards being able to optimize potential drug compounds, but QGEM 2016 wants to introduce more flexibility and control of adenylation domain substrate modifications. It has been observed that modules often contain domains which modify their substrate such as ketone¬reductases, and oxidases embedded within the adenylation domain. Therefore, the site of these domain additions is a great target for introducing engineered auxiliary domains which can add additional functionality to adenylation domain substrates.

Using the IndC module tagging system discussed in Phase 1, it would be possible to apply high throughput methods to screen for modified modules. During the summer QGEM

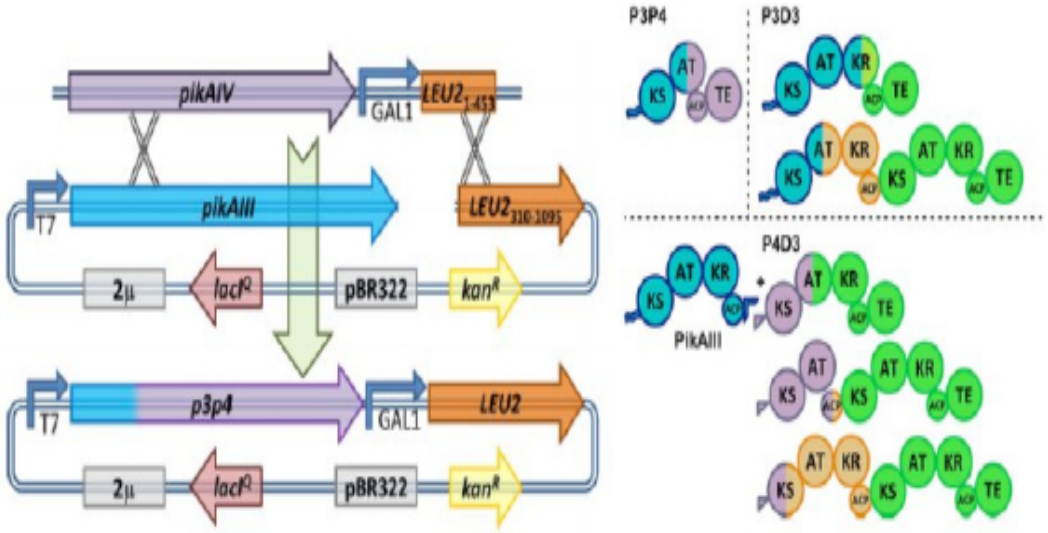

Figure 4. (Left) Proposed method of using homologous recombination in yeast to construct chimeric NRPS systems similar to those produced with PKS. S. cerevisiae Leu(¬) mutants were grown on Leu(¬) media. Successful recombination resulted in recovery of Leu synthesis. (Right) Chimeric PKS systems created using homologous recombination. Possible recombination sites are demonstrated

such as docking domains and critical protein¬protein interactions may prove difficult. Hence we will construct a NRPS system that is as close as possible to the desired sequence using homologous recombination and then change the specificity of certain adenylation domains as well as add auxiliary domains.

Multiplex automated genome engineering (MAGE) will be used to efficiently change the Stachelhaus residues of the adenylation domain of interest found in the gene cluster. This has been done effectively before in literature and has been shown to preserve biosynthetic compound production when compared to whole module swapping. Additional auxiliary domains may need to be added to the module. In order to insert the domains, we will use MAGE to insert a protospacer adjacent motif (PAM) site in between the A8 and A9 domains and use a CRISPR¬Cas9 system to insert the engineered auxiliary domain(s) into the module of the NRPS gene cluster.

By accomplishing the proposed three phases, we will be able to create a pipeline to optimize drugs produced by NRPS systems as well as produce novel drugs. This would allow one to rapidly construct and modify cyclic peptides which are difficult to chemically synthesize. This proposal has huge implications for the pharmaceutical industry by helping to create biosynthetic drugs which are safe for consumers, therapeutically effective, and more economically sound than chemical synthesis. The creation of this pipeline has the ability to revolutionize the way we look at biosynthetic drug design and optimization.

SYSU-CHINA

@iGEM_SYSUChina

A lack of techniques to figure out cells undergoing different number of cell-cycle in their lineage has limited our ability to evaluate the efficiency of stem cell therapy and investigate the mechanism behind it.

Here, we SYSU-China, describe Cyclebow, a system for labeling cells undergoing different number of cell cycles after a specific state in the lineage based on cyclic promoters combined with recombinases and fluorescent proteins.

We intend to demonstrate imaging of up to three cell cycles in a specific lineage, which can help tracking the proliferation, differentiation and migration of stem cells in vivo.

OUR TEAM

Team SYSU-China has been established since 2011, then recruits undergraduate students from School of Life Sciences, Department of Mathematics and other institutes.

Team SYSU-China 2016 invokes experiences of their own as well as those of their predecessors to address some issues related to the administration, management, and leadership of an iGEM team.

Tec-Chihuahua

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The state of Chihuahua is the 2nd producer of alfalfa in Mexico and as we all know, phytopathogens are a great problem concerning agriculture, and frequently lead to great economic losses. Although chemical pesticides and fungicides have been used against these pathogens, they often result in the accumulation of toxic compounds or increase the resistance of the pathogens. This is why biocontrol using mircroorganisms has become an effective alternative of controlling plant pathogens.

For this alternative we decided to use a type of soil bacteria known as Myxobacteria, which are a common and diverse group of bacteria largely fed through predation and able to produce a wide range of secondary metabolites. We isolated this bacteria from our region and got proof that they are able to inhibit fungus and other bacteria. This may be due to competition for nutrients or the production of antifungal compounds. Therefore, we saw a potential project on enhancing Myxobacteria's properties to attack some specific endemic fungi.

To achieve this, we intend to create a BioBrick™ that can give this bacteria the ability to resist extreme weather, and enhancing its antifungal capability. For this investigation we took samples from damaged alfalfa crops found nearby Chihuahua city from which we pretend to isolate phytopathogenic organisms and prove the efficiency of our modified bacteria making confrontations between them. This will also help us broaden the impact in other crops as well, such as chili and potato.

OUR TEAM

Our team is composed mostly by biotechnology students from different semesters but has also the

collaboration of law, mechatronics and computer science students. We all have different areas of interests but the thing we all have in common is that we are eager to learn and do something of value with that knowledge.

Tel-Hai

iGEM Tel Hai

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Cystic Fibrosis is an autosomal genetic disease. It is the most common lethal genetic disorder affecting mostly Caucasian populations, but affecting populations worldwide as well essentially.

It is most known for affecting the lungs (through accumulation of mucus, causing difficulties in breathing) but it also leads to problems in multiple additional organs, such as the liver, kidneys and pancreas. In addition, mutations correlated with Cystic Fibrosis have been seen to be in correlation with male infertility.

Currently, there is no cure for Cystic Fibrosis, and most patients with the disease pass away by the away of approximately forty, though multiple medicines have been used or developed in order to alleviate multiple symptoms the patients have been found to suffer from, aiming to improve the quality of life of those for as many years as possible.

Of the hundreds of mutations affecting the CFTR protein and indicating the existence of CF amongst patients, the most common is ΔF508. This mutation leads to a damaged CFTR protein due to the loss of one Phenylalanine amino acid on the 508th place on the protein. The protein folds incorrectly, and leads to an imbalance in osmosis, therefore leading to salty skin, and negatively affecting sweat, mucus and digestive juice accumulation.

Our aim in this project is to correct the CFTR gene in the epithelial cells of Cystic Fibrosis patients by using the CRISPR technology. The conjugation of the CRISPR/Cas9 Plasmid/ B Subunit of the Cholera Toxin will allow tissue specific delivery, and therefore assure a reversal of the ΔF508 mutation.

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iGEM2016Tianjin

Our project this year is about the biodegradation of PET, a widely-used plastic material. We use two enzymes, PETase and MHETase, which were found this March and certified to have much higher activity than any PET degrading enzyme found before in room temperature. We express the enzymes by Saccharomyces cerevisiae, a well-researched and generally-regarded-as-safe (GRAS) microorganism. The products of the degradation reaction are terephthalic acid (TPA) and ethylene glycol (EG), which are also toxic to environment. We construct a co-culture system are introduce the Rhodococcus rhodococcus, which can use TPA as its carbon resource and Pseudomonas putida, which can degrade the EG. If possible, we also want to introduce Cyanobacteria to our system to transform optical energy to chemical energy and make our system autotrophic, so that we can apply our system in degrading the PET products in nature. What is impressive is that the Pseudomonas putida can produce PHA, a kind of biodegradable plastic, so we apply the particular promoter from former iGEM project to control the VanX gene expression, which can cause bacterial lysis and release PHA. Another direction of our project is directed evolution of the key enzyme, PETase. Since we do not know the 3D structure of PETase, we turn to other enzymes which can degrade PET and analyze the possible amino acid sites which is likely to affect the degradation activity and then we design 21 possible mutant and realize them by site-directed mutation. We also apply error-prone PCR to randomly mutate our PETase gene and we are looking forward to obtain mutant which has higher activity than wild–type enzyme.

OUR TEAM

iGEM Team Tianjin is one of the first batch of iGEM

team in China, which was found in 2007 and this year is our 10th time to participate in the iGEM competition. Look back on the history of Team Tianjin, we have won 4 gold medals totally, and last year we won the Best Energy Project Prize.

Tongji_Shanghai

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The up-conversion nano particle(UCNP) is a luminescent material which converts 980 nm light into 670 nm light. The carbon dot serves as photosensitizer intakes 670 nm light and brings heat effect, helps lysosome escaping. We joined two materials with SO2 and transport the complex into the breast tumor cell, start apoptosis by ROS from sodium copper chlorophyllin on C-dot. To amplify the heat therapy, we designed a virus expressing P53 in the tumor cell by cancer specific promoter. During the therapy, we load the virus into all cells, express P53 only in tumor ones. Afterwards the UCNP in injected, guided by the light to trigger heat therapy. This treatment is considered to be a better targeted however less toxic method to cure cancer.

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CAN A NEGLECTED TROPICAL DISEASE BE ERADICATED?

Leishmaniasis and our Project

Vaccines prevent 3 million deaths and 10.5 million cases of infectious diseases every year. One of the major components of our project involves developing a protein delivering platform to act as a vaccine. This can be used as a prevention for a neglected tropical disease, namely leishmaniasis. Our inexpensive platform through oral administration has the capacity to deliver an immunogenic protein to antigen presenting cells. This could potentially immunise against the life cycle of leishmaniasis. This disease affects approximately 1.3 million people every year. It is most prevalent in the Americas and Asia.

Leishmaniasis is caused by a protozoan parasite and is transmitted by the bite of the female sandfly. There are 3 forms of leishmaniasis ; visceral, cutaneous and mucocutaneous. The strain we are targeting is Leishmania infantum which is transmitted by the sandfly *Lutzomyia longipalpis*. This strain is particularly prevalent in Honduras, which is a country in Central America. There are 1500 cases reported annually in Honduras. The treatments which are currently available are lengthy and onerous. Hence, our vaccine could present a welcome alternative to current elimination strategies.

The cases in the Middle East are also of particular note due to the Syrian refugee crisis, which has been prevalent in the news over the past year. L.tropica (a species of Leishmania) which originated in Syria now accounts for 90% of cutaneous leishmaniasis cases. As Leishmaniasis is a communicable disease, the vast

number of migrants entering EU from Syria could present a risk to public health. Although with our project, we are not targeting this particular strain, a similar basis could be used to produce a vaccine for EU citizens in the future. How are vaccines regulated in the European Union?

EU VACCINE REGULATION

In general there are six main stages in development of new vaccine; exploratory stage, pre-clinical stage, clinical development, regulatory review and approval, manufacturing and quality control.

In the exploratory stage, an understanding of the disease is obtained. The epidemiological data is collected and the correct antigen or protein (which in our case would be LJM11) to use in prevention or treatment is identified.

The second stage involves identifying the relevant antigen via screening, creating the concept and evaluating if the vaccine is efficient in vitro and in animals. Following this, the production procedure must abide by Good Manufacturing Practice standards.

This leads to the Clinical development stage, in which the vaccine is tested in humans. There are four stages involved over a number of years. Phase 1 trials involve determining if the vaccine is safe to use for humans and studying the nature of the immune response the vaccine evokes. Leishmaniasis is a disease of poverty. Thus, 1a trials would involve European volunteers and subsequently there would be 1b trials with populations in developing countries.

Phase 2 trials are on a larger scale. They assess how effective the vaccine is against artificial infection, then the clinical disease. The safety of the vaccine along with side effects and immune response are all evaluated during this stage.

Phase 3 trials involve hundreds of subjects in an array of sites. Efficacy can thus be determined under the natural disease conditions. A license can be applied for after a defined successful period in this stage. Phase 4 trials involve post market surveillance i.e. detecting any rare long term effects and long term efficacy.

Other than the extensive regulatory procedure, another consideration when bringing a vaccine to market is whether public opinion will be conducive to its introduction.

TO VACCINATE OR NOT TO VACCINATE, THAT IS THE QUESTION

There have been many controversies in the past in relation to the introduction of particular vaccines such as the HPV (human papilloma virus) vaccine and MMR vaccine. Personal beliefs and fear of side effects are two of the most significant reasons the public may be opposed to vaccine introduction.

Gardasil and Cervaxil which are HPV vaccines utilised in Ireland have been associated with 856 reports of side effects, since introduction in 2011. These reports have deterred many parents from giving permission for administration of this vaccine to their children.

In relation to the MMR vaccine, in the late 1990's a researcher released a paper attempting to illustrate the link between administration of MMR and incidence of Autism. Although the contents of this paper have been since retracted, the publication of the article caused a significant decrease in uptake of the MMR vaccine over the past 20 years. In the US alone the MMR vaccine rates decreased by almost 3% in one year (2008:93.5%, 2009: 90.6%).

From this controversy, it becomes apparent that having factual information available to the public is vital. This ensures people can be protected against preventable diseases. Misinformation as with the MMR controversy can lead to preventable fatalities.

Undoubtedly, vaccination is a societal bone of contention however immunisation is one of the most cost effective public health investments. Vaccines have helped to cut child deaths in half over the last two decades. By facilitating medical research and distributing factual information this trend may continue and hopefully completely eradicate the most common preventable diseases.

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OUR TEAM

UCC iGEM 2016 are the third team from UCC, Ireland partaking in the iGEM competition. In 2014 our university entered the first Irish team into this competition. Our team this year is composed of 7 members. There are 2 medicine students (James Meeke and Aoife O'Brien Horgan), 2 pharmacy students (Kevin Ryan and Donnacha Fitzgerald), 2 genetics students (Amy Bergin and Seema Subedi) and a biomedical science student (Regina Walsh). We are all third year students and our team leader Brandon Malone is in 3rd year Pharmacy.

In order to become a member, all applications had to be submitted by the beginning of February. There were three components to our initial application, these included:

- Curriculum Vitae
- An original idea on how synthetic biology can be used to solve a particular problem in the world

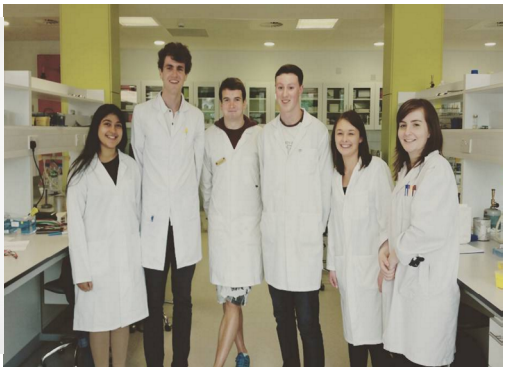
- A brief illustration on why we wished to partake and which skills and abilities we could add to the team

After narrowing down applicants, several were invited to partake in an interview. We were informed of our acceptance to join the team by the end of that month. To learn more about our team check out our Youtube channel where we have a Meet the Team video!

Our project name this year is *Limitless Lactis* as we are utilising *Lactococcus lactis* as a protein delivery platform for disease treatment. Potential applications which we have investigated include vaccination strategies and macrophage modification. This modification is en-

-abled via the use of CRiSPRi CRiSPR is a unique genome editing tool that enables precise genetic manipulation. This platform may be employed to modify the phenotype of other phagocytic cells associated with diseases such as cancer.

We have also developed a vaccination platform against leishmaniasis, a neglected tropical disease increasing in geographical distribution. LJM11 is an immunogenic salivary protein of the sandfly vector, Lutzomyia longipalpis. Our inexpensive platform, through simple oral administration, has the capacity to deliver this protein to antigen presenting cells, and potentially immunise against the lifecycle of leishmaniasis.



UNIK_Copenhagen

iGEM_TecChih

CosmoCrops

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OUR TEAM

Univesity of Copenhagen has had an iGEM team for the past four years, with last year's team called SpaceMoss as the most successful with a gold medal and two nominations. This year, University of Copenhagen will be represented by ten highly dedicated students from several different life sciences programs of the university - These students are also commonly known as CosmoCrops.

Assembling of the team

The headquarter for the iGEM team at University of Copenhagen is Center for Synthetic Biology and they believe that the best team will be assembled if the students have the best basis for what iGEM is. Therefore, they believe that it is the students from last year's team that can assemble the best team, because they have the knowledge to explain what iGEM is and what is the best way to think synthetic biology when thinking of iGEM.

In February members of last year's team held an introduction event where all interested could come and hear more about SpaceMoss and iGEM in general. Shortly hereafter, they opened for applications, so all interested could make an application to join this year's team. Because last year's team was very diverse, including students from Biotechnology and molecular biomedicine to physics and bio business, they wanted to make this year's team as diverse. Therefore, the application should include what program we are studying, what contribution we can make in an iGEM team, here meaning laboratory experience, applying for funding or having contacts to the media. Furthermore, we

should also take a personality test and include the result for the application.

After the deadline for handing in an application, members of last year's team sat down and looked all the applications through. Out of all the applicants, they choose the ten students they thought would make the most diverse team, seen from competences, studies and personality.

All of this added together gives CosmoCrops - we are ten students that represent 8 different programs from the faculty of Life Sciences at University of Copenhagenranging from Biotechnology and Biochemistry to Computer Sciences and Mathematics. We believe that because of our diversity, we are able to work together as one team and everyone gets to use all their competences, instead of one person controlling everything. Therefore, we can definitely suggest making as diverse team as possible!

[CosmoCrops that is representing University of Copenhagen at the iGEM competition 2016]

Structure of the team

To make a team work most efficiently, we believe it is important to have some structure within the team so each person know what tasks one is responsible for. Therefore, we decided on five sub-groups where each person should belong to at least one depending on the interest and competences of the person. These sub-groups where made to include all areas within an iGEM project and they were called Organisation, Outreach, Funding, Green lab and Red lab. To make sure everyone is up-to-date we believe that meetings are important and should be often.

- Organisation: The Organisation has the full overview of the project, and make sure that we will reach all the deadlines within the time. Furthermore, they are the ones that will book flight tickets and hotels every time we are attending a meet-up or conference outside Copenhagen.

- Outreach: The Outreach group will be the face of the team. The outreach people will be contacting the media to get articles out about the project and control the social media such as Facebook, Twitter and LinkedIn, and make sure those are updated. Furthermore, the outreach will also be those who are presenting the project at most of the lectures and conferences we are attending, and make deals with museums and such to get out to the public.

- Funding: The Funding group is the people who will be applying for money so we can attend different conferences abroad and the Giant Jamboree in Boston. Furthermore, they are also the ones that will make sure that we get sponsorships from relevant companies. This could for instance be Eurofins or QiaGEN so the lab work will be cheaper.

- Green lab: The Green lab consists of

the biology-related people, and they will be doing most of the wet-lab work of the project. This could be the cloning and transformation work and setting up the bioreactor.

- Red lab: The Red lab is on the other hand the physic lab of the project. This lab will be doing all the testing of the viability of our organisms in extreme environments.

PROJECT

After the new team was assembled we should decide on a project. Very soon we all agreed on keeping the space theme that last year's team started. To get some ideas, our supervisors had an inspirational lecture during one of our first meetings to come up with ideas on what is trending and what topics that could be interesting. This gave a lot of ideas that the people in the Green lab started looking into. This was done by using literature search to find what is already known for the different topics and TedTalks to find some inspiration as well. After a few weeks where Green lab along with Red lab had brainstormed different projects, it was narrowed down to three; primarily continuing on last year's project, working with a co-culture or working with tardigrades. These three project and the ideas behind each project were then presented to our supervisors and the rest of the team, and feedback was giving on each of the projects. Hereafter, the team decided on a project - the co-culture!

Then it was up for Green lab to make a project description to define the scope of the project. This included finding the problem we want to solve and how to solve it. Space exploration is a costly affair but important for the life here in Earth. Most of the things we use every day were invented because of space exploration; therefore making space exploration cheaper will not only help exploring space and maybe find life out there, but also push the innovative ideas forward here on Earth. Therefore, our aim is clear - Make space exploration cheaper!

The way we want to do this, is by decreasing the amount of material that is needed on-board on the space shuttle before launching, hereby the amount of fuel can be decreased. So we thought - why can't we produce the material we need out in space when we need them? Therefore, we are developing a biological system that can produce almost every kind of material and product that can be needed on space missions or on future settlements on other planets. This biological system consists of two organisms; *Synechococcus elongatus* and Bacillus subtilis. The *S. elongatus* will make sucrose out of sun light and carbon dioxide from the air. The sucrose can be used by *B. subtilis* to produce whatever compound we have modified it to produce. In a proof-of-concept, we are producing the bioplastic P(LA-co-3HB). The bioreactor with these two organisms are designed in such a way that they two organisms are physical separated, meaning that one of the organisms - *B. subtilis* - can be removed

without disturbing the other organisms. This provide a bioreactor with a high modularity where one of the organisms can be removed and replaced with another engineered strain, so instead of production of bioplastic we get production of vitamin B12 - all of this without starting a new bioreactor!

Furthermore, the two organisms, *S. elongatus* and *B. subtilis* will be tested for their viability in low pressure, low temperature, high UV and microgravity - all parameters that are found in space. Hopefully some beneficial mutations can be induced that makes the organisms more able to survive those parameters. This is in short what we try to obtain this summer!

UrbanTundra_Edmonton

UrbanTundra Edmonton - IGEM HS 2016
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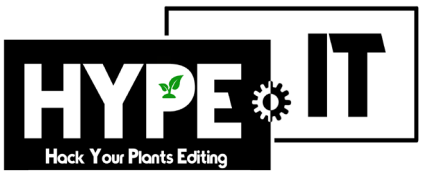
Our project came together from learning about iGEM through the "Fusion" Science Expo last fall; and the theory behind the movie, "The Martian". With these two components in mind, Urban Tundra Edmonton has committed the bulk of our summer to lab work.

The goal this year aims to colonize Mars by creating oxygen through the metabolic pathways of e. Coli; as well as provide rocket fuel. Martian soil has been reported to have a toxic perchlorate (ClO4-) concentration of 1%. However, ClO4- can be broken down into oxygen (O2). Using this information, our team is genetically engineering e. Coli DNA with the enzymes perchlorate reductase and chlorite dismutase. This allows for the bacteria to biodegrade ClO4- firstly into ClO2-; and later biodegrade ClO2- into Cl- and breathable O2. As for rocket fuel, when perchlorate is reacted with ammonia, it produces ammonium perchlorate. With these two essential elements- oxygen and rocket fuel energy- human life and activity can be sustained on the Red Planet.

OUR TEAM

Our team, Urban Tundra Edmonton, is composed of twenty-one students from four different Edmonton high schools. The majority of us are from the graduating class of 2016, attending the University of Alberta this fall. Nonetheless, each and every one of us shares a keen interest in the STEM fields- science, technology, engineering, and math. Our primary investigator is Professor Mike Ellison (Ph.D., Dept. of Biochemistry at the University of Alberta). This year, we will be presenting our project at two sites: aGEM in Calgary mid-September, and iGEM in Boston late October.

Valencia_UPV



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Our project is supported by IBMCP-CSIC (Plant Molecular and Cellular Biology Institute-Superior Council of Scientific Research). The development of our project was mostly inspired by the innovative genome editing technique CRISPR/Cas9 and our wish to apply it as a new plant breeding technique. The obtaining of new crop varieties usually takes a long time and a high economical investment. Additionally, the mutations that characterize the phenotype of the new variety are not known, except if it was obtained through transgenesis. However, transgenics are not socially accepted and in some regions like Europe they are practically forbidden.

We found that the solution to these problems was to improve the accessibility of plant genome editing with CRISPR/Cas9. We aim to create a system that allows local plant breeders to obtain their new varieties in a simplest and fastest way than the current techniques. This includes making the information needed to work with CRISPR/Cas9 easier to use and to understand.

Our project is based in making knockouts in the selected genes to obtain new plant varieties. The knockouts are possible by using CRISPR/Cas9 and the necessary gRNA, which are inserted in the plant with viral vectors. But, how do we make the process accessible to local plant breeders? We propose four methods to achieve this:

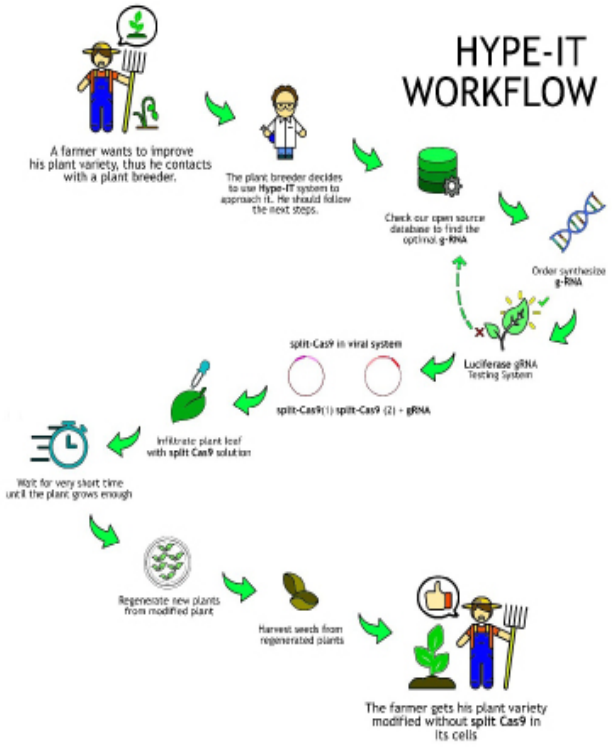
- Data processing software: we firstly will create a database which connects desired plant traits with the gene that is necessary to knockout to obtain the trait. This database will include genes found in bibliography and predicted genes that can be knocked-out in other plants to obtain possibly the same phenotype. Using this database, the data processing software will be able to obtain the optimal guide RNA to knock-out the gene

that the user selected.

- gRNA testing system: the database provides gene consensus sequences. However, plant breeders might use a plant variety different from the one which is sequenced. Given that, it is necessary to test the gRNA for the specific variety that they want to improve. Our modular and standard testing system will inform the user if the gRNA works on his plant and which efficiency does it have compared to other gRNA. The reporter system is based on luciferase, so the breeder will obtain luminescent signal if the gRNA works and hence the CRISPR has cut.
- Split Cas9: one of the keys of our project is the way to make more efficient and faster the obtaining of the new variety. The traditional technique for plant genome editing uses Agrobacterium as vector to insert the CRISPR/Cas9 in the plant. This makes the plant transgenic and has low efficiency, given that a low proportion of the plant cells get infected with Agrobacterium, lacking the Cas9 and the gRNA, making impossible the editing. The alternative is using viral vectors, which have higher infection rate and don't insert transgenes in the plant. However, the insert size admitted by viral vectors is 2.2kb. Cas9 measures around 4kb. For that reason, we will divide Cas9 in two, insert each part in a different viral vector and once inside the cell, both subunits of Cas9 will bind through inteins.
- Lab-case: finally, to be sure that actually anyone who wants can have access to this editing technique, we will design and build low-cost laboratory equipment specific to make plant genome editing with CRISPR/Cas9. This will include centrifuge, electroporator, thermal cycler, luminometer and electrophoresis module. The cost could be around 500$ for all this equipment, considerably cheaper than the traditional equipment.

OUR TEAM

Valencia UPV team has been participating in iGEM the last ten years. In our team it has always been valuable the multidisciplinarity, so it is composed by biotechnologists, industrial, electronics and biomedical engineers and computer scientists from the Polytechnic University of Valencia (UPV), Spain. The team members are all undergraduate, between 19 and 23 years old, including iGEMers from iGEM 2015 that advise and support the new members.



Vilnius-Lithuania

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The aim of Vilnius-Lithuania iGEM 2016 team is the treatment of a genetically inherited condition called phenylketonuria (PKU). The condition is defined by person's inability to metabolize an essential amino acid phenylalanine due to the mutation of phenylalanine hydroxylase (PAH) gene. As a result, the phenylalanine hydroxylase enzyme is not produced and phenylalanine derivatives accumulate in the brain of the affected person. This, in turn, causes different neurological symptoms ranging from depression to epilepsy and severe mental retardation. At the moment, there is no known cure to this condition; however, since phenylalanine is found in almost any protein-rich food, the only treatment is a low-protein diet. This diet excludes the most common foods consumed by the majority of the population – bread, meat and dairy products. Although the patients are being supplied with a special phenylalanine-free powdered food, the disease might have a negative effect on the quality of their lives leaving them with the struggles of food choice in the public catering.

Vilnius-Lithuania iGEM team came up with an idea of a possible treatment for phenylketonuria – a probiotic, which would absorb phenylalanine and metabolize it in the intestinal tract of the patient. To be more precise, the team has two approaches to this idea. The primary approach is a phenylalanine ammonia lyase (PAL) producing bacteria – the PAL enzyme will break down phenylalanine. To fulfill the second approach, the team created a new synthetic gene, which consists of a large amount of phenylalnine codons. During the process of translation, the excess phenylalanine will be incorporated into the synthesized protein. Such protein is expected to form inclusion bodies inside the bacterial cells. Lastly, since the constitutive synthesis of phenylalanine-rich protein is highly

disadvantageous and possibly even harmful to bacteria, the team is thinking of developing a riboswitch-based posttranscriptional gene expression regulation. The riboswitch will consist of a phenylalanine aptamer and a ribozyme, providing the translation only in higher phenylalanine concentrations in the environment.

OUR TEAM

Our team consists of 18 students from different tracks of life science – biochemistry, genetics, molecular biolo-gy, medicine and bioengineering. To make the teamwork more efficient, we have divided our team to several subgroups – PR group (6 people), finance and marketing group (5 people), research group (4 people), Interlab group (6 people) and human practices group (5 people); however, as it is seen by looking at the numbers, team members have overlapping responsibilities. Such partition enables more organized project development, hopefully leading to better performance at Giant Jamboree.

Washington

UW IGEM Team

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Viva la Violacein

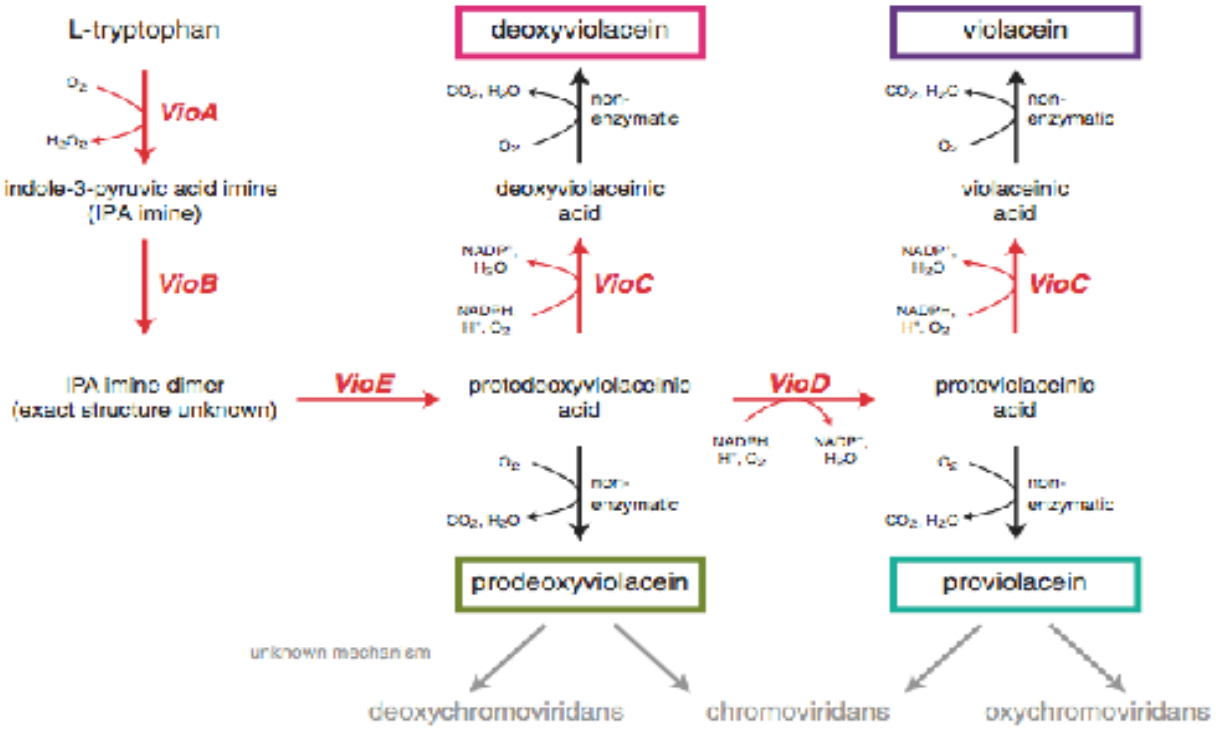
An Autonomous Control System for Yeast Cultures

Managing cultures is a vital task in synthetic biology, but constantly measuring and adjusting culture conditions is both tedious and labor intensive. Our project aims to reduce the amount of time and effort needed to maintain cultures through the creation of an affordable image analysis system that reads visual data to measure the current state of a culture and then determines whether to release inducer chemicals based on user input.

Our project utilizes the violacein pathway to simulate other metabolic pathways with colored signals. By regulating gene expression in this gene set with two different inducible promoters, we are able to yield up to four different color outputs.

These outputs are then measured by an open-sourced Raspberry Pi setup, which captures visual data via camera, measures the culture's RGB value, and then directs the gradual release of inducer chemicals to maintain or change the culture's color over time.

To control the violacein pathway in S. cerevisiae we are using the CUP1 inducible promoter, a concentration dependent yeast promoter that responds to CU2+ ions, as well as the GAL1 yeast inducible promoter which responds to galactose. However, switching out the inducible promoters might lead to a number of new applications.



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OUR TEAM

The University of Washington iGEM team was founded in 2008, and is run by students from all over the world. With a diverse set of skills from bioengineers, computer scientists and aspiring entrepreneurs, our team has been able to tackle problems with biofuels, paper-based diagnostics and complex multi-enzyme pathways. This has proved especially helpful with this year's project which wouldn't be possible without a significant amount of drylab work. With an innovative approach, our research will serve as a building block in the expanding field of synthetic biology.

XMU-China

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Abstract

A post-antibiotic area becomes a very real possibility for the 21st century. Here we supposed to built a programmable bacteria with three distinct engineered genetic circuit modules, including biosensor module, switch module and killer module, which can be used to combat the drug resistant bacteria.

Background

Antibiotics made a vast medical advancements over the past 70 years [1]. The annual consuming rate of antibiotics appears to be rising. It is reported that in 2010, 70 billion individual doses of top seven antibiotic classes were consumed, which equates to about 10 pills, capsules, or teaspoons for everyone on earth [2].

People and animals get antibiotics and develop drug resistant bacteria. When the antibiotics kill pathogenic bacteria, some of them mutating and developing the "drug-resistance". Drug resistant bacteria flourish in the absence of diminished competition, and the resistance can be transferred among the bacteria, which made their infections considerable mortality and morbidity [3]. Furthermore, the prevalence of the infections is still increasing by abused antibiotics and resistance spreading. It is predicted that 10 million people would be killed for the drug-resistant pathogen infections each year by 2050 [4]. Multidrug-resistant (MDR) pathogens has been identified as one of the top three threats to human health by the World Health Organization (WHO) [1].

Bacteria develop clinically significant resistance

in a period of just months to years. There have been several common drug resistant microorganisms such as methicillin-resistant Staphylococcus aureus (MRSA) , vancomycin-resistant Enterococcus, fluoroquinoloneresistant Escherichia coli and multidrug-resistant tuberculosis mycobacteria [5]. The new antimicrobials or modifications of current arsenal may not address the trends in resistance effectively [1]. Combination therapies for the treatment are needed such as quorum sensing inhibitors, bio surfactants, bacteriophage, enzymes, etc. [3].

Ideas

We aimed to combat the drug resistance bacteria based on the engineering of gene regulatory networks. During our brain storm, the gene circuit "plug and play" designed by Kobayashi et al. helped us to find the design strategy for constructing the programmable bacteria [6]. The circuits of detecting and killing MRSA were from iGEM Team TU-Delft 2013 and LMU 2014. And we modificated the Synthetically Synchronized Lysis Circuit (SLC) design by M. Omar Din et al. for our gram-negative bacteria detecting and self-lysing synchronously [7].

The programmable bacteria would be comprised of three modules.

A. Biosensor Module
- Gram-positive transgenic sensing
- Gram-negative transgenic sensing

B. Switch Module
- Self-destruction switch
- Toggle switches

C. Killer Module
- SiRNA for knocking down gene expression
- Toxins

Limitation

For the time limitation, we didn't test every combination of the modules. In the future work, more combinations need to be tested and more gene regulatory modules need to be constructed to enhance the capabilities of modular genetic control circuits. In this study, we tried to protect the natural host microbiome through the self-destruction switch. However, biologics have pitfalls such as vitro stability, restricted delivery options and limited high-throughput, etc.[3] . It is a challenge for us to overcome.

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OUR TEAM

Our team, XMU-China, consists of 18 undergraduates. We major in different disciplines, including chemistry, chemical engineering, material, life science, pharmacy, energy and public health. This year, we are making effort to deal with some realistic problems like antibiotic resistance, which will be talked later. Besides experiment, we also designed various activities for human practice. Newsletter is a part of it and we'll show you more details in the next part.

PART 2
HUMAN PRACTICE

Aachen

In this part our team focused on visiting schools and to organize different surveys, which should help us to understand and analyze the opinion of the German public towards synthetic biology.

BIT

Our project aims to create a real-time device connect with software to detect the specific microRNA in the human body. So besides our experimental work, we reached out of the lab and did some human practice activities. Our human practice consists of online and offline. In the first part we will make a questionnaire which aims to realize practicability of the project, through some social software like Wechat Platform, Facebook and Twitter. In the mean time we can find out how well people know about the breast cancer. In the second part we are going to make a survey in schools, biotechnology companies and tumor hospitals. We will also communicate with technical personnel about our project. By listening to them, we can solve the problems we have meet.

Cardiff_Wales

We have been exploring GM regulations, getting expert advice on the design aspects and applications of our diagnostic, and setting up public engagement events for September and October. We'll be doing a talk with Cardiff's Science Cafe in October, taking part in the Live Mars event at Cardiff University with an exciting activity (using 3D printed E.coli and luciferase), and setting up a stall at the Biology Rocks event in the National Museum in October. We are also in continued talks to set up a stall and demonstration at Techniquest. The GM regulations issues we faced with this endeavour inspired us to look deeper into safety, and GM regulations. We have had displays at an open day and the STEM conference at Cardiff University for sixth formers. Two group members represented us at a European iGEM teams meet up in Paris, and two members will also be attending the UK iGEM teams meet up at Westminster this week (17th-18th August).

Endinburgh_UG

In 2014, over 10 sextillion bits of data were digitally stored worldwide. To put this in context, there are only 1 sextillion grains of sand on this entire Earth. In 2020 data storage demand will reach 44 trillion gigabytes. In 2040[1] global memory demand will reach 3 billion billion million bits; the silicon required to store all this data vastly exceeds total silicon supply. Nowadays, data centres consume 1.52%[2] of all global electricity. There is a dire need for new storage methods. DNA is a stable, dense and longlasting molecule, making it perfect for storing data. Recently, researchers at Microsoft[3] have stored 200MB of data in DNA. However, their methods, using de novo synthesis are expensive, inflexible and inaccessible methods, using de novo synthesis are expensive, inflexible and inaccessible to the general public. We aim to create a cheaper and hence more accessible DNA storage method that will hopefully encourage the proliferation of this incredible technology in the future.

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Freiburg

This year, Freiburg's iGEM team intends to spread the awareness of synthetic biology in the public. It doesn't only mean to speak to students and academic people about our project but also includes talking to people of non-scientific professions.

We've started a collaboration with the university's radio program to share our visions and ideas with students through a radio interview. We talked about iGEM, synthetic biology and the basics of our project. Our motivation is to get the synthetic biology and the iGEM competition closer to public. We believe that the state of the art of scientific research is a rapid development that also concerns students from other majors. For example, do the history students of your university know anything about promoters, the bacteria used in drug development or even in their dairy products? ;)

Since our project has a high medical relevance, we are also interested in the professional medical input doctors and scientific clinicians can give us. Therefore, we've conducted interviews with dermatologists and gastroenterologist who helped us to get new input.

Hannover

The iGEM competition is not limited to lab work only or transferring your dream project into practice. We are also applying our project into a social context.

The enormous potential and the risks as well, are still not too much present in the media, and the general public. That is why we want to inform people that there are indeed silver linings. In fact, TALEs were already used to cure a girl from cancer.

Moreover, we want to address younger future scientists by giving talks at their schools and telling them about our fields of study and the iGEM competition.

Since we also want to enhance collaborate with other teams, we took part in the annual iGEM Meetup in Marburg and the European Meetup in Paris. Both weekends were great and we could talk to other iGEM teams about their problems and their ideas.

HokkaidoU_Japan

For our Human Practice, we organized a DNA-extracting booth at the school festival designed to introduce synthetic biology and iGEM to the public. Because there is still a negative impression of genetic recombination in Japan, we hope that this offered a good opportunity to spread the correct knowledge of what it is all about and how synthetic biology has a great potential and influence over other fields of study. Last year, other than the school festival, we also tried crowdfunding for the first time. Crowdfunding is a system where people present their project via a website to encourage the public to fund for them. We used a recently created crowdfunding website that specializes in academic projects to fundraise by promoting our previous iGEM project.

Thanks to the advance of such systems, the public and researches all over the world will be able to gain a better understanding about synthetic biology as well as other frontier researches. At the same time, beneficial or intriguing research projects will be able to gain more fund. We hope to continue engaging positively in such stimulating approaches to research.

Jilin_China

On April 4th we were invited by our local television through which the influence of our project is greatly expanded. On May 29th, we attended Changchun International forum of Oncobiology and Translational Medicine. We asked experts about new information and methods of treating solid tumors and their advice on our project. They provide us with lots of useful advice to improve our project. At the same time, we set up our own WeChat Public Number and Twitter account to update our news and receive feedback from other teams and those who are interested in our project. The feedback will be used to improve our project. We were invited by Huazhong University of Science and Technology and attended HUST-Cheering meeting in Wuhan. We introduced our project to iGEMers from all over the country. Professor Wenliang Chen provided us with some insightful advice on our model and cell experiment. We also learnt lots of very valuable information to improve our project better.

NCTU_Formosa

This year NCTU_Formosa has designed an exciting board game, Pest Crisis. Pest Crisis is about scientists versus pests, fighting for crops. The player will separate into two groups, scientists, and pests. For scientists, players have to design biobricks to produce pesticides. Besides, pests have to evolve some traits to resist pesticides. The reason why we decide to create a board game is that want to make it easy to learn the knowledge of synthetic biology, and to make players know the importance of the pest problem and chemical pesticide issue.

We played our board game in many Conferences and meeting ups with other iGEMers. It's a great tool to let other iGEMers preliminarily understand our project and use it to promote synthetic biology. Everyone was so excited for our board game, and we soon became good friends. We have designed both Chinese and English version of our board game and will reveal on the giant jamboree. Hope you will like it!

To make sure the opinions about our Project from the potential users in

the future. We went to Organic Green Market in NTHU to have an interview. There are many organic farmers in this market and we visited them one by one. According to our product demonstration, except introducing insecticidal peptide PANTIDE only, we also ask them some questions about

the device including a detector and automatic sprinkler to get farmer's recognition and recommendation. Most farmers really appreciate our project because, in the recent organic agriculture system, the pests of

cruciferous vegetables still rage the farm. As a result, they are all willing to use our product. Additionally, the farmers are willing to let us go to their farm to grab pests for the intra-laboratory experiment. Moreover, they are even willing to provide their farm to let us have a real test for the field test.

To realize the professional opinion of pesticide residues, we went to the famous organic tea store – 飲川 consulted with the owner about organic knowledge including the effect of the pesticides residues on the tea leaves. He said though the cost of organic tea is high, it still has its market value. He also reminded us that if the upstream farm using pesticides, the downstream farm will be polluted by the pesticides residues too. So we think our project will solve this problem due to PANTIDE is biodegradable. All in all, he supported our project very much.

Besides, we consulted Dr. Huang and his postgraduate student in Taiwan Agricultural Research Institute Council of Agriculture. He thought our device has its existent value because Agribusiness and related administrative departs need it to

monitor farms. The device helps them detect the pests and analysis the related data such as temperature, soil moisture, and rainfall in real time and so on. Dr. Huang also told us the method of pest detection and interrelated knowledge. Other than

conferring knowledge, Doctor Huang also gave us some remarks for our project, which makes us realize different aspects of agriculture in manufacturing and research. Even more, he let us visit the cultivated room of Oriental fruit flies.

Pretoria_UP

Last year we visited two high schools, one in a developed area and one in a previously disadvantaged area. The aim was to introduce the field of synthetic biology and to present our 2015 project to the learners in the two schools. This was followed by the learners filling out a short questionnaire (see more under surveys in this document). From the results we realised that as synthetic biology is a relatively new field, especially in South Africa we need to make people aware of it. This applies not only to academics and university students but also to the public in general.

For our human practices this year we want to focus on awareness and education. We aim to make people in south Africa aware of synthetic biology and its many applications. We plan to do this through social media (Facebook, Twitter, YouTube). We will also be presenting to a group of secondary school learners as well as at a synthetic biology symposium which the team will be involved in planning. We will conduct radio, newspaper and hopefully TV interviews where we will also be introducing the field of synthetic biology and making the public aware of its applications. To gain more knowledge that we can apply to our project we will survey and interview experts in the photo-bioelectrochemical cells and Energy field in general. We have already interviewed Dr Karen Surridge-Talbot, centre manager of the Renewable Energy Centre of Research and Development (RECORD) at the South African National Energy Development Institute (SANEDI). Her input has proven to be very valuable and we hope to talk to other representatives from stakeholders in the energy sector such as the National Energy Regulator and Eskom. All human practices events will be documented on our wiki with links to the videos as well as extra information if necessary.

Queens_Canada

Second Annual Synthetic Biology Research Seminar

On September 28th, 2016 Queen's iGEM will be hosting its second annual Synthetic Biology Research Seminar. We believe that it's important to educate undergraduate students, high school students as well as the general public about synthetic biology technology and what it can offer to their daily lives. Since synbio is an emerging field, we are compelled to define synthetic biology to the public and give them examples of successful synbio technologies that have improved society in some way or another. Furthermore, at these seminars we also discuss out research findings from our studies over the summer. This is a fantastic opportunity to promote Queen's iGEM and the research that we do as well as engage with the public on the ethical facets of synthetic biology and the benefits the technology can offer to us.

Course Development ¬ APSC 100: Engineering Practice (Module 3: Engineering Design)

APSC 100 is a first year engineering practice course taught at Queen's University. The design module, a twelve week project, offers students an introduction to team¬based work. A team is formed of four to five students who are paired with an upper year advisor and a community client. Students are guided through the design process as they work to solve open¬ended design challenges which often emphasize prototype development and system modeling, two critical overarching concepts in engineering. QGEM partnered with APSC 100 again this year to offer an engineering¬related project with a focus on biology. While engineering is a key component of the design and modelling aspects of our project, the team has traditionally struggled to breach the gap between the biological sciences and engineering within the university. This partnership is QGEM's way of strengthening the relationship and bridging the gap between these two disciplines at Queen's University. By incorporating synthetic biology and the considerations of our work into an engineering project, we hope to introduce the students to the possibilities of merging applied science with more traditional forms of research, with the aim of promoting interest in the biological applications of engineering. This year, QGEM entrusted APSC 100 students with the task of designing and producing either an incubator, a thermocycler, or a transilluminator in the most efficient way possible, integrating skills from their other courses.

Interview Series

To supplement our project this year on novel drug discovery and optimization, as well as related projects engaged by other iGEM teams, we've decided to film a three¬part interview series. This interview series aims to address overarching questions related to biosynthetic production, aspects of drug design, metabolite reprogramming and much, much more from a variety of unique perspectives. We welcome you to join us through each of the three segments as we explore perspectives from research, the industry, and academia! See our blog at queensigem.ca for more updates on the interview series as well as some short clips from the interviews we've conducted!

Synthetic Biology Summer Enrichment Program

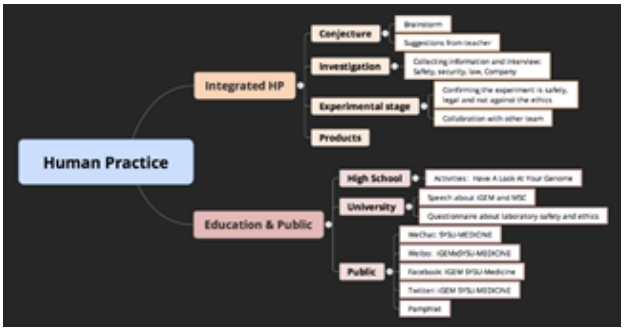
This summer, Queen's iGEM decided to hosted three, week¬long synthetic biology courses for middle school and high school students through the Summer Enrichment Experience at Queen's(SEEQ) program hosted by the Enrichment Studies Unit (ESU). We believe that synthetic biology is an emerging field that students are seldom educated about whether that be from elementary school, high school, and or even postsecondary institutions. We believe that synthetic biology is the future, and therefore educating young people about it is a crucial component to raising public awareness. It is also an excellent way to promote iGEM to high school students on the verge of attending postsecondary institutions, for which they will have gained prior exposure that can potentially influence them to join an iGEM teams.

Our lesson plans were modified from the William and Mary 2013 iGEM team's Synthetic Biology Curriculum. We included many interactive activities (such as making cell models using dessert treats, DNA helices using Twizzlers®, and extracting DNA from bananas) to ensure that the learning process is hands¬on, engaging, interesting, and drives the important points home. We were fortunate to have run these courses in partnership with the Queen's Enrichment Studies Unit (ESU) who helped us with much of the advertising and enrolment process for our synbio course. Our synthetic biology course ran for 3 weeks in total. The first week featured grade 6 students. the second week included students from grades 7 to 8, and the final week was taught to high school students. Overall, the students were lots of fun to teach, and consisted of very bright young individuals and budding scientists who asked very advanced and probing questions for their age. We received great reviews from the students on the course and it was a pleasure to teach students so eager to

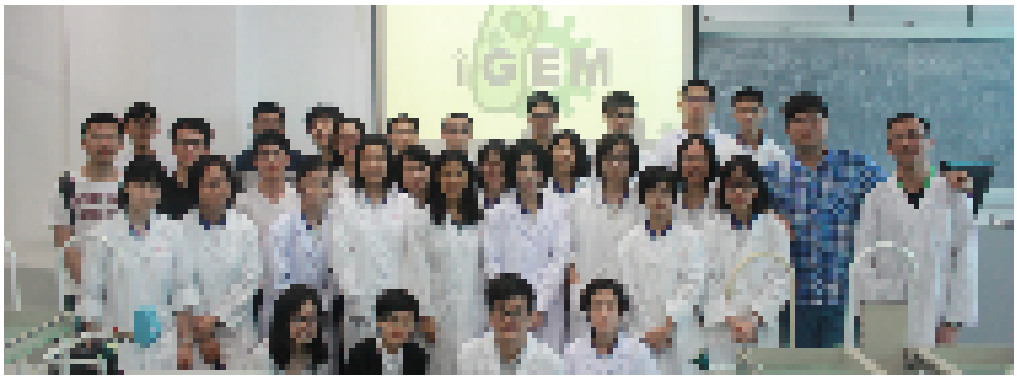
Students fascinatingly observe DNA extracted from bananas.

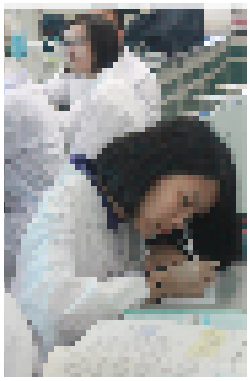
SYSU-MEDICINE

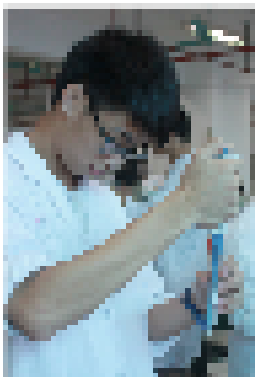
The human practice of our team can be divided into two parts. One is integrated human practice, which is bounded with experiment together, serving the experiment group. The other one is about public education, which is to help the public to know more about our project, synthetic biology and iGEM.



Connecting with the experiment, all the team members had a brainstorm about what we were going to do. Several members of our team were having pharmacology course at that time and knew some traditional anti-inflammatory agents. At the meantime, the instructor of our team experts in Mesenchymal Stem Cells (MSCs), who told us about the anti-inflammatory effects of MSCs. However, during the discussion, we found that both traditional anti-inflammatory agents and existing MSCs have effect on the whole body instead of working just at the inflamed site. Then, an idea come to our mind-modify the MSCs to home to the inflamed site. For HP, the second step was to search all the information about MSCs like ethics, law, safety, etc. To learn more about the background of MSCs, apart from collecting information and literature reading, we had interview

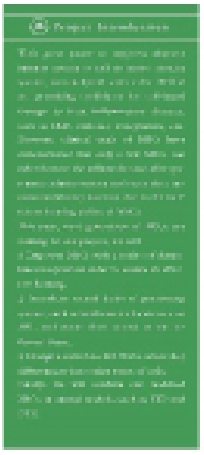


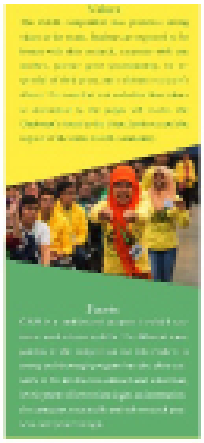




of doctors, patients, companies and legislators. Experiment started at the third step, during which HP group had to confirm whether the experiment is safe, legal and not against the ethics, and moreover, asking for collaboration with other teams. The fourth step—products, is what we are going to do when finishing the experiment.

"Human Practices is the study of how your work affects the world, and how the world affects your work."— Peter Carr, Director of Judging. As what I mentioned above is "how the world affects our work", then the next part is "how we are trying our best to affect the world". For offline activities, for example, "Have a Look at Your Genome". The objective of this activity is to help high school students to know more about synthetic biology.





Additionally, we sent out pamphlets.

Tec-Chihuahua

Our Human Practices team works on an analysis of the implications of Synthetic Biology from the Ethical, Economical and Legal perspectives, with a focus on the Latin-American dimension, for the diffusion of Synthetic Biology in the light of a responsible progress.

We intend to give Synthetic Biology diffusion by contacting local farmers and stakeholders from the agricultural sector, in order to learn about their positions, targeting their main necessities, as well as knowing how would our project be perceived.

Tianjin

We have our own Tweet account and WeChat public platform to inform our recent work to other teams and students. We have made a questionnaire and spread it online and we have received 686 effective results totally. (Turn to appendix file for details).

Tongji_Shanghai

Exhibition in Shanghai technology museum

Our team delivered an exhibition at Shanghai science and technology museum at 8/16/2016 together with three other schools. At the scene we use a computer to broadcast the acknowledgement of synthetic biology and IGEM. Further more, we built our own post to help illustrate what our work is all about to visitors. It is a very interesting experience!

UCAS

For human practices one of our focuses was in students' education.

We delivered a speech to the students from many different high school, aiming to explaining the students what the igem was and the current situation of antibiotics. After our speech we had a communication with them, not only they gained some knowledge about igem and started to concern about the antibiotics but we were inspired by their questions and opinions.

Beside delivering speech, we are also helping the igem lab of Beijing National Day School analyze their data and lending equipment to them.

Another important part of our human practice is talking with different igem team or experts of synthetic biology.

Up to September 2016, we have taken part in conferences with Peking University, Xiamen University, Tianjin University and Beijing Institute of Technology. We also met Mr. James Schroeder, who is a Penn Alumni & Synthetic Biology Advisor, at World Financial Center in Beijing. He has collaborated with leading Synthetic Biology organization SynBERC. Mr. Schroeder discussed the emerging synthetic biology market in China, showing us how works done in labs can serve society and make profits.

UNIK_Copenhagen

CosmoCrops from University of Copenhagen iGEM is a competition within synthetic biology to promote the field of synthetic biology among students and to make synthetic biology more accessible by making it an open source. However, one important part of iGEM is not only the research and the BioBricks, but also the Human Practices. This is the things that go beyond the lab bench (which many of us are stuck at during the summer, where we work on iGEM), such as ethics, information to the public or intellectual property rights (IPR). Explained in other words; we need to think about what societal impact our project can have on the society and for the general public.

In CosmoCrops, we are working with something most people have a hard time relating to - space exploration. However, this does not hinder us in thinking and applying the Human Practices to our project, in fact we do think that Human Practices is one of the most important parts of our project. This is also why we for the first time ever, hosted a Human Practices Workshop in Copenhagen for the teams from SDU, DTU and Gothenburg-Chalmers, to help them see the beauty in Human Practices as well. Our Human Practices consists of ethics, collaborations and lectures/ informative speeches for the public.

Ethics

When doing a science project there is a tendency that scientists forget about the ethics - which that is very important. The importance of ethics cannot be stressed enough because it says something about the project and if it is morally right or wrong. But what is morally right and wrong? This is a subjective decision, because some people think it is okay to do something, while others think it is a wrong decision. In our case, we work with a co-culture we want send to space. However, is it ethical correct to send living organisms into space and use them out there or on settlements on other planets? This

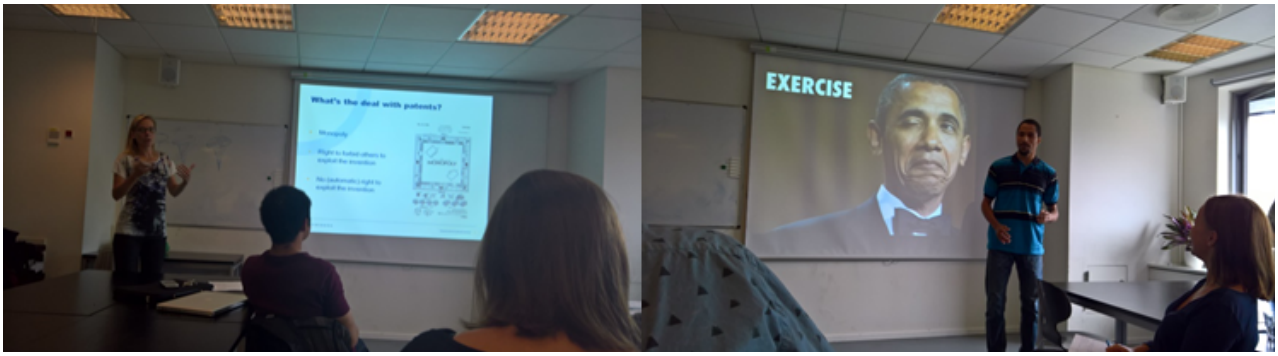


Figure1&2. Pernille Gojkovic from Højberg giving a talk about patents, and Joel from SDU doing a storytelling for the public speaking activity

is just one of many ethical questions we have, and there is no right or wrong answer to it. By sending living organisms to for instance Mars we potential disturb the ecosystem, which can be ethical wrong - the big problem is, what if the living organisms we bring up there by accident is set free? This could potential destroy the whole ecosystem on Mars or the two organisms we bring up there could outcompete all of the already present inhabitants of the planet hereby destroying a whole planet. This is also why it is illegal by law to introduce new organisms to new planets.

Like for every colonization, one of the big ethical and political issues is, who are going to own the place of interest? This has been seen several times during history, and it might be repeated if we begin to colonize Mars or other planets. Should the planet of interest be giving to the first to arrive or should it be divided up so every country that thinks they have a claim of the planet can get a piece of the planet? This might end up in a war - not on Earth but on the planet of interest, and the history will begin to repeat itself again.

Besides the ethical problems regarding space exploration, comes the whole ethics around synthetic biology in general. Are we, as humans, allowed to change living organisms just because we can? You can argue that the nature have had millions of years to evolve and make the best organisms as possible, so if an organisms cannot make a certain compound, it is because the nature does not want that compound to be produce in that organism. As scientists and consequentialists we do not see this as a problem. By engineer Bacillus subtilis to produce bioplastic, we do not only make space exploration cheaper, which can make life on Earth easier as well, but we do also help the environment that already contain too much conventional plastic. This will help to maximize the overall good on the planet. However, we do acknowledge that not all have this point of view - especially not in the public. In Denmark there can be a very skeptical view of synthetic biology. This skeptical arise from different things, but one of the main reasons can be lack of knowledge - the Danish population does not simply know what synthetic biology is, and how it is even possible to combine synthesis with biology. Therefore, we think that it might be needed to give the population a bigger knowledge on synthetic biology and why it can maximize the overall good for the world. One way of doing this is to make public event where we go out and talk about synthetic .biology and our project, so the general public can get an inside to what synthetic biology is, and why it is actually important for the way they are living their life today.

Lectures/Presentations for the public

As mentioned above, one way to give the general a bigger knowledge of synthetic biology is to give public speaking about synthetic biology. This is something we regard as important for the future of both the iGEM teams here.

in Denmark, but also for the scientific community as general. Therefore, we have been out to several Danish media to get them to tell our story about synthetic biology, and how it can be used to help the future generations on Earth. This is for instance videnskab.dk and ing.dk there both is big scientific platforms in Denmark. Furthermore, we have been giving several different talks, for instance for the FantastiCon in Valby, Denmark. FantastiCon is a Sci-fi convention, where science fiction and reality was discussed, and how those might be mixed more and more in the future by persons like us. This was mostly for Science fiction fans that actually think that this topic is interesting, but it also important to come out with the message to younger minds that then might see the how fantastic synthetic biology can be, if it is used correctly. This we will do in the middle of September, where we for four days will give a presentation about our work and synthetic biology for around 500 high schools students. This will help to get the attention of the future generations and might get them interested in synthetic biology, just as we are!

Besides that, we will have presentations at the Planetarium in Copenhagen where all interested in space and space exploration can come by and hear more about our work among other space related things. We will also be found at the European Astrobiology Symposium in Athens, Greece in late September, where we are going to present our project to astrobiologists.

Collaborations

In part 2 of this issue, we mentioned our collaborations and why it is important to have collaborations in iGEM. However, this is also important for the Human Practices, because the collaborations will enable you to get some feedback on your project and what you can make better to make it more feasible for the general public to accept it.

Besides the more scientific collaborations we mentioned in the previously part, we have a close collaboration with the teams from the University of Southern Denmark, Technical University of Denmark and the University of Gothenburg and Chalmers in regard to the Human Practices. From the 19th to the 21st of August we were host for the very first Human Practices Workshop in Copenhagen, where the above teams participated. During this workshop the teams went through ethics and why it is important for synthetic biology, intellectual property rights and how they can be used to make your project into a start-up and what should draw your attention when talking patent and patentability. We also went through public speaking and how a good presentation should look like, and how it should be presented. This workshop gave some ideas in regard to Human Practices to all the teams that participated and how to think when thinking about Human Practices. The workshop ended with a presentation by Ana Sifuentes from the iGEM Headquarters who talked about Human Practices and why it is

important for synthetic biologists and iGEM.

Conclusion

In conclusion, we have considered the ethics as a big part of our project and the Human Practices. However, during the workshop we were made aware of the patents and the patent landscape which we also need to consider. A short look into this by using a few keywords of our project showed that there is a lot of patents within the scope of our research. This means we need to consider to either change the project if we want to make it into a start-up, because we cannot use already patented inventions or ti buy licenses from the patent holders, which might be an expensive affair. Including the ethics, this is something we need to consider during the last two month of the iGEM competition and how we can apply it our project.

www.facebook.com/CosmoCrops

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http://2016.igem.org/Team:UNIK_Copenhagen

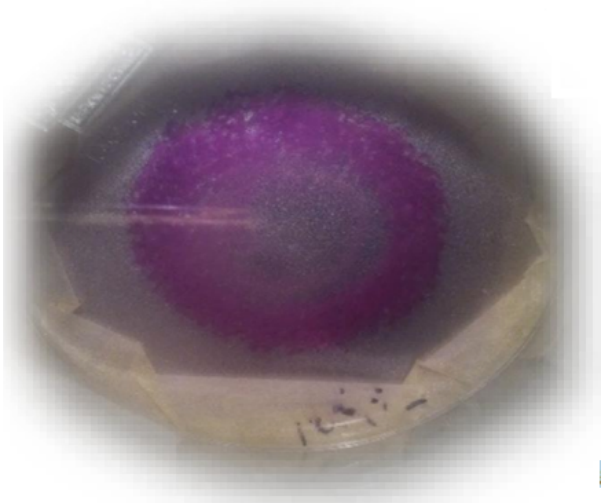
Figure3. The teams from DTU, SDU, Gothenburg-Chalmers and KU eating dinner after the first day of the Human Practices Workshop.

UPO-Sevilla

Through the human practices we want to show people that we have an important project that can improve problems in the environmental field, and produce some advances in industrial production. We are aware that those goals are not enough. Therefore, if we want to ours become a great project, we have to believe in our team and effort. We believe that science should be closer and more interactive and for this we have participated in science fairs and exhibited in several schools. Interacting with young students has been a unique experience for us, and has made us better communicators and better people. In science the only goal should be to make the world a better place. This is the compromise that all of Spain iGEM teams have decided to become real, and so we work together for the same purpose.

Science Week, Universidad Pablo de Olavide

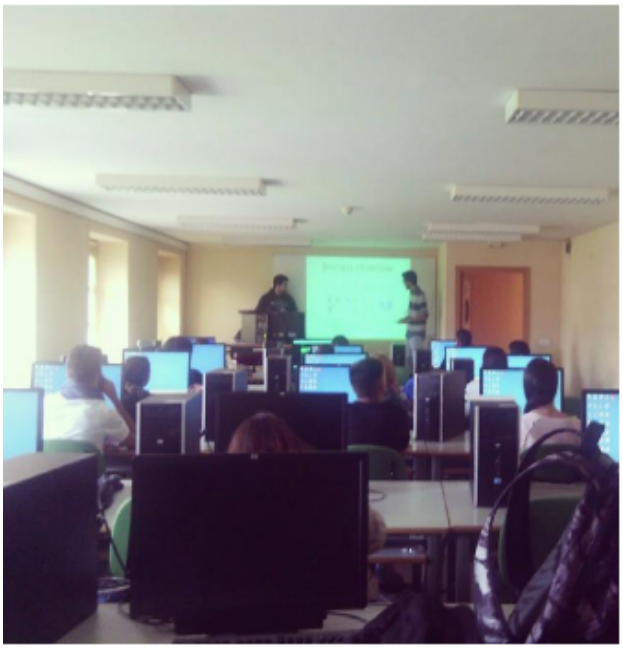
This was our first contact with teenagers that wanted to learn a bit more of "real science". It was funny to explain them what synthetic biology was, and how did it work. They seemed fascinated about this, and they were bewildered when we explained them how our project was going to develop. We also showed them a software developed by a team from Paris, in which they had to read some text and give answers. They all told us that it has been a good experience, so we were extremely happy!



Lab practices with students form IES Martínez Montañés

At the beginning of the summer, some students of this high school came to the university to do some practices with us. We prepared a practices lab and we show them how to do an electrophoresis gel or a digestion. They were all fascinated to be able to perform some real experiments, that otherwise they had only seen in text books. Some of them decided that wanted to study a biotechnology or biology degree, what made us feel very

proud.
During those days, we also learned lots of things, as it usually happens when you are the one that has to give the information to others. In summary, it was instructive and fun!

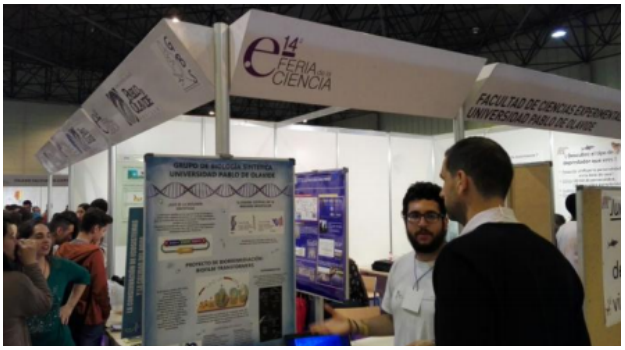


Science fair

The 14th Science Fair celebrated at the Exhibition and Conference palace at Seville on 5, 6 and 7 May 2016. This

year the theme was climate change and environmental pollution. Because of that we decidedthat our project fit perfectly in this edition, and had our own stand in which we could talk about the project. During the fair we made contact with people from very different fields, from teachers of different Spanish and foreign universities to children of primary

school. It was a great experience to show our project, and to answer the questions of all the people that wanted to ask. For children we were able to turn our project into an interactive game, and for young students our idea was inspiring for their future, as themselves told us. As we were also explaining how synthetic biology works, people instructed in some technical careers could also understand us.



Meeting of IGEM groups of Spain

On August 18 we traveled to a meeting
with other Spanish iGEM teams to the city of Valencia. Throughout the weekend the 3 groups (UPO-Sevilla, Barcelona and Valencia) discussed constructively on different projects and applications and contributions to science. It was a wonderful way to collaborate and help each other. All projects were very applauded and congratulated by the others. We are really delighted and integrated when interacting with the different disciplines that make up the total of equipment, from biotechnologists and biomedical or computer, to a journalist.
Thanks to this meeting different teams have created good friends who made us now a great family that helps each other.

UrbanTundra_Edmonton

Our team takes special precaution when working at the University. All of our team members diligently wear lab coats, latex gloves and closed toed shoes when working in the lab.

Valencia_UPV

One of our basic needs as living beings is nutrition. However, it is a luxury good in many areas around the world. Countries in development are regions in need of basic food resources because of its lack of access to developed technologies. Nevertheless, people in countries that are classified as first world suffer similar situations every day. World population is going to increase exponentially the next years, but natural resources won't be enough for provide minimal calorie necessities to each person. For that reason, providing staple food to everyone has become one of the main social problems to solve in this century.

There are several problems related with this issue. First, food is lopsided distributed. There are areas without enough provisions to supply necessary nutritional intake to less than half of its population while others waste several tons of edible food. Also, available food often does not provide the correct amount and proportion of nutrients. Second, there are several problems with food expiration date. For example, fast ripening after fruit harvest avoids a correct distribution and remote areas are not able to consume them.

Scientific research has the possibility of solve these kind of social problems by managing their biological and engineering tools. However, different barriers limit the expansion of scientific advances and the possibilities of take advantage of them to solve basic social challenges. Some of those barriers are related to social opinion about new technological progresses, caused mainly by misinformation. Additionally, basic laboratory tools are too expensive for average users, so most of them usually struggle to obtain enough funds to start a seedbed or to buy new

equipment.

Bearing that in mind, we want to develop our project, HYPE-IT, to knock down those barriers that avoid scientific advances to arrive to those who have actual problems. Farmers need new plant varieties to have more efficient crops, as well as products with enhanced properties. Consumers need new plant varieties that arrive to the market, with better flavor, less expensive and more durable. The world needs plant improvement to cope with the increasing demand of food amount and quality.

However, the obtaining of a new plant variety is expensive, and requires a long time, usually around 10 to 15 years. The population increases 1 billion each 12 years. The time to obtain any new variety is unacceptable if we take in account these figures. Our team aims to offer an affordable technology that allows plant breeders obtaining desired enhanced crops by blocking gene routes, making the editing faster and more efficient. New plant varieties could be obtained in 1 or 2 years. If every local plant breeder improved its local varieties, a new green revolution would help the world to overcome one of the biggest problems of the century.

Vilnius-Lithuania

As a part of iGEM initiative, we are very dedicated to the outreach activities. One of the greatest achievements in this area is the foundation of Synthetic Biology Organization in Lithuania. The organization is aiming at spreading the knowledge of life sciences to the public. To this day we have visited a large number of schools where we introduced the possibilities of synthetic biology and gene engineering to the students and launched an art competition. Adding to that, this summer, a high school student has been practicing life science research in our laboratory.

Also, we have launched a cycle of lectures called Café Synthetique, during which we hosted different professors and specialists in the fields of our interest to discuss the most intriguing science-related topics of the society in one of the city's coffee shops. We have also appeared on the news pages and participated in several Facebook and Youtube live translations. In autumn, we are planning to launch even more outreach activities, such as bio-breakroom, bio-art exhibition and a quiz.

We are also keeping in touch with the Lithuanian PKU association – we have attended several meetings, interviewed the patients and participated in several workshops.

Washington

For years scientists have been observing the Violacein Pathway. Originating from the Amazon and marine protozoa, the pathway produces violet pigments (Violacein) in common bacteria. Today, this pathway is produced in laboratories to dye textiles and is studied for its medicinal properties. Violacein is unique as it is both antibacterial and tumoricidal, and thus at the frontier of cancer research. Despite numerous studies, little is known about the capabilities of Violacein and its full effect on protozoa and eukaryotic cells.

Our diagnostic culture imaging system will increase efficiency of those studying the Violacein pathway and other pathways with colored signals. An analysis of the RGB value will improve accuracy and precision in measuring the amount of Violacein, Prodeoxyviolacein, Proviolacein and Deoxyviolacein present in a culture. Our project will also add to the current information on violacein and eukaryotic organisms as we are using yeast cultures.

L-tryptophan, the first step in the Violacein pathway, is an amino acid which increases serotonin in the brain and also functions as an antidepressant. High doses can lead to chronic muscle pain and cognitive deficiencies. Violacein's effect in eukaryotic cells on the molecular level is also still unknown. Therefore, additional testing should be conducted before humans receive high exposure. It is also imperative to wear personal protective barriers between the cultures and human skin.

What is the effect of the release of this waste into systems?

A major concern is the waste that is generated from an increased production in Violacein. Fifteen percent of healthcare waste produced annually is biohazardous waste. Like most non-sharp biohazardous waste, the end result of the Violacein Pathway will be incinerated or autoclaved.

While the waste produced from the cultures will be a fraction of the global output, it is necessary to preserve limited resources. By measuring cultures with our diagnostic technology, scientists will incur fewer errors from solely human observation, resulting in the production of less biohazardous waste. Often in the lab trials are repeated due to calculation errors or imprecise readings. Our computer simulation will also improve accuracy and reduce the time in the lab analyzing the cultures or repeating trials. With the information stored online, sharing data will be more feasible and thus promote a global education and awareness of the Violacein Pathway.

Further questions to explore:

Is this commercially feasible?

This system will be able to be downloaded onto computers for easy access. Licenses have the potential to be sold online or instore. By selling our product online, we would increase the overall net profit as less money is spent on the assets required to manufacture the software.

What is the effect of an increased electrical output? Can the screen be dimmed when not in use?

Laboratories consume on average between thirty and one hundred kilowatt hours of electricity per square foot. However, if our system averages 100 kW of power for one hour, it will only consume 0.1 kWh per day. Taking into consideration the other devices used in synthetic biology labs, our diagnostic technology is an energy efficient option. It is also important to consider the amount of resources used to create the cultures, such as electricity for the laboratory, microwave, and other devices necessary to produce L-tryptophan. If our system reduces the need for repeated trials, our system is the most cost effective and eco-friendly approach.

How much would it cost to produce?

Not only is our system orders of magnitude cheaper than most commercial bioreactors, taking into account it may cost $0.10 per kWh, it would cost the laboratory $3.65 annually. Considering most lab equipment and electrical bills, this is not only energy efficient but a cost effective solution to repeating trials.

Would this take the position of workers in the lab?

This would not affect the labor required in the lab, but would potentially save time for each worker. Fewer trials would be repeated, but not to the extent that someone would be laid-off. This is assuming that the initial analysis of cultures is mostly accurate.

Westminster_UoW

We were also delighted to host the UK meet up for two years in a row. The #iGEMUKmeetup2016 consisted of a 2 day conference-like event; where there were talks delivered by academics: Professor Jane Lewis (University of Westminster), Dr Anatoliy Markiv (University of Westminster), Dr Robert Smiths (King's College London), Dr Tom Ellis (Imperial College London) and Dr Vitor Pinheiro (UCL/Birkbeck). 100 students from 18 UK universities attended this event with the aim to practice their presentation skills before going to the Giant Jamboree (Boston, USA) in October. Each team had 15 minutes to present their project and their report their current progress, each team also had an extra 5 minutes for Q&A. During the Q&A section, other teams raised interesting points about their project, giving constructive feedback and suggesting new ideas – making room for the teams to improve. The teams were provided with tea, coffee, biscuits, sandwiches, crisps, pizza and soft drinks throughout the conference with no cost. Furthermore, the event also offered a pub crawl around London's iconic places as a social event where the teams could socialise.

XMU-China

We conducted online and offline billingual surveys regarding to the understanding and usage of antibiotics. In order to get a deep understanding of people's thoughts, we did some interviews and during the interview, we showed them the approprite usage of antibiotics. Moreover, through interviews with experts, we got a lot of expertise. We went to undeveloped rural areas to distribute leaflets about detriments of antibiotics abuse. Taking the opportunity of the start of the a new term, we showed the freshmen brochures concerning synthetic biology, our project and iGEM competition. The opinions of project-related issues on ethics, social justice and intellectual property were also spread to them. We visited primary schools and taught children the proper usage of antibiotics in vivid methods.

We did many efficient commucations with other teams. Not only on the Internet but also by holding conference in universities. Some of us attended the Synbiobeta conference and learned a lot of knowledge about synthetic biology.

Newsletter which is an electronic journal as an information exchange platform is a shining point. We have founded it since 2014 and it do help many teams with collaberation.

PART 3
COLLABORATION

Aachen

We are definitely interested in scientific collaborations linked to proteases, proteins or other parts of our project.

Moreover we are in general also interested in collaborations regarding the Human and Practice Track.

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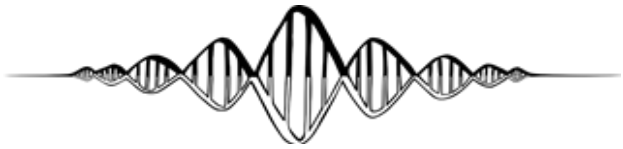
Aalto-Helsinki

One of the judging criterions in iGEM is to do collaboration with other teams. It is a great opportunity to communicate with and learn from different teams all over the world, but how do you find teams with similar visions regarding collaboration? Since in our experience iGEM currently lacks an easy collaboration platform, we at Aalto-Helsinki decided to step up and make one!

We are introducing CollabSeeker, a search engine where you can find all of this year's projects with different keywords. Your team can also login with your team's facebook or twitter account and edit your own team page in order to tell others what kind of collaboration you are looking for, and also to provide the page with additional contact information, something that has till now been quite hard to find. You can find more detailed information about the CollabSeeker and how to use it from our blog, which has step by step directions on how to use the platform. The blogpost about CollabSeeker: https://tmblr.co/ZT7snk2AlllKB.



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BIT

In the last year we had collaborated with USTC because we faced the same difficulties in experiment, modeling and hardware.

This year our team choose the DIAGNOSTICS as our prime track and we are still looking forward for collaboration with any team who are interested in diagnostics, detection, model, hardware and software.

If anyone else would like to collaborate with our team we will be pleased to hear from you. If yours project is similar with us and want to discuss the problems, please do not hesitate to tell us! We are waiting for your connection.

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Edinburgh_UG

Newcastle iGEM

We are collaborating over a simulation game designed to help people consider the ethics of both our projects. Additionally we will create DNA 'labels' for Newcastle's biocircuits and they will be checking our BabbleBricks for Biobrick compatibility.

Dundee iGEM

Cohosting a debate on GMO policy in Scotland between our respective university debating societies.

National Library of Scotland

We will be encoding Mary Queen of Scot's historic final letter before her execution into DNA format for the libraries archive.

Finally, we are always looking for new collaborators and suggestions on how to improve our project. In particular we are creating

Biobricks for Dps to provide resistance to DNA damage from radiation and would love to hear from any teams interested in utilising this.

@EdiGEM2016

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Freiburg

We are working with Bacillus subtilis and GFP nanobodies. So if you have any thoughts concerning those two components we are happy to collaborate. Also if you need any advice, we are eager to help you!

igemfreiburg2016

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Hannover

We are looking for other teams to collaborate with. Sharing ideas, knowledge, tips or even working together on part of the project would be great. If you are working with TALE proteins, CRISPR/Cas9 or you think that our project might help your research, don't hesitate to contact us.

Team TALe bots

igem_hannover

iGEMTeamHannover

info@igem.uni-hannover.de

Imperial

In conjunction with our circuit, we are developing a software to facilitate the design and optimization of co-cultures.

Our software will allow researchers and future iGEM teams to conveniently access co-culture protocols for the best practices in their own experiments. The software will provide information on appropriate pH, temperature, and inoculation ratios among other data. We will be verifying the information in our software through our own experiments, models, and collaborations with other iGEM teams who are utilizing co-cultures for their own projects.

Please contact our team if you would like to collaborate. We are specifically looking for teams who are growing different cells in co-culture. However, we are open to other suggestions for collaboration.

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Jilin_China

To simulate the interaction between normal cells, tumor cells and our engineering Bifidobacterium, we have adapted a model based on classic predator-prey model. We hope that this mathematical model can fit the in vitro experimental data well. Therefore we need an ingenious design of vitro experiment that can mimic the environment in vivo. Since there are both normal and hypoxic areas in the body of tumor-bearing mice, this vitro experiment must have both normal area and hypoxic area. In this situation, we will know whether our Bifidobacterium can migrate from normal area to hypoxic area or not.

In addition, this hypoxic area needs to be similar to the environment in solid tumor, which will help us to evaluate the ability of our Bifidobacterium to kill tumor cells in vivo. If you have any suggestions or comments about the design of our experiments, please do not hesitant to contact us through any of the approaches below.

Jilin_China
2016

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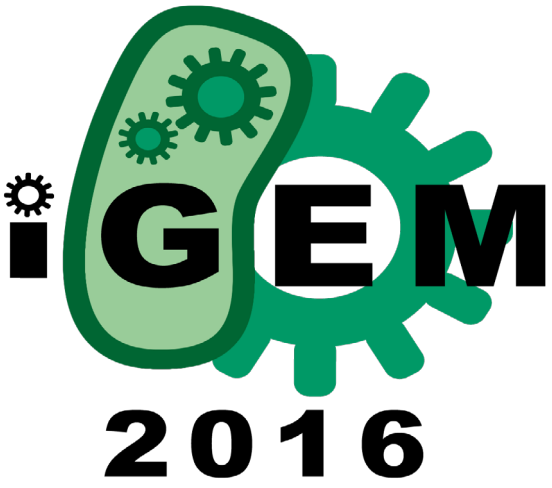
NCTU_Formosa

To help the teams achieve their project, we give the iGEM distribution kits to Mingdao, NCKU_Tainan, and NTHU_Taiwan iGEM teams. Besides, our team and Mingdao also exchanged both our biobricks to test each other.

Furthermore, we helped our partner, Aachen iGEM, to promote their survey in Taiwan area. And now we are focusing on one special idea for a Human and practice collaboration with Aachen, Israel, and Mexico iGEM teams. And we also helped Evry and Hannover to promote their surveys, too.

And Thanks for NYMU iGEM team provided us the Lepidoptera eggs. For our insect test, we needed lots of larvae to do experience. Additionally, they introduce the Pro. Hwang, who majors in agricultural science, and gave us many advises in our insect test. All in all, we thank for them lots.



NCTU_Formosa-IGEM-team
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Peking

Meet up

In August, we invited three other iGEM teams to attend the meetup in the College of Life Sciences of Peking University, where we met and exchanged ideas with members from Tianjin, BIT-China and UCAS.

We introduced our projects and built up mutual facilitation among teams. As one of the first teams of China to attend iGEM, Peking take the responsibility for guiding and helping other first-time contestants, UCAS for example.

Additionally, we suggested the members of Tianjin to use Golden Gate Assembly methods by considering their problem of low efficiency of assembling.

Visit

In the end of July, we visited the iGEM team BIT(Beijing Institute of Technology)-China. We shared our project design and gained some feedback which might promote us. Zhang Yihao, our instructor, shared with them his iGEM experience and insight to synthetic biology.
The process of BIT-China was limited because the result of RFP expression and asked us for help. By consulting literature and doing experiment, we suggested them to wait for a period to make the color displaying complete or have the protein exposed under UV light.

Support

We assisted several iGEM teams of China by offering them plasmids and other experimental materials.
For instance, our team assisted Jilin-China with Interlab Measurement Study by sending them the plasmid J23117+I13504.

In addition, we mentored a high-school team: BHU(Beijing High School Union) from July to October. We supported them not only the guidance of fundamental molecular laboratory operating but the experimental materials such as expression vector pET28a and corresponding primers, as well as all enzymes and laboratory equipment.


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Pretoria_UP

We have been in contact with the Aix-Marseille and Egypt teams and hope to possibly collaborate with them and contribute to their respective projects in a valuable way.

We are also looking for other teams we can collaborate with for our project. the teams can either contribute towards our project as a whole or the human practices part of the project.

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SYSU-MEDICINE

KERWORDS about our project:

- Mesenchymal Stem Cell (MSC), tem cell
- Chemokine receptor
- Fluorescence protein: luciferase, dTomato, eGFP, eBFP
- α-SMA and its promoter
- Apoptotic gene of MSCs
- IBD and DTH animal model
- Mathematic modeling
- Gateway, single point mutation and other experimental skills etc.

If your project has any connection with these key words, or you just want to know more about us, do not hesitate to contact us.

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SYSU_MEDICINE

Tianjin

The aim of iGEM competition is not only encourage students all over the world to accomplish a project in synthetic biology, but also spread the idea of synthetic biology to more people. Therefore, we never neglect the Human Practice part of our project. We have helped the Tianjin University of Science and Technology to establish their own iGEM team, two students from there have studied with us for a whole month. Team Tianjin, BIT, BIT-China, Jilin_China, and CGU_Taiwan have set up a league and we can easily communicate our project and seek for help from each other.

Apart from these teams, we also seek for collaboration everywhere. For instance, we help the HFUT-China to test their software. We have communicated with other university and asked for bacterial or plasmids we need. We will go to the Dagang No.1 middle school in Tianjin next month to give a speech about synthetic biology and help them establish their own iGEM team. We also collaborate with some famous corporation for financial support for our experiments, competition and travel. We also conduct our human practice online.

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UNIK_Copenhagen

At CosmoCrops we are really eager to get to know so many people as possible, and therefore we would like to hear from so many different iGEM teams as possible! Collaboration is an important part of iGEM, because it is not only a competition but it is a place to meet new people and share knowledge within the field synthetic biology. Also, it is a possible to have fun with people you otherwise will not have met - therefore, we love having Skype meetings with people all around the globe.

The Skype meeting with the iGEM team from Leiden, the Netherlands seen from the point of view of Leiden.

We already have several different collaborations going, but could always use some more! We are working closely with the Leiden iGEM team, because we both work with space exploration. We are doing some low pressure and high UV experiments on their Escherichia coli strain and in return they test the viability of our B. subtilis and S. elongatus in microgravity.

In the collaboration we have going on with the Imperial iGEM team, we are providing them with some data on how our organisms are growing in our co-culture under certain growth conditions. They are using those data to make a model on how different organisms are working together and when it is best to grow them together and how the amount of one does not out-growth the other organism. They will then do some modelling work for us, because we do not have time to do the modelling on how much sucrose our S. elongatus is secreting.

Our first Skype meeting with the iGEM team from Imperial College London.

The last collaboration we already have going on is with the iGEM team from Istanbul, Turkey. We have a monthly skype meeting where we discuss the progress of the projects, and if we have any problems we talk about them and try to solve them together with our combined knowledge. And here we have not mentioned the two other teams from Denmark that always will be there to help if something happens or we have any questions, and the same goes the other way around.

We are looking for all kind of collaborations - this could be sharing of data, helping each other with making experiments or just monthly Skype meetings to discuss how the project is going. In short, we are working with co-cultures, Bacillus subtilis, Synechococcus elongatus and space explorations.

Group picture of the teams that participated in the Danish Meet-up at the Technical University of Denmark.

cosmo crops

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CosmoCrops

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UrbanTundra_Edmonton

If you want to find ideal partners, do not hesitate to tell everyone! We would love to collaborate with other iGEM teams on a local and global scale.

Yielding the technology we have today, our most efficient way of collaboration is through face-to-face video conferences. By getting to know other iGEM teams, we not only have an insight of each other's projects- but each other's ways of life outside the lab. A video call with Urban Tundra Edmonton generally entails getting to know project details, protocols, and backstories, as well as cultural customs and personal quirks.

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UCAS

As for collaboration, we provided the gene of toxin CcdB for ShanghaiTech University. They are also working on toxin genes as we are doing and we are glad to share what we have. We are also participating in this year's CCiC held at SYSU in September. As one of the biggest events in China, we are looking forward to meeting iGEMers from all over the country. We are having some problems with modeling, and we would be grateful if other team could help us with this.

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Vilnius-Lithuania

If you want to find ideal partners, do not hesitate to tell everyone!We would gladly appreciate any help regarding probiotics and metabolic diseases whilst we too are capable of providing any help in this field.

Also, since our project includes the creation of an artificial aptamer, we are seeking help in computer modeling of the aptamer. We have found software written by Heidelberg iGEM 2015 team (MAWS and JAWS); however we did not succeed in launching it.

Since our life sciences research centre brings together specialists from various fields, we can be of any use to other iGEM teams. What is more, we have a strong CRISPR/Cas research background, especially with prof. dr. Virginijus Siksnys as our PI, so we can offer help to the teams working with this system. Do not hesitate to contact us if you want to discuss collaboration opportunities.

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Valencia_UPV

Our team is one of the few working with plants as chassis. We always wish to make contact with other plant teams to exchange experiences and ideas. We would like to make a call to these teams, so we can establish a solid collaboration that will benefit both parts.

The objective of our collaboration is firstly to test our gRNA testing system with other teams. We have designed it in a way that it can be standard for plants, and the only way to be sure about this is that other teams around the world try it in their labs.

We are open to help other teams in anything they need, from testing their models to try their parts in a different chassis. If some team is working improving the accessibility of synthetic biology technologies, we could make together a solid study for human practices, taking in consideration the general variables that affect this issue.

HYPE IT
Hack Your Plants Editing

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XMU-China

Need your help

We need this enzyme which can destroy the biofilm. Previous study showed that the combination of triclosan and DspB effectively inhibited the formation of biofilms on both the internal and external surfaces of urinary catheters . BBa_K1659200 may be a useful part but we can not get it. If you have any advice, please help us.

An interesting web game regarding to reducing antibiotics abuse is requested to educate children. We would like to upload it to a public gaming site. If you can make it, please contact us.

What we can do

We are making the Newsletter on which different teams can exchange their ideas and introduce their project. We issued 7 edition last year and it did help many teams with their projects. Would you like to join in this year? Please give us your email address if you are interested in it, and then we will send you an email for more details. Our email address is igemxmu@gmail.com and please notice that the deadline is 21st August.

We have skillful and kind team members who come from College of Chemistry and Chemical engineering, College of Materials, School of public health, School of life sciences, Medical College, College of energy and School of pharmaceutical Sciences. Any collaborations such as software testing and survey translating are welcome and do not hesitate to contact us.

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PART 4 DISCUSSION

BIT

Our chassis organism is E. coli (Trans 5 alpha Chemically Competent Cell and Trans1-T1 Phage Resistant Chemically Competent Cell). We have several preventive measures for potential risks:

- Wearing rubber gloves.
- Handling bacteria experiments with alcohol burner.
- Sterilizing bacteria by using 84 disinfectants.
- Using specific sewer to deal with bacteria waste. As for the product in real world, the bacterium will be made into dry powder by the method of freeze-drying. And the powder will apply to the chamber of micro-fluidic chip. When users need to detect certain disease, users can add their blood sample into the chip and insert chip into the hardware we designed so that results will be simply shown.

Edinburgh_UG

To enable BabblED to be as widely used as possible we have had to consider a number of important legal and safety points. Firstly due to the restrictions surrounding the use of GMOs outside of a laboratory we made the decision early on that our system should be cell free with our DNA messages instead being stored in solution. This means that we can send or store our BabbleBlocks without concerns over breaking these strict regulations. Additionally to combat the eventuality where one of our encodings needs to be used in an organism, for example in labelling a construct, we've added a 17bp stop codon region into every BabbleBlock to prevent the creation of any unexpected or potentially dangerous proteins.

Peking

Our team aims to construct a biological material to absorb uranyl ion. As a result, uranyl ion is an indispensable part of our experiments, which may pose potential threats to lab safety. To alleviate the problem, all the experiments about uranium are carried out in a qualified Radiation Laboratory in Peking University. To assure the health of our members, we measured radioactivity in different positions of the laboratory. The data obtained proved that the radioactivity in every corner of the working area was close to the background value measured in grassy playground.

Consequently, we can affirm that our members are doing experiments in a safe environment.

Furthermore, in the laboratory with potential radioactivity, all the students would be well-equipped with special protective garments, lead protective aprons, respirators, gloves and caps.

Pretoria-UP

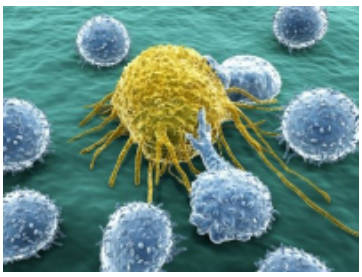
We hope to get conversations going and provide a platform where synthetic biology and its applications will be discussed. Such discussions will be around how synthetic biology can be applied to other fields such as energy, engineering, environment, health, medicine, food and nutrition in South Africa. People can also use these discussions to voice out their opinions and concerns regarding this. Experts in the field will also have a chance to share their opinions and answer any questions that people might have. We hope this will bridge the communication gap between the scientific community and the public in addition to the education and awareness parts. These discussions will form part of our human practices.

Tel-Hai

- Ethics and Genetic Engineering- friends or enemies?
- For years this debate has been a heated one and has attracted scientists, religious figures, social scientists and more.
- From the religious perspective- how dare us play God and interfere with the divine work. On the other hand, if we can help save lives, could it be an exception?
- From the scientist perspective- if we have the technology and ability, why not essentially?
- From the social scientist perspective- At what expense will this all come? Does using embryos mean denying the birth of a potential baby in the future? Are we researching in the safest and most responsible way possible?
- Does beginning genetic engineering necessarily mean we will begin creating "designer babies" or will we know when to stop, so as to utilize technology only for necessities and life- saving instances?

Tongji_Shanghai

What is cancer? For many years people considered it a terrible word to be heard. Meanwhile, if we see at the angle of the *homo* sapiens, we may understand that cancer is the weapon to promote evolution. There are typically two reasons to trigger cancer, one of which is defective gene before birth, the other is bad living environment causing the expression of cancer gene or inhibit of cancer inhibitor gene. Never the less, both triggering factor can lead to one consequence, which is defective gene passing on. In order to prevent that, cancer is developed in our body to destroy an individual from passing his gene. As most of the immune system can't avoid sacrificing, if we consider cancer a kind of eternal immune system, it sacrifices single body to protect the human gene, and in the end leads to better and healthier human.



UrbanTundra-Edmonton

In this part, we discuss something about safety, health, ethic, etc.

Regarding the ethics and safety of our work, remediation of Martian soil does not directly violate human nor animal life. However, the mission to provide sustainability of life on Mars brings up controversial discussion as to whether it is ethical to create a manmade habitat on a different planet. Due to the exponential growth of the human population, Earth and its resources are becoming less sustainable. In order to protect life as it is, we must think outside the box quite literally and figure out how to sustain fundamental elements, starting with oxygen.

Valencia-UPV

Nowadays, food and nutrition are considered as necessary goods. Food production should be increased in order to satisfy all the nutritional needs in developing countries. In order to improve the production of the basic crops, transgenics play an essential role.

Transgenic plants are obtained when DNA of a specific plant variety is genetically modified by introducing genes from another species, which confer new traits to the variety. These traits could have an important agronomic interest. Transgenic plants could have significant benefits. For example, herbicide resistant plants allow the farmer to improve yield production, avoiding the direct damage to its crop with the herbicide. Other example is modified plants that can be resistant to bacteria that introduce toxins into the genome of the plant, producing lethal effects. This modified plant includes a foreign gene that blocks the bacterial toxin.

However, the advantages of transgenics go beyond this. Plants can be modified to introduce nutritional benefits such as vitamins or hormones. With this application, nutritional deficiencies may extinguish in the whole world. Furthermore, therapeutic proteins produced in transgenic plants are used in many treatments. Antibodies against hepatitis B and vaccines against infectious diseases are examples of how transgenic plants are necessary.

Nevertheless, some people think that transgenic crops could cause allergies. They also believe that they are no natural, and hence transgenic crops must be rejected. In general, people do not like eating food in which foreign DNA has been inserted. Moreover, people think that transgenic crops may damage the natural environment and themselves, so they prefer not to consume them.

Enhanced production of crops through transgenesis could end with all the nutritional and health problems around the world. However, public opinion plays an important role in the future of the transgenics and this is not very optimistic.

For this reason, in this project we consider that the genome editing technique CRISPR/Cas9 is an alternative to obtain new crop varieties. With this method, the mutations that allow the obtaining of new traits are known. These crops are more probably to be socially accepted because the genetic researchers do not "play God"crossing genes of different species. Moreover, there are not any risks to the environment or even to the consumers. It is the same plant variety with a specific modification in the genome which allows us to

obtain a new and interesting phenotype. The same mutation could have been obtained through the more common and traditional technique of random mutagenesis. CRISPR/Cas9 technique is a faster and simpler method compared to random mutagenesis, and can be used in an easy way by anyone when comparing to transgenesis. We hope that more countries, and particularly the European Union, will recognize the benefits of gene editing and will approve its usage as plant breeding technique, not stopping this time the revolution that brings scientific innovation in the synthetic biology field.

Vilnius-Lithuania

In this part, we discuss something about safety, health, ethic, etc.

Due to the fact that the project is aiming at producing a probiotic, it was very important to consider the opinion of the society of this kind of medication. The outreach activities showed that a lot of people lack basic knowledge of what probiotics are. Also, the fact that probiotic would be a genetically modified bacteria disseminated skepticism and insecurity in whether it would be safe to consume such product. We had to do a lot of research on the available data on this subject to ensure that our engineered bacteria will not have any negative effect as on the patient, as on the environment. At the same time, we feel the urge to educate other people on this topic and we are fulfilling this desire during our outreach events.

Washington

In this part, we discuss something about safety, health, ethic, etc

Education:

Our iGem team not only focuses on the work of students at the University of Washington, but we aim to inspire the next generation of bioengineers through community outreach. The team has traveled to venues across the Puget Sound region to share our love of research and synthetic biology with kids K-12. Interactive demos such as a strawberry DNA extraction [left] provide kids and parents an opportunity to ask questions about biology and our team's research.

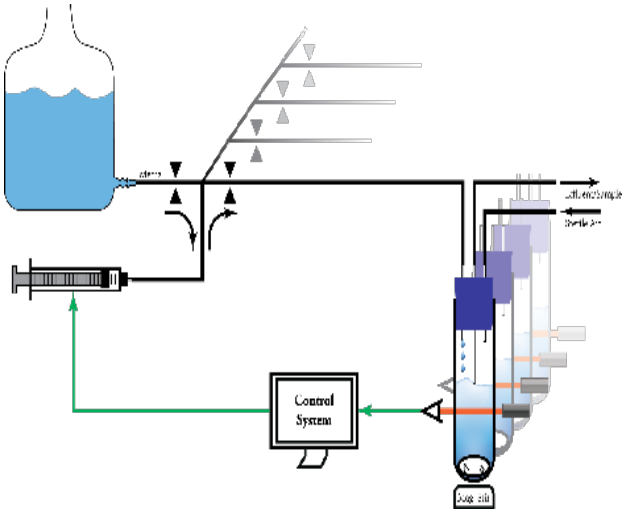
Our booth at Engineering Discovery Days at the University of Washington

Want to extract Strawberry DNA in your community?
Search this link: http://uwigem.org/post/127224577381/cool-outreach-ideas-for-igem

Open Source Science:

The iGEM registry is evidence of the open-source nature of iGEM. However, there are many other ways iGEM teams are contributing and benefiting from open-source science.

In our project we benefited from open-source access to the design of a mixture controlled turbidostat created by the Klavins lab at the University of Washington. We used the turbidostat's wiki to help build our image analysis system, a significant part of our project. This is an example of how important access is to our team and to other iGEM teams. We plan to use the wiki to share our image analysis system and research for others to use and benefit from like we did.



Basic design and operation of the Klavin's lab turbidostat

XMU-China

Safety and security

In 1928, Alexander Fleming found the first antibiotic, penicillin, which led us to a new epoch of fighting against bacteria. However, the antibiotics bring great convenience as well as antibiotic-resistance to us. Sensitive strains which are killed because of long-term using of antibiotics are replaced by drug-resistance bacteria which survive. According to the First global report on antimicrobial resistance released by the WHO [(1)], antibiotic resistance is not prediction any more and we have entered post-antibiotic era. Antibiotic resistance has affected our daily life greatly.

The generation of antibiotic resistance is the inevitable consequence of natural evolution, while the human intervention accelerates the pace of this process. In terms of animal husbandry and aquaculture, a serial problems, including the low education level of the practitioner, cause the overuse of antibiotics. Beta-lactams, aminoglycosides, macrolides and lincosamides are major antibiotics used. What is more, the antibiotic resistance can spread with the market circulation, and finally harms the stability of this industry. If the hidden danger once breaks out, it will be a humorous disaster.

The National report on bacterial drug resistance surveillance in 2015[(2)] showed that 2,400,786 drug-resistance bacteria were detected in 1,143 hospitals. The detection rate of Methicillin-resistant Staphylococcus aureus(MRSA) whose fatality rate is 64% higher than normal Staphylococcus aureus, has reached 35.8%. The drug resistance will lead to a higher fatality rate of pathogens, threatening the cure rate of patients. The danger of some normal disease could increase highly, which could also make some clinical treatment invalid. At the same time, the increasement of medical industry risk could be against with medical industry and social stability.

Ethics

Some kind of medical injuries are unavoidable, but the intentional injuries are illegal and violate the ethical principles. The ethical principle "No Harm" means that the physician should not intentionally harm the patient, the patient should not deliberately injure himself either. Both of them would be violated by the overuse of antibiotics. In medical treatments about antibiotics, physicians are obliged to act more logically and perform the right of intervening in the treatments when necessary.

The lack of internationally accepted principles of antibiotics usage in the food industry lead to a inadequate

supervision system in this field. WHO, FAO and OIE should established a food processing monitoring platform.

Human society and bacteria world are in balance. The dosage and usage of antibiotics regulate the balance to some extent. If antibiotics are used properly, disease infected by bacteria can be controlled by mankind. So antibiotics have the satisfactory effect. But the rate of bacteria resistance would increase because of the overuse of antibiotics, which lead to the fact that scientific development can not keep up with the pace of bacteria resistance. The side effects of antibiotics are reflected by degrees.

Modern technology and industrial rationality are creating a growing gap between human and nature, and shadowing the symbiotic relationship between the two. People have the moral obligation for nature. Abusing of antibiotics is something greedy and out of control. It broke the natural balance, and under the natural forces, antibiotic resistant bacteria were created. The fact is that people will naturally be put on a firmer shackles for their greedy. If we want to meet demand, obey the rule of nature first.

Social justice

Although the academia is appealing to the restricted using of antibiotics, many developing countries do not have valid control measures. This ph--enomenon is not only related to the economics, but also a representation of some social problems.

According to reports in the People's Daily Online, the amount of antibiotics used in Chinese Mainland in 2003 had reached to 162,000 tons, which was about half of the amount in the world. In addition, more than 50,000 tons were discharged into soil and water. Although the Chinese Government has made laws to limit the use of antibiotics, the problem persists. In most hospitals, the use of antibiotics has been controlled suitably, while in clinics and meadows, supervision practices are insufficient. Why do some medical institutions overly rely on antibiotics? There're three main reasons: high efficiency, the lack of cognition of antibiotics and the high profit of selling antibiotics. The rate of abuse depends on the economic condition, the gap between the wealthy and poor, the educational level and other social factors, which could not only be controlled by the policy. To solve this problem, we need to pay more attention to the social justice.

Sustainability

The bacterial disease needs some sustainable treatments. As an emerging research field, synthetic biology uses physics, chemistry, computer science, math, etc. to design and redesign the biological systems. Maybe synthetic biology can bring a new and practicable idea

to a sustainable treatment. The traditional bacteria detection method may take 2 or 3 days to get the test result. During the waiting time, the doctors may use broad spectrum antibiotics to treat the patient. Using Synthetic biology methods, we can explore and design a new circuit which can detect the pathogenic bacteria quickly so that the more specific medicine can be timely used. In addition, new engineering bacteria which can degrade the antibiotics in the river or sewage can reduce the envionmental pollution. What's more, the engineering bacterium killers may kill the Pathogenic bacteria instead of antibiotics.

Synthetic biology shows great potential on the sustainable development of the antibiotics treatment. But Synthetic biology is in the initial stage and needs more scientists to promote it.

Intellectual property rights

With the development of the society, intellectual wealth become more and more important and intellectual property which is protected by law gets more attention. In our project, bacteriophage which infects the Escherichia coli. specifically and non-lethally is planed to be used. We find that the resource of phage is all mentioned in the wiki in other iGEM team's project. In the academic world, everyone takes intellectual property seriously. However, there are some infringements which indicate that the law needs to be improved and public awareness of intellectual property rights needs to increase.

References:

[1].Nischal PM. First global report on antimicrobial resistance released by the WHO. National Medical Journal of India. 2014;27(4):241-.
[2].National report on bacterial drug resistance surveillance in 2015. China Licensed Pharmacist. 2016(03):3-8

SURVEY

- Aachen

  Synthetic Biology Survey

- AHUT_China

  DNA 计算及最短路径规划

- BIT

  Questionnaire about person health,a medical condition,breast cancer cognitive.

  关于个人健康、体检情况、乳腺癌认知以及产品调研

- EPFL

  Your opinion about your iGEM participation

- Evry

  Let's PLAy: Polylactic Acid Plastic Revolution

- HUST-China

  基因表达问题的问卷调查

- IIT_Kharagpur

  Survey 1

- Jilin_China

  实体瘤的认识及其治疗方式

- Manchester

  Alcohol consumption questionnaire

- OUC-China

  合成生物学及定量化与定性化认知情况

- Peking

  2016 国际基因工程大赛（iGEM）北京大学 Peking 团队项目调查问卷

- Peshawar

  iGEM Peshawar

- UCAS

  Antibiotic residues/resistance

- UCL

  Synthetic Biology survey

- USTC

  朊病毒的认识及科研应用

- Valencia_UPV

  goo.gl/forms/offWSLR5

- BGU_ISRAEL

We are the BGU iGEM Team and our goal is to devise several approaches using synthetic biology tools for efficient plastic biodegradation using bacteria. In addition, we plan to utilize the high energy stored in polyethylene terephthalate (PET) molecules, for electricity production. We have created a game which illustrates the basic idea behind our project, our bacteria secretes LC-cutinase an enzyme found to degrade PET and uses it`s biocatlysis products to create energy.

a link to our game: http://bgu-plastikiller.netne.net/# (PC use only)

- Hannover

This year, we are organizing an online survey about our project TALebots and its relevance for other scientists. It would help us a lot, if you could spend a few minutes to answer our questions on the following website:

https://www.umfrageonline.com/s/TALebots

Thank you very much!

- NCTU_Formosa

We let the public understand our PANTIDE and device by doing a public survey. In this survey, we use easy words to introduce our project and current agricultural overview. And how we solve the problem. Here is our survey's link.

Link: https://tony367.typeform.com/to/ZtmVG6

- Pretoria_UP

We have surveyed experts in the field of photobio-electrochemical cells and if more want to fill in the survey the link is https://www.surveymonkey.com/r/XGR8RYX.

- Tec-Chihuahua

Our Human Practices team created a survey for people familiar with both synthetic biology and agriculture. If any iGEM team can answer it or share to people who can, it'd be very helpful for our investigation. Here's the link to our survey: https://docs.google.com/forms/d/e/1FAIpQLSf8mKaPEfKZd9D9nzRuXSvBWqkiVDgTZsgzD4P7UhtKRucPCQ/viewform

- UPO-Sevilla

OPINION POLL ON GENETICALLY MODIFIED ORGANISMS

We are a group of bachelor students who belong to the iGEM competition, which tries to develop an open community for the advancement of synthetic biology.

Link_encuesta

- Vilnius-Lithuania

We have created a survey for previous iGEM teams. The survey is aimed at finding out what makes a successful iGEM team. We are analyzing several criteria – the size and the composition of the team, work distribution, number of mentors etc. – and its correlation with the achievements of the team. We are planning to announce the results of the survey on our wiki page. If you are interested, pass the survey to the previous teams from your institution. The link: https://goo.gl/forms/BSKLq4lZeHnvXGDo1

- XMU-China

  Antibiotics and Antibiotic-Resistance Bacteria

  抗生素调查问卷

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