iGEM 2012 World Championship Jamboree

Program Information

Arizona State

Chimerasensors

Track: Health & Medicine
Presentation: Room 10-250, Sunday 2:00 PM, Session 6
Poster: Session A, #27 (Lobby 13)

Diarrheic pathogens including E.coli O157:H7 serotype, campylobacter, shigella, and salmonella often contaminate drinking water supplies in developing nations and are responsible for approximately 1.5 million worldwide annual deaths. Current technologies for detection of bacteria include DNA hybridization FRET signaling, electrical detection via immobilized antimicrobial peptides, and PCR amplification followed by gel visualization. Our method of bacterial detection fills a niche in biosensor technology. Our design implies lower costs, higher portability, and a more rapid signal output than most bacterial biosensors. Additionally, our interchangeable DNA probe confers modularity, allowing for a range of bacterial detection. Using a split beta-galactosidase complementation assay, we have designed three unique chimeric proteins that recognize and bind to specific pathogenic markers and create a functioning beta-galactosidase enzyme. This functioning enzyme unit then cleaves x-gal and produces a colorimetric output signal. Our research demonstrates success in initial stages of chimeric protein assembly.

Austin Texas

Caffeinated coli: An addicted E. coli for biosensing and bioremediation of methylxanthines

Track: Food & Energy
Presentation: Room 32-123, Sunday 4:30 PM, Session 7
Poster: Session A, #23 (Lobby 13)

The widespread use of caffeine (1,3,7–trimethylxanthine) and other methylxanthines in beverages and pharmaceuticals has led to significant environmental pollution. We have developed a novel detection and bioremediation strategy for caffeine contamination by refactoring the methylxanthine degradation operon native to Pseudomonas putida CBB5. Escherichia coli cells with this synthetic operon degrade caffeine by N-demethylation to the guanine precursor, xanthine. Cells deficient in guanine biosynthesis and containing our refactored operon were addicted to caffeine; their growth density was limited by the availability of caffeine. Remarkably, they were able to sense the caffeine content of several common beverages. Characterization of nearby genes in theP. putida operon revealed a potential methylxanthine regulatory system for use in biological circuit design. The synthetic N-demethylation operon could be useful for cheaply producing pharmaceuticals or precursor molecules and for detoxifying waste so that it can be recycled into animal feed and biofuels.

Berkeley

MiCodes - enabling library screens with microscopy by connecting genotypes to observable phenotypes

Track: Information Processing
Presentation: Room 34-101, Sunday 11:00 AM, Session 5
Poster: Session B, #21 (Lobby 13)

Many applications in synthetic biology demand precise control over subcellular localization, cell morphology, motility, and other such phenotypes that are only observable via microscopy. At present, engineering these properties is challenging due in large part to the inherent throughput limitation imposed by microscopy. We have developed a strategy that enables high-throughput library screening with microscopy by coupling a unique fluorescence signature with each genotype present in a library. These MiCodes (microscopy barcodes) are generated by targeting combinations of fluorophores to several organelles within yeast, and they eliminate the need to isolate and observe clonal populations separately. MiCodes can potentially scale to library sizes of 10^6 or more, and their analysis can be largely automated using existing image processing software. As a proof of principle, we applied MiCodes to the problem of finding unique pairs of protein-protein interaction parts.

Bielefeld-Germany
TOXIC COMPOUNDS IN NATURAL WATER - A CASE FOR LACCASE

Track: Environment
Presentation: Room 32-123, Sunday 1:30 PM, Session 6
Poster: Session B, #12 (Stata)

The accumulation of endocrine disruptors and toxic substances in wastewater has serious consequences for aquatic life and may lead to severe damages in humans. Especially the use of synthetic estrogen in birth control pills results in increasing the concentrations of this disruptor in wastewater. Therefore, "iGEM Team Bielefeld" is developing a biological filter using immobilized laccases, enzymes able to radicalize and break down a broad range of aromatic substances. For the production of laccases from different bacteria, fungi and plants, two expression systems are used: "Escherichia coli" and the yeast "Pichia pastoris". Immobilization is carried out either by using cpc-silica beads or by fusing the enzymes to cellulose binding domains. The concept could be extended to other toxic pollutants in drinking and wastewater, as well as to industrial applications in paper and textile industries or even for bioremediation of contaminated soil.

BostonU
Abandon All Hope, Ye Who PCR: MoClo and the Quest for Genetic Circuit Characterization

Track: Information Processing
Presentation: Room 32-123, Saturday 3:30 PM, Session 3
Poster: Session A, #15 (Stata)

Our project has three aims: to introduce MoClo as an alternative assembly technique to BioBricks, to develop a standardized protocol for the characterization of genetic circuits using flow cytometry, and to share our MoClo Kit with the iGEM community. MoClo is an assembly technique developed by Weber et al. (2011), which involves a multi-way, one-pot digestion-ligation reaction, enabling faster and more efficient construction of genetic circuits. We converted a large subset of BioBricks from the Registry into MoClo Parts using PCR and cloning strategies. We are in the process of building and characterizing various genetic circuits using MoClo Parts, which we will compare to their BioBrick counterparts. A characterization workflow will be shared once this is complete. We also developed a data sheet using Clotho to be included in the Registry of Standard Biological Parts for each Part we characterized to easily share our data with the synthetic biology community.

Buenos Aires
Synthetic ecology

Track: Foundational Advance
Presentation: Room 34-101, Sunday 9:30 AM, Session 4
Poster: Session B, #7 (Stata)

We aimed to create a stable community of microorganisms that could be used as a standard tool. Our system would allow the co-culture of several genetically engineered machines in tunable proportions. Hence the engineered organism would be a standard part! This defines a new level of modularity allowing the increase of the complexity of the system by moving to the community level. We´ve come up with several plausible circuits designs and in silico predictions and decided to build a “crossfeeding” system in which each strain produces and secretes an aminoacid the other strains need to grow. We characterized two auxotrophic yeast strains (for tryptophan and histidine) and designed novel biobricks that regulate the export of Trp and His rich peptides. In the future this would allow for other modules to control the proportions of each strain, thus allowing dynamic and stimulus dependent changes in the abundances of each strain.

Calgary
Detect and Destroy: Engineering FRED and OSCAR

Track: Environment
Presentation: Room 34-101, Sunday 3:30 PM, Session 7
Poster: Session A, #1 (Stata)

Tailings ponds are concentrated pools of toxic and corrosive compounds resulting from oil and mining extraction. The Calgary iGEM team aims to alleviate this potential environmental and economic threat by developing a detection and bioremediation system for these toxins: FRED (Functional, Robust Electrochemical Detector) and OSCAR (Optimized System for Carboxylic Acid Remediation). FRED detects multiple compounds within one sample using an electrochemical output. We created an open-source hardware and software platform to be used as a biosensor prototype. For OSCAR, we designed and modeled a bioreactor to remove impurities (sulfur, nitrogen, and carboxylic acids) from tailings ponds. Known degradative microbial

pathways were combined with unique engineering solutions in a bioreactor model. Furthermore, we developed 'Ribo-kill-switches' to prevent antibiotic resistance and disturbing natural flora. Overall, this system aims to detect and convert toxins into clean hydrocarbons in an economical, safe, and self-contained process.

Cambridge

Parts for a reliable and field ready biosensing platform

Track: Foundational Advance
Presentation: Room 32-123, Sunday 12:00 PM, Session 5
Poster: Session A, #19 (Lobby 13)

Implementation of biosensors in real world situations has been made difficult by the unpredictable and non-quantified outputs of existing solutions, as well as a lack of appropriate storage, distribution and utilization systems. This leaves a large gap between a simple, functional sensing mechanism and a fully realised product that can be used in the field. We aim to bridge this gap at all points by developing a standardised ratiometric luciferase output in a Bacillus chassis. This output can be linked up with prototyped instrumentation and software for obtaining reliable quantified results. Additionally, we have reduced the specialized requirements for the storage and distribution of our bacteria by using Bacillus' sporulation system. To improve the performance of our biosensing platform we have genetically modified Bacillus' germination speed. Lastly, we demonstrated the robustness of our system by testing it with a new fluoride riboswitch, providing the opportunity to tackle real life problems.

Carnegie Mellon

Real-time quantitative measurement of RNA and protein levels using fluorogen-activated biosensors

Track: Foundational Advance
Presentation: Room 32-123, Sunday 11:00 AM, Session 5
Poster: Session B, #3 (Stata)

The design and implementation of synthetic biological systems often require quantitative information on both transcription and translation rates. However, quantitative information about the expression strength of a synthetic promoter has been difficult to obtain due to the lack of noninvasive and real-time approaches to measure the levels of both RNA and protein in cells. Here, we engineer a fluorogen-activated bio-sensor that can provide information on both transcription strength and translation efficiency. This biosensor is noninvasive, easily applied to a variety of promoters, and more efficient than existing technologies. To demonstrate the utility of our biosensor, we constructed and characterized several designed T7Lac hybrid promoters. Furthermore, we developed a mathematical model of our synthetic system to guide experiments and an open-source electronic kit that mimics experimental setup and well suited for education purposes. Our results could have a broad impact on the measurement and standardization of synthetic biological parts.

CBNU-Korea

BUGS(Brick and Unique minimal Genome Software)

Track: Software Tools
Presentation: Room 32-155, Saturday 12:00 PM, Session 2
Poster: Session A, #SW4 (Stata)

We have developed two distinct software tools. The first tool, MG-designer, is functionally divided into designer and viewer. The viewer shows the information of genomes in both linear and circular form. So it is easier for users to understand the characteristic of genomes. By the designer, user can design minimal genomes by essential genes which are analogized by our team in this year. The minimal genome can be designed depending on characteristics of species by inserting the function of genes into particular locations. With the second tool, brick-designer, user can design new bio-bricks. It is also able to synthesize bricks by using the bricks registered in partsregistry. User can also utilize bricks he just designed. We tried to enhance software potability by enabling the bricks to save as Genbank and SBOL types. Brick also can be saved as picture file so that it is helpful in the Wiki implementation.

CINVESTAV-IPN-UNAM MX

Rhodofactory, controlling genetic expression: an oxygen and light response

Track: Foundational Advance
Presentation: Room 34-101, Sunday 9:00 AM, Session 4
Poster: Session B, #25 (Lobby 13)

The metabolic versatility of purple non-sulfur photosynthetic bacteria allows them to grow in light, darkness and with or without oxygen; all it is due to their genetic regulation mechanisms. Taking advantage of this, our project aims to build two genetic control systems based on R. sphaeroides photosynthesis cluster regulation. The first one is a light dependent system controlled by two proteins AppA/PpsR that works like an antirepresor/repressor mechanism, and the second one is an oxygen dependent system of two-component called PrrA/PrrB. This two devices were tested on R. palustris chassis, using a cassete in which a reporter (GFP) is regulated by external conditions that activate or repress its expresion. Once we have characterized the functionality of these networks, our perspective is to develop a Rhodofactory, it means to control the produccion of differents metabolites, such as biodiesel and butanol, using simple signals.

Colombia
Pest-busters

Track: Environment
Presentation: Room 34-101, Saturday 10:00 AM, Session 1
Poster: Session B, #15 (Stata)

We are developing a modular synthetic system that is able to recognize pathogen-associated molecules from either fungi or bacteria, aiming to speed up the activation of the plant immune system in an infection process. Three major parts comprise the system: A chitin-sensor system that is activated in the presence of Hemileia vastatrix (coffee rust) or, alternatively, a device that senses 3OH-PAME, a diffusible signal of Ralstonia solanacearum, cause of bacterial wilt. A second construct, the communication device, receives the input from the sensor device and starts the production of salicylic acid, a plant hormone that stimulates an hypersensitive response in the plant. The third part, toxin-antitoxin systems, will be either placed in the final plasmids or in the chromosome in different combinations, causing the cells to stay dormant most of the time without pathogen presence, and also ensuring no transfer of plasmids to other cells.

Cornell
SAFE BET: The Shewanella Assay for Extended Biomonitoring of Environmental Toxins

Track: Environment
Presentation: Room 10-250, Sunday 11:30 AM, Session 5
Poster: Session B, #6 (Stata)

Cell-based biosensors have potential uses in environmental monitoring for toxins, medical diagnostics, and drug discovery. However, current methods for information output from whole cells (fluorescence, luminescence, pH) are very cumbersome to measure. To overcome this obstacle, the Cornell iGEM team has developed a new generation of biosensors capable of a direct current output which can be recorded easily with high precision. By upregulating the metal-reduction pathway of Shewanella oneidensis in the presence of a target compound, these sensors can act as a continuos monitoring system. While our system is adaptable to sensing a wide range of analytes, we have focused on the detection of arsenic-containing compounds and naphthalene, which are common contaminants in oil sands tailings. Furthermore, we have integrated these organisms within a field-deployable device capable of wireless data transmission – a fully autonomous electrochemical biosensor.

Edinburgh
Tools that make synthetic biology easier and safer - questioning legacy and friendliness

Track: Foundational Advance
Presentation: Room 34-101, Saturday 1:00 PM, Session 2
Poster: Session B, #4 (Stata)

Edinburgh's 2012 iGEM project focuses on developing tools that expand the range of synthetic biology applications. We are characterizing Citrobacter freundii as a chassis in order to investigate the potential of a new host organism as an alternative to Escherichia coli in synthetic biology. The team is also looking at novel selectable and counter-selectable markers as a substitute for antibiotic based systems which facilitate the spread of antibiotic resistance in the environment. We seek to implement the MtrCAB electron transfer system from Shewanella oneidensis into E. coli, and test the resulting electron output from the organisms using microbial fuel cells. We are constructing computer models of the electron transfer chain and of cell

survival with non-antibiotic markers. This tools-based project responds directly to legislation and safety. We considered how iGEM gives us the freedom to pursue blue-sky research and whether our work is driven by preconceptions of public opinion.

ETH Zurich
E.colipse – Who's your pABA: intelligent sun protection

Track: Health & Medicine
Presentation: Room 10-250, Sunday 4:00 PM, Session 7
Poster: Session B, #28 (Lobby 13)

E.colipse is an intelligent and adaptive sun radiation protection system which responds to UV exposure with the production of the protective agent pABA. To detect hazardous levels of sun radiation our system is based on UVR-8, a UV sensing protein from plants. In its dark state, this protein forms a homodimer that dissociates upon UV radiation. We fused UVR-8 with the DNA binding domain from TetR, which is unable to dimerize and to bind DNA in monomeric form. UV-exposure might force the TetR-UVR8 fusion dimer to split, release the DNA and enable transcription. Thus, TetR-UVR8 might act as a light-activated on-switch in bacteria. We plan to use this novel switch to start the production of para-aminobenzoic acid (pABA), a common ingredient of sunscreen, and - dependent on the intensity and duration of exposure as determined by our detailed in silico model - a colored pigment as a visible warning signal.

Evry
A synthetic hormonal system for the vertebrate chassis Xenopus tropicalis

Track: Foundational Advance
Presentation: Room 34-101, Saturday 12:30 PM, Session 2
Poster: Session B, #14 (Stata)

Building on a long-standing French fascination for frogs, we wanted to spread this enthusiasm to the world of synthetic biology by introducing a new, vertebrate chassis to the community: Xenopus tropicalis. This leap towards multicellular biological engineering required new tools, so we first developed a new set of frog compatible vectors, biobricked tissue specific promoters and a new technique to assemble them in a single shot. To benefit from tissue compartmentalisation, we created a synthetic, orthogonal hormonal system using the plant molecule auxin. We also investigated E. coli/Xenopus interfacing, effectively creating a synthetic ecosystem. We modelled our system at the organism scale, using a multi-level and multi-technique approach. Finally, working with whole animals during iGEM brought a load of difficult ethical questions regarding animal biotechnologies and experimentation. This led us to wonder: Are we a chassis?

Freiburg
Let us tell you a fabulous TALE ...

Track: Foundational Advance
Presentation: Room 34-101, Sunday 2:00 PM, Session 6
Poster: Session B, #30 (Lobby 13)

Transactivator-Like Effectors (TALEs) are a brand-new technology that currently revolutionizes the way researchers manipulate DNA with exceptional site specificity. Originally derived from Xanthomonas spp., this type of protein comprizes an effector domain and a modular DNA binding domain that can be rationally designed to bind to virtually any target sequence of DNA. Over the past two years, universal endonucleases (TALENs) and transcription factors have been tested in various organisms ranging from bacteria to humans. According to existing protocols, TALE assembly requires several weeks of work and substantial lab skills. In order to bring this technology within reach for iGEM students, we invented an extremely fast and easy TALE assembly strategy and developed a TALE platform with expression plasmids and new classes of TALEs. With our so called GATE assembly kit, future iGEM students will be able to precisely manipulate genomic loci easier and faster than anyone else in the world.

Groningen
The Food Warden. It's rotten and you know it!

Track: Food & Energy
Presentation: Room 10-250, Sunday 9:00 AM, Session 4
Poster: Session A, #8 (Stata)

Every year, one third of global food production -1.3 billion tons of food- is thrown away, partially due to the "best before" dating system. iGEM Groningen 2012 seeks to provide an alternative method of assessing edibility: The Food Warden. It uses an engineered strain of Bacillus subtilis to detect and report volatiles in spoiling meat. The introduced genetic construct uses a promoter to trigger a pigment coding gene. This promoter, identified by microarray analysis, is significantly up-regulated in the presence of volatiles from spoiled meat. The activity of the promoter regulates the expression of the pigment reporter and will be visible to the naked eye. For safe usage of the system, spores of our engineered strain are placed into one half of a semi-permeable capsule, the second containing a calibrated amount of nutrients. Breaking the barrier between the two compartments allows germination and growth, thereby activating the spoiling meat sensor.

HKUST-Hong Kong
B. hercules---The Terminator of Colon Cancer

Track: Health & Medicine
Presentation: Room 10-250, Sunday 2:30 PM, Session 6
Poster: Session A, #26 (Lobby 13)

The dispersal of toxic anti-tumor chemicals in the circulatory system during conventional cancer treatment prompts us to consider the need of alternative cancer therapies. In an effort to combat with colorectal carcinoma, we aim to use genetically modifiedBacillus subtilis to execute targeted drug delivery to cancer cells in the digestive tract, offering an advantage of generating minimal adverse effect on normal colon epithelial cells. Targeting is achieved by expressing RPMrel, a colon tumor specific binding peptide, on the cell wall using a LytC cell wall binding system. The anti-tumor cytokine, bone morphogenetic protein 2 (BMP-2), is synthesized and secreted out from the bacteria with the help of a signaling peptide fused to the protein. To control the timing and amount of BMP2 release, two regulatory systems, xylose-inducible system and ydcE/ydcD toxin-antitoxin system are introduced to minimize the harmful effect from BMP2 overdose.

Hong Kong-CUHK
Light of No Return

Track: Foundational Advance
Presentation: Room 34-101, Sunday 1:30 PM, Session 6
Poster: Session A, #22 (Lobby 13)

Although the sensory technology has been deeply explored and implemented in various means, most of the developed sensors are chemically-dependent promoters which regulate downstream gene expression. We exploited the use of halobacterial sensors, the sensory rhodopsins which are sensitive to a wide spectrum of readily available light source and build a series of sensing systems to control cellular movement and gene regulation. This system can be executed as a fundamental part for further applications, such as cell targeting and refining. Furthermore, to counter the safety issues caused by the leakage of bioengineered cells, this sensing method altogether with the CRISPR/Cas sytem can targart and achieve the cleavage of the transformed plasmid under the stimulation of natural light sources.

Johns Hopkins-Software
AutoGene

Track: Software Tools
Presentation: Room 32-155, Saturday 2:30 PM, Session 3
Poster: Session A, #SW3 (Stata)

Autogene is an innovative CAD tool used to automate the design process of synthetic DNA sequences. The first module, AutoPlasmid, leverages the power of cloud computing, sophisticated bioinformatics algorithms, and an expert curated feature database containing over 40,000 features to automatically annotate natural/synthetic DNA sequences, finding both perfect and imperfect matches. It also provides an effective solution to the Registry of Parts for annotation automation and pathogen sequence detection. The second module, AutoDesign, provides users with a drag-and-drop design environment to construct new sequences using user-imported features as well as those from our database. The third module AutoFab, which is still being developed, will provide users with guidelines of fabricating and optimizing their synthetic DNA. Compatible with other

common bioinformatics tools such as ApE and capable of documenting in SBOL, genbank, and fasta formats, we hope that Autogene will allow synthetic biologists to take their research to the next level.

KAIST Korea
CO2 Fixation Pathway and Pathway Switching Module

Track: Environment
Presentation: Room 34-101, Sunday 4:00 PM, Session 7
Poster: Session B, #24 (Lobby 13)

1. CO2 Fixation Pathway
Reductive acetyl-CoA pathway is a pathway for carbon dioxide (CO2) fixation in many anaerobes. Acetogenic use this pathway to synthesize acetic acid from carbon dioxide. Because the pathway is non-regenerative, reductive acetyl CoA pathway is a appropriate target pathway to consume atmospheric carbon dioxide (CO2). Nowadays, full genome sequences of bunch of acetogens are available. Also, the enzymes consisting the pathway are elucidated allowing us to reconstruct the pathway in Escherichia coli.

2. Pathway Switching Module
Throughout past iGEM competitions, many kinds of bio-modules were proposed and tested. In our project, we are suggesting dual-phase switching module using DNA recombination system that is new to iGEM part registry. With this module we will be able to control metabolic pathway we are targeting. Coupling of suggested module with cell growth, we expect to enable our cells to control their metabolisms according to cell growth.

Kyoto
Flower Fairy E.coli

Track: New Application
Presentation: Room 32-123, Saturday 10:30 AM, Session 1
Poster: Session B, #19 (Lobby 13)

A flower fairy had been merely a creature of imagination until October 5 2012, but not more. Our Flower Fairy E.coli are capable of blooming flowers on demand by producing FLOWERING LOCUS T (FT) protein, called Florigen, a kind of plant hormone composed of 175 amino acids. To make it possible for FT protein to access to plant cells directly from E.coli, we established a new protein translocation system, R-TAT. Our R-TAT system can carry proteins from the cytoplasm to plant cells while maintaining appropriate folding of target proteins. We will show that FT protein induces expression of genes involved in anthesis and functions effectively at low doses by confirming that FT protein activates some key blooming-related genes such as AP1. We will also provide iGEMers incredible promoters constructed through Golden Gate Assembly. Our Giant Controllable-Promoter, for example, is composed of 5x promoter regions following a Lac repressor element.

LMU-Munich
Beadzillus: Fundamental BioBricks for Bacillus subtilis and spores as a platform for protein display

Track: New Application
Presentation: Room 32-123, Sunday 10:00 AM, Session 4
Poster: Session B, #29 (Lobby 13)

We chose to work with Bacillus subtilis to set new horizons and offer tools for this model organism to the Escherichia coli-dominated world of iGEM. Therefore, we created a BacillusBioBrickBox (BBBB) composed of reporter genes, defined promoters, as well as reporter, expression, and empty vectors in BioBrick standard. B. subtilis naturally produces stress resistant endospores which can germinate in response to suitable environmental conditions. To highlight this unique feature using the BBBB, we developed Sporobeads. These are spores displaying fusion proteins on their surface. As a proof of principle, we fused GFP to the outermost layer. Expanding this idea, we designed a Sporovector to easily create any Sporobead imaginable. Because theSporobeads must be biologically safe and stable vehicles, we prevented germination by knocking out involved genes and developed a Suicideswitch turned on in case of germination. With the project Beadzillus, our team demonstrates the powerful nature of B. subtilis.

Lyon-INSA

Biofilm Killer: long-term destruction of biofilms in an industrial context.

Track: Food & Energy
Presentation: Room 10-250, Saturday 3:30 PM, Session 3
Poster: Session A, #18 (Lobby 13)

Biofilms are responsible for billions of dollars in production losses and treatment costs in the industry every year. Biofilm-related problems are major concerns in the food industry where it can cause food spoilage or poisoning, in health industry because of pathogens' persistence and dispersal, or in the oil and water industry where it causes corrosion. Assuming that the environment is already over-saturated with harmful chemicals such as biocides, whose long term health effects remains to be elucidated, there is a great need for innovating solutions to reduce detrimental biofilm effects. To reduce the use of biocides, the INSA-Lyon iGEM team aims to engineer a bacterial "torpedo" capable to infiltrate and destroy biofilms formed on industrial equipments, pipes or reservoirs. Industrial surfaces will then be protected from further deleterious contamination by either a surfactant coating, or the establishment of a protective biofilm produced by the torpedo bacteria.

Macquarie Australia

Flick of the Switch: Employing Light-Sensitive Bacteriophytochromes to Control Gene Expression

Track: New Application
Presentation: Room 32-123, Sunday 9:00 AM, Session 4
Poster: Session A, #9 (Stata)

Phytochromes, or photoreceptors with the ability to control the expression of genes, exist in bacteria as bacteriophytochromes. This project creates a light-dependent biological switch using the bacteriophytochromes from Deinococcus radiodurans and Agrobacterium tumefaciens. When coupled with heme oxygenase, these bacteriophytochromes are supplied with biliverdin, a pigment which allows for the self-assembly of a switch within the host system. In the presence of red light, the conformation of the bacteriophytochrome is modified. This reaction produces a visible colour change in the presence of red light, and can be used to control expression of a targeted gene when coupled with the appropriate response regulator. Exposure to far-red light will cause the bacteriophytochrome to revert to its original conformation, thus repressing the gene and reversing the colour change.

Michigan

Utilizing FimE and HBif Recombinases to Tightly Control a Bi-directional and Inheritable Switch

Track: Foundational Advance
Presentation: Room 32-123, Sunday 11:30 AM, Session 5
Poster: Session A, #7 (Stata)

Recombinases can be used to create responsive, low background, boolean genetic circuits in biological systems. Further, it is theoretically possible to create complex control circuits using combinations of invertible DNA sequences. We utilized the recombinase HbiF to augment an existing system in Escherichia coli that relied on the recombinase FimE. A burst of induced, low level expression of one recombinase will invert the promoter flanked by the recombinase binding sites, triggering a switch from strong expression of one set of proteins to another set. Induced expression of the second recombinase will revert the promoter to its original orientation, triggering the original set of protein expression. The inversion will be sustained across cell divisions with little leaky protein expression and negligible performance degradation after repeated inversions. This is a heritable, binary memory system and can be used as a component in more complex systems.

MIT

RNA Strand Displacement for Sensing, Information Processing, and Actuation in Mammalian Cells

Track: Information Processing
Presentation: Room 34-101, Sunday 11:30 AM, Session 5
Poster: Session B, #1 (Stata)

The complexity of engineered genetic circuits in eukaryotic systems is limited by the availability of regulatory components and further hampered by the inability to assemble and deliver large DNA constructs. In contrast, in vitro synthetic DNA circuits utilizing strand displacement have demonstrated complex digital logic with reliable and scalable behaviors in a small base-pair footprint. The possible adaption of such circuits into cellular environments can amplify the scale and complexity of biological

circuits, broadening synthetic biology's application space. Our project leverages strand displacement to create a process technology that supports multi-input sensing, sophisticated information processing, and precisely-regulated actuation in mammalian cells. We construct RNA strand displacement circuits that detect endogenous mRNA, perform digital logic computation, and output desired proteins through programmable RNA interference pathways. We envision in-vivo RNA strand displacement as a new foundation for scaling up complexity in engineered biological systems, with applications in biosynthesis, biomedical diagnostics and therapeutics.

NCTU Formosa
EcoFuel E.coLine

Track: Food & Energy
Presentation: Room 32-123, Sunday 4:00 PM, Session 7
Poster: Session B, #13 (Stata)

Greenhouse Effect and the limitation of the fossil fuels have been a huge concern to people on Earth. Research shows that higher alcohols possess qualities making them more suitable as a biofuel than ethanol, including lower vapor pressure, lower hygroscopicity, and higher energy density. So our team (NCTU Formosa) managed to produce isobutanol by E. coli. With thetemperature control system, we can reduce the toxic intermediates of synthetic pathway to enhance isobutanol yield. Furthermore, we add 4 zinc fingers to the synthetic enzymes trying to increase the chance of protein interaction, making E. coli much as a production line to produce isobutanol more efficiently. This Ecofuel E.coLine gives an insight of yielding biomass energy, providing better biofuel and, in the long run lowering the burden of our Earth.

Nevada
iRICE: A Novel, Non-GM Approach to Biofortification of Rice

Track: Health & Medicine
Presentation: Room 32-123, Saturday 12:30 PM, Session 2
Poster: Session A, #28 (Lobby 13)

Even though white rice is a major source of calories for over half the world's population, it is a poor source of nutrients. While rice can be fortified using vitamin powders, such approaches have had limited success because many vitamins are leeched away during the washing process prior to cooking. To address this problem, we have engineered proteins that will adhere nutrients to rice grains and prevent losses. These proteins contain a starch-binding domain that is fused to specific nutrient-binding domains. Because rice is composed mainly of starch, the starch-binding domain prevents nutrient leeching during washing. Upon cooking, the nutrient-binding domain denatures and releases the nutrients into the cooked rice. Supplementing rice with these fusion proteins will provide a novel, non-GMO approach to fortifying rice. Proteins with a starch-binding domain connected to a vitamin B12-binding domain, a thiamine-binding domain, a lysine-rich protein, and a RFP have been created.

Northwestern
The Phytastic Probiotic: Increasing the Bioavailability of Nutrients in the Digestive System

Track: Health & Medicine
Presentation: Room 34-101, Saturday 3:30 PM, Session 3
Poster: Session A, #13 (Stata)

Iron deficiency affects 2 billion people - or over 30% of the world's population – and can lead to anemia, ill health, and even death. Surprisingly, this deficiency is typically not due to a lack of dietary iron, but rather due to low bio-availability, and thus poor absorption of iron. Phytic acid is a prevalent chelator of iron and other nutrients in food. Our mission is to build a system that breaks down phytic acid in the digestive system, releasing bound iron for the body to absorb. Our solution comprises two engineered components: a module that constitutively produces phytase to break down phytic acid and a pH-sensitive module that causes cells to lyse and release the accumulated phytase in the stomach. If successful, our strain would be a low-cost sustainable solution to preventing iron deficiency without the need for constant supplies of iron supplements.

NTU-Taida
PepdEx: Smart Peptide-based Therapies

Track: Health & Medicine
Presentation: Room 10-250, Sunday 3:30 PM, Session 7
Poster: Session A, #24 (Lobby 13)

In our project, we aim to utilize a microbe that responds to conditions in human body as an approach to administer smart peptide-based therapies. GLP-1, a human innate neuro-peptide for energy balance, is chosen to combat for obesity and metabolic syndrome. We engineer the non-pathogenic E. coli which senses fatty acids in intestines and secretes synthetic GLP-1. Appropriate signal peptides and penetratin are used to facilitate peptide secretion and intestinal uptake. Furthermore, we design a circuit with quorum sensing and double repressors, which aims to generate quick but sustainable responses and serves as an anti-noise filter. Plasmid stabilization modules including partition system and multimer resolution system are also incorporated to circumvent the undesirable loss or segregational instability of our artificial device. With this general concept of delivery of short peptide into human body, we can also target other human diseases with alternative circuit designs.

NYMU-Taipei
Venus Marvel

Track: Environment
Presentation: Room 34-101, Saturday 10:30 AM, Session 1
Poster: Session A, #12 (Stata)

Nowadays, pollution spreads through the world and our environment is deteriorating day by day. Our project is mainly about the removal of several pollutants, including nitrogen oxides, sulfur oxides and carbon oxides, from exhaust air and waste water. We planned to cultivate a special strain of genetically engineered cyanobacteria. With reductases metabolizing nitrogen, sulfur and carbon oxides, our organisms reduce three major pollutants in the modern day. Furthermore, we also focus on the removal of cadmium ions from soil. We tried to engineer E.coli to gain better capability of collecting cadmium ions. In fact, our engineered E.coli could stay inside of Dictyostelium discoideum, which allows us to build a biosafety system to make sure our GMOs won't become another threat to the environment. Combining our engineered cyanobacteria and the concept of endosymbiosis, we grant eukaryotes, ultimately human being, the ability to colonize Venus and expand our territory.

OUC-China
oceanfilm and oceanfeel(a portable ratio sensor that can float)

Track: Environment
Presentation: Room 10-250, Sunday 11:00 AM, Session 5
Poster: Session A, #16 (Stata)

Our projects focus on warning and countermeasure against red tide. A precise sensor and an effective processor is coming to solve it. N/P is recognized as the key indicator and floatable E.coli is needed for survival. The second one was successfully solved by means of engineering our E.coli with a brand-new gvp gene clusters that possess far shorter length and better property for bacteria to float. Characterization and analysis of the gene cluster is underway. Phosphate and nitrate sensor have been finished respectively, together with three test devices which facilitate our quantitative analysis. More detailed measurements are underway. Once those sensors work as expected, N/P as input would better match our model. Fine-tuned comparators and ratio sensors with sRNA-mRNA interactions serve as the processor for decision-making. This model-driven part would take advantage of our fine-tuned N/P sensors and synthetical RNA interactions together to accurately alarm red tide.

Paris Bettencourt
bWARE

Track: Environment
Presentation: Room 32-123, Sunday 2:30 PM, Session 6
Poster: Session A, #29 (Lobby 13)

Many synthetic biology projects propose the application of Genetically Engineered Organisms (GEOs) in natural environments. However, issues of biosafety and ethics constrain the use of GEOs outside the lab. A primary concern is the Horizontal Gene Transfer (HGT) of synthetic genes to natural populations. Strategies developed to address this problem provide varying levels of containment, however, the substantial elimination of HGT remains difficult or perhaps impossible. We have developed a new containment system to expand the range of environments where GEOs can be used safely. To do so, we rely on three levels of containment: physical containment with alginate capsules, semantic containment using an amber suppressor system, and an improved killswitch featuring delayed population-level suicide through complete genome degradation. We aim to raise the issue of biosafety by engaging the general public and scientific community through debate, and to advocate the discerning use of biosafety circuits in future iGEM projects.

Peking
Luminesensor: Programming Cells through Light

Track: Foundational Advance
Presentation: Room 10-250, Saturday 11:00 AM, Session 1
Poster: Session A, #14 (Stata)

Optogenetic tools have made significant impact on life sciences and beyond. However, several serious issues remain: cytotoxicy, narrow dynamic range, and dependency on laser and exogenous chromophore. To circumvent these, Peking iGEM has rationally constructed a hypersensitive sensor of luminance- Luminesensor. Primarily, the sensor was designed by fusing blue-light-sensing protein domain from Neurospora with DNA binding domain of LexA from E.coli, following which protein structure inspection and kinetic simulation were conducted to rationally perform optimization. Amazingly, Luminesensor was proved to be as sensitive as to sense natural light and even bioluminescence. With this sensor, spatiotemporal control of cellular behavior, such as phototaxis, high-resolution 2-D and 3-D bio-printing using dim light and even luminescence of iPad were shown to be very easy. What's more, we successfully implemented cell-cell signaling using light, which is the very first time in synthetic biology and of great importance for biotechnological use.

Penn
pDAWN Of A New Era: Engineering Bacterial Therapeutics

Track: Health & Medicine
Presentation: Room 32-123, Saturday 12:00 PM, Session 2
Poster: Session B, #11 (Stata)

We are engineering E. coli bacteria which may enable highly targeted eradication of human epidermal growth factor receptor 2 (HER2) overexpressing cancer cells. Upon binding to HER2 overexpressing cells, bacterial cytotoxicity can be triggered with spatial and temporal precision by illumination with blue light, which activates overexpression and secretion of Cytolysin A (ClyA) under the control of the pDawn transcriptional module. Furthermore, we are also investigating the feasibility of engineering bacterial biofilms that can act as antimicrobial surfaces. We are engineering E. coli bacteria to form non-pathogenic biofilms that express bacteriolytic proteins capable of inhibiting the formation of pathogenic biofilms that are potential sources of hospital acquired infections. These cells carry the a gene encoding lysostaphin (lss), which selectively destroys the cell walls of Streptococcus bacteria, a common pathogen in many hospital settings.

Penn State
Questioning the Central Dogma of Molecular Biology

Track: Foundational Advance
Presentation: Room 34-101, Sunday 2:30 PM, Session 6
Poster: Session A, #25 (Lobby 13)

The central dogma of molecular biology does not always accurately predict results acquired in the lab. A construct containing two adjacent start codons in different reading frames measures the E. coli DH10B ribosome's proclivity for either one start codon or the other through a fluorescent protein reporter in each respective reading frame. Variations in RBS translation initiation rates and length between start codons provide additional data. Repeating sequences of non-degenerative threonine and alanine codons measure codon bias and determine E. coli DH10B's ability to translate varying lengths of identical codons through the use of mCherry and GFP reporters. Promoters are tested for bidirectionality in protein translation by measuring the rate of forward expression through downstream GFP or reverse expression through upstream RFP. A ratio of fluorescence characterizes each tested promoter.

Potsdam Bioware
Antibody Generation System - Maturation, Selection and Production in CHO Cells

Track: Manufacturing
Presentation: Room 10-250, Saturday 2:30 PM, Session 3
Poster: Session B, #22 (Lobby 13)

Antibodies are of utmost importance for research and therapy but their generation is laborious and time consuming. We established a novel streamlined workflow for obtaining antibodies by incorporating all natural steps such as antibody maturation, selection and production in one genetic system implemented into a eukaryotic cell line. We stably transfect an antibody construct into CHO cells and mimic maturation by using the enzyme AID (activation-induced deaminase), which is known to induce somatic hypermutation. For selection, we are testing and deploying a versatile and continuous viral system as

well as magnetic beads and cell sorting. Finally, a genetic switch enables the transition from surface expression to production of soluble antibodies. In addition, we pursue phage display with an antibody fragment to study mutation rate and evolution by AID in prokaryotes. Our system supersedes animal immunization, and the smooth process will increase the ready availability of antibodies in various formats.

Purdue

Synthetic Biology in the Community: Accessible Biotechnology for Water Treatment

Track: Environment
Presentation: Room 10-250, Sunday 12:00 PM, Session 5
Poster: Session B, #26 (Lobby 13)

Polluted water is the world's largest health risk, killing over three million people a year. Our project focused on enhancing biofilms used in water treatment. We designed a system to accelerate the adhesion of bacteria to surfaces. On biofilm aggregation, expression of silica-binding peptides works to build silica matrices on the surface of cells. These matrices act as a mechanical filter for large particles and a barrier between the biofilm and fluid shear, decreasing dislodgment of organisms that could otherwise lead to fouling. We envision these improved biofilms being used in municipal water treatment to help recycle and filter home waste water streams, a concept we implemented in lab-scale membrane bioreactors. Bringing awareness of synthetic biology closer to our community, we initiated a community bio-lab and a Girl Scout biotechnology badge. Ultimately, we hope to take synthetic biology from benchtop to park bench.

Queens Canada

ChimeriQ x SynthetiQ: Chimeric flagella scaffold enhancing bioremediation and manufacturing, presented with dance!

Track: Foundational Advance
Presentation: Room 10-250, Saturday 10:00 AM, Session 1
Poster: Session B, #17 (Stata)

This year, Queen's iGEM team is using flagella to host heterologous proteins that will result in thousands of useful enzymes organized in an extensive scaffold, with the benefits of extracellular synthesis, degradation and arrangement. The fliC (flagellin) protein is known to spontaneously polymerizes to form the length of flagella in E.coli. By replacing the variable D3 domain of the fliC protein with proteins for binding, degradation, adhesion, and synthesis, we can increase the effieicny of bioremediation and biosynthesis, and facilitate the collection of products *in situ* or *ex situ*. This year we will also introduce dance as a presentation form and part of our human practices project. Known as SynthetiQ, we will be the first group ever to use dance to replace powerpoint slides at a research conference.

SJTU-BioX-Shanghai

Membrane Magic

Track: New Application
Presentation: Room 10-250, Saturday 12:30 PM, Session 2
Poster: Session A, #3 (Stata)

In this year's project, we aim at constructing a set of protein systems on the E.coli cell membrane as carriers of enzymes of assorted reactions. Distinct from linear DNA or RNA scaffolds in the traditional sense, the membrane protein system expands the dimension of reaction space, making possible the framework of numerous complex reactions on the two-dimensional plane, for example, switchable or circular reactions. In such a device, the membrane replaces DNA or RNA scaffolds as an extensive surface for proteins to anchor without limitation of expression amount. More importantly, by gathering the downstream enzymes through signal regulation, the reaction can be accelerated sharply. Besides, products can be transported much more efficiently from the inside to the outside of the cell in that the enzymes are tied to the membrane proteins. Hence the membrane is where the magic happens.

Slovenia

Switch-IT (Inducible therapeutics)

Track: Health & Medicine
Presentation: Room 10-250, Sunday 1:30 PM, Session 6
Poster: Session B, #5 (Stata)

Currently, biological drug-based therapies require periodic invasive application. Often, due to their systemic administration, adverse effects are observed. Furthermore, large quantities of these substances are needed because of their distribution throughout the body. This, coupled with expensive production and especially purification, imposes a great burden on health systems. We aim to develop a safe and cost-effective biological delivery system for biopharmaceuticals, which would increase the quality of patients' lives, because it would minimize the number of required procedures. This type of delivery system would increase patient compliance to the therapy while the local administration will reduce the side-effects associated with current treatments. We plan to design the mammalian cells-based delivery system to be regulated by the digital logic from the outside.

Stanford-Brown

The Transit of Synthetic Astrobiology

Track: New Application
Presentation: Room 10-250, Saturday 12:00 PM, Session 2
Poster: Session B, #8 (Stata)

Astrobiology revolves around three central questions: “Where do we come from?”, “Where are we going?”, and “Are we alone?” The Stanford-Brown iGEM team explored synthetic biology’s untapped potential to address these questions. To approach the second question, the Hell Cell subgroup developed BioBricks that allow a cell to survive harsh extraterrestrial conditions. Such a toolset could create a space-ready synthetic organism to perform useful functions off-world. For example, the Biomining branch attempted to engineer bacteria to recycle used electronics by degenerating silica and extracting metal ions in situ. The Venus Life subproject grappled with the third key astrobiological question by exploring Carl Sagan’s theory that life could exist in Venusian clouds. To this end, Venus Life designed a cell-cycle reporter to test for growth in aerosol within an adapted Millikan apparatus. Through this triad of projects, Stanford-Brown iGEM aimed to illuminate synthetic biology’s value as a tool for astrobiology.

SUSTC-Shenzhen-A

BioSearch-An iPhone App for Partsregistry

Track: Software Tools
Presentation: Room 32-155, Saturday 12:30 PM, Session 2
Poster: Session A, #SW1 (Stata)

The era of Partsregistry on mobile phone has arrived! With BioSearch on your iPhone, you can now check biobricks and partsregistry in the seminar room; You can design your genetic circuits when you are waiting for a bus! BioSearch is fully interacting with Partsregistry (http://partsregistry.org) and has all parts information of Partsregistry database with enhanced user-friendly interface. BioSearch has a powerful search engine. Users can search parts and devices by type, by category, by keywords, etc. Our online survey shows that BioSearch has major improvement in search result ranking. In addition, our iPhone App has new functions including sharing, rating, adding bookmarks and downloading to local system. These new functions shall promote the commuting and sharing between synthetic biologists. The BioSearch is going to be available on Apple Store and is free to use.

SUSTC-Shenzhen-B

Theoretical modeling and experimental measurement of transcription terminator efficiency

Track: Software Tools
Presentation: Room 32-155, Saturday 1:00 PM, Session 2
Poster: Session A, #SW7 (Stata)

Transcription terminator is an essential part of biobrick circuits, but is not well characterized. We studied the rho-independent transcription terminators using both theoretical modeling and experiment method. We first developed a theoretical model. This model calculate the free energy of RNA folding and can predict the secondary structure of terminators. From the secondary structure, we proposed an algorithm that can calculate terminator efficiency. In the aspect of experiment, we construct 100 terminators. We measure the the terminator efficiency by measuring the GFP and RFP which are placed before and after terminators. The efficiency calculated from theoretical model fit quite well with experimental results. We also created a software and a web surver for people to calculate their terminators and also built a database of terminator efficiency which we believe to be the largest database of such kind. Our work is by far the most comprehensive study on terminator efficiency.

SYSU-Software

BiArkit, A Versatile Toolkit For Synthetic Biology

Track: Software Tools
Presentation: Room 32-155, Saturday 10:00 AM, Session 1
Poster: Session A, #SW5 (Stata)

BiArkit is a versatile toolkit that integrates different modules together and helps researchers approach information on synthetic biology. The first function is Genome Browser, which visualizes the genomes of some model microorganisms, locates the genes on the genome and make it easy to study the genome. Secondly, Regulator Designer helps the design of regulatory elements, mainly non-coding RNA,in which we firstly develop Riboswitch Designer. Thirdly, we optimize the methods of scanning and output of the existing database of pathways. Fourthly, to analyze the dynamic change in various metabolic networks, we present a simulator that help the researchers analyze the network in silico, with the application of flux balance analysis (FBA). Further, to make it more convenient, the software is localized; that is to say, all functions mentioned above can be achieved without linkage to Internet.

Tianjin

AegiSafe O-Key

Track: New Application
Presentation: Room 32-123, Sunday 9:30 AM, Session 4
Poster: Session A, #4 (Stata)

The Shine-Dalgarno (SD) sequence is a ribosome binding site several basepair ahead of start codon AUG. It interacts with the anti-Shine-Dalgarno (ASD) sequence in the 16S rRNA in the ribosome to initiate protein translation. By mutate the basepair in the SD and ASD sequence, we produced an orthogonal translation system where the canonical ribosome cannot translate the orthogonal mRNA, and vice versa. We call this system O-Key. Using the O-Key, we are able to strictly control the synthesis of desired product and prevent potential contamination to the publics and environment. We can even build a completely new orthogonal phage that can only infect our engineered E. coli. With these successful examples, we demonstrated a bright and secure future that guarantees the safety of the human and environment with our O-Key.

Tokyo Tech

"Romeo and Juliet" by E.coli cell-cell communication

Track: Information Processing
Presentation: Room 32-123, Saturday 2:30 PM, Session 3
Poster: Session A, #20 (Lobby 13)

A love story contains several processes. Two people fall in love and their love burning wildly. However, no forever exists in the world, in most occasions, love will eventually burn to only a pile of ashes of the last remaining wind drift away. In our project, we have recreated the story of "Romeo & Juliet" by Shakespeare vividly by two kinds of Escherichia coli. We aim to generate a circuit involving regulatory mechanism of positive feedback rather than commonly-used negative feedback to control the fate of E.coli by signaling between two types of E.coli. Besides, Rose represents love. We will challenge to be the first iGEM group ever to synthesize PHA (a kind of bio-plastics) from glucose using the whole PHA gene sequence to represent rose.

Trieste

The JOLLY JoCARE

Track: Food & Energy
Presentation: Room 10-250, Sunday 10:00 AM, Session 4
Poster: Session A, #6 (Stata)

Recent studies have evidenced that having a beneficial and healthy intestinal microflora is very important for human health. Our aim is to modify a bacteria normally found in human gut and create a safe, controllable and versatile molecular platform which can be used to produce a wide range of molecules leading to a beneficial probiotic. For this purpose we have chosen the E. coli strain Nissle 1917 which has been used for many years as a probiotic. We designed a robust gene guard system regulated by a novel and easy to control inducible cumate switch that activates the production of a human antimicrobial peptide LL-37 that can kill the bacteria and also avoid horizontal transfer. The safe probiotic constructed here can be used to produce nutritious, preventive or therapeutic molecules. For example, we have used it to produce an antibody against the emerging virus, Norovirus.

Tsinghua-A
CPLD: a Cell-based Programmable Logic Device

Track: Foundational Advance
Presentation: Room 34-101, Sunday 10:00 AM, Session 4
Poster: Session A, #21 (Lobby 13)

The ambitious Tsinghua-A iGEMers are still dedicated to a beautiful combination of biology and engineering, and this year, the realization of a programmable logic device (PLD) on the gene sequence has become the focus of our attention. A series of symmetric logic-toggle modules, or briefly speaking, AND-OR switching gates, are designed to act as the basic parts of this Cell PLD. The idea comes from PLD which is widely used in electronics engineering. Hopefully, the construction of these modules in the cell will be achieved, with the help of the site-specific recombination systems. Feedforward control theory is introduced into the module and mechanism on the behavior has long been under our analysis, all aiming at a better performance of the logic gate. Modeling as well as computer simulation will help to evaluate and thus improve the robustness in this process.

TU-Delft
Snifferomyces

Track: Information Processing
Presentation: Room 34-101, Sunday 12:00 PM, Session 5
Poster: Session A, #11 (Stata)

The aim of this year's iGEM project will be the synthesis of an olfactory device for the purpose of characterization of volatile compound. Here, the aim is to introduce olfactory receptor gene fusions into Saccharomyces cerevisiae and linking these receptors to a transcription response. Aims:

I. The diagnostics of the presence of tuberculosis bacteria in the lungs by sensing chemical compound methyl nicotinate by S. Cerevisiae. For diagnostics, the response to these molecules is light generated by the lux proteins (visible blue light) or GFP (fluorescent green0.
II. Introducing receptors for sending the presence of banana-smell (iso-amyl acetate). This is done to see whether communication between S. Cerevisiae and E. coli is possible by this volatile intermediate.
III. Supplying a toolkit whch allows scientists to introduce olfactory receptors in yeast with minimal effort. Further we want to characterize the receptor parts submitted by the 2009 Hongkong university.

TU Munich
TUM-Brew: iGEM's first and finest SynBio Beer

Track: Food & Energy
Presentation: Room 32-123, Sunday 3:30 PM, Session 7
Poster: Session A, #30 (Lobby 13)

The TU Munich iGEM Team engineers "Saccharomyces cerevisiae", also known as baker's yeast, in order to lay the foundations for a new generation of functional foods with nutritionally valuable ingredients.

As an example, for iGEM's first "SynBio Beer" the compounds Xanthohumol (anticancerogenic), Limonene (limeflavor), Caffeine (stimulant) as well as the Thaumatin (protein sweetener) were chosen to demonstrate the spectrum of possibilities to complement traditional foods or beverages.

The metabolic pathways for these substances were converted to genetic BioBricks. Using the shuttle vector pYES2, which was adapted to the iGEM standard, transient transfection and expression in yeast were achieved. The gene products were subsequently characterized and their biosynthetic activities investigated.

Constitutive, alcohol-inducible and light-switchable promoter systems were developed, to individually regulate the expression of these gene cassettes. By combining these BioBricks our team has been able to brew iGEM's first and finest SynBio Beer.

UC Chile
Luxilla: a light rechargeable and programmable biolamp

Track: New Application
Presentation: Room 34-101, Sunday 4:30 PM, Session 7
Poster: Session A, #2 (Stata)

Synchronization of biological processes in populations is essential to achieve strong measurable and functional traits. Circadian rhythms are one of nature's most exquisite mechanisms to regulate and synchronize biological processes over time. Our team has taken advantage of the fine time control offered by the circadian clock machinery to construct a genetic circuit that allows robust oscillatory behavior in a synchronized and predictable manner. We have coupled the expression of genes of a bioluminescent pathway to the endogenous circadian clock of Synechocystis PCC 6803. The benefits of using Synechocystis as our chassis for practical applications include minimal production costs due to its autotrophic growth capacity and precise synchronization to time-dependent events using environmental cues such as light. As a direct application we designed the first self-rechargeable programmable bio-lamp. Secondary projects include a novel secretion system, the first spider-silk biobrick and an optimization of the Gibson assembly reaction for small parts.

UC Davis

Engineering Pathways for Polyethylene Terephthalate Degradation in E. coli

Track: Environment
Presentation: Room 32-123, Sunday 2:00 PM, Session 6
Poster: Session B, #2 (Stata)

Current plastic recycling practices successfully reduce the accumulation of non-degradable waste in the environment and landfills. However, they remain surprisingly expensive. Synthetic biology holds the potential to transform the recycling industry by altering the economics of waste processing. To this end, we are engineering a model organism, E. coli, to degrade polyethylene terephthalate (PET), a common plastic found in soda bottles, carpets, clothing, food packaging, and even space blankets. We engineer and express a gene originally found in leaf-branch compost encoding a cutinase enzyme whose product degrades PET into two products: ethylene glycol and terephthalic acid. Through rational and directed evolution of the E. coli chassis, we also create strains that utilize the breakdown product ethylene glycol as their sole carbon source.

UIUC-Illinois

PUF, The Magic RNA Binding Protein: Programmable RNA Binding Protein with Custom Functions

Track: Foundational Advance
Presentation: Room 34-101, Saturday 12:00 PM, Session 2
Poster: Session A, #5 (Stata)

RNA has characteristics that are important in human gene expression (i.e. alternative splicing of mRNA, noncoding RNA). Therefore, a modular RNA binding protein is an invaluable tool for gene regulation. The PUF domain of human PUM1 gene contains eight tandem repeats, each recognizing one of the four nucleotide bases. In theory, a PUF protein can be programmed to recognize any 8-nt ssRNA sequence. Here we demonstrate that PUF can be tethered with other functional domains for applications in E. Coli. Specifically, we show that a PUF/endonuclease fusion protein acts as RNA scissors, silencing gene expression through site specific mRNA cleavage. PUF was also tethered to split GFP to test its ability to co-localize proteins using a RNA scaffold. PUF biobricks offer a wide range of possible functions including gene expression modulation and scaffolding of metabolic pathways.

UNAM Genomics Mexico

Bacillus booleanus

Track: Information Processing
Presentation: Room 32-123, Saturday 3:00 PM, Session 3
Poster: Session A, #31 (Lobby 13)

Bacillus booleanus is a project that wants to create a “molecular computer”. How it works? We are working on the creation of different strains of Bacillus subtilis, each one will be able to perform a single Boolean operation just like a transistor. A single transistor is not a computer, they need to communicate with others to perform new logic operations, but how our bacterial transistors can communicate? In 2011, Ben-Yehuda et. al. identified a type of bacterial communication mediated by nanotubes that bridge neighboring cells, providing a network for exchange of cellular molecules within and between species. By using these nanotubes our bacterium will be capable to communicate with others so that create complex networks of logic gates. Using this it could be possible to develop a complex network of "transistors" to create, for example, a synthetic metabolic pathway.

UNITN-Trento
Crust Away

Track: New Application
Presentation: Room 32-123, Saturday 10:00 AM, Session 1
Poster: Session B, #10 (Stata)

Statues and monuments all over the world are often covered in a disfiguring black crust caused by weather and pollution. Current methods to clean black crust are either too destructive or non-effective. The aim of our project is to develop a system to more gently restore statues and monuments. To achieve this goal, we engineered E. coli to eat the black crust. More specifically, we introduced an aerobic sulfate reducing pathway and a hydrogen sulfide producing pathway into E. coli. In this way, the sulfate component of the black crust is transformed into a gas, thereby degrading the offending substance without degrading the original material of the statue. In addition to our black crust project, we developed a ratiometric fluorescence platform to test transcriptional terminators and subsequently used the platform to compare the efficiencies of T7 and E. coli transcriptional terminators with T7 and E. coli RNA polymerases.

University College London
Plastic Republic - Bioremediation of Marine Microplastic Waste

Track: Environment
Presentation: Room 34-101, Saturday 11:00 AM, Session 1
Poster: Session B, #20 (Lobby 13)

It is in the Great Pacific Garbage Patch that we are confronted with the real consequences of human plastic dependency: an immense mass of accumulating microplastic particles floating just beneath the surface of the North Pacific Ocean. Where attempts at physical removal and biodegradable plastics have failed to solve this pollution disaster, synthetic biology steps in. UCL's project proposes the bioremediation of microplastic waste by two systems: degradation using a laccase enzyme or aggregation by controlled expression of curli. Ultimately we envisage the construction of habitable islands - turning waste into a resource. We used novel chassis: two marine bacteria, Oceanibulbus indoliflex and Roseobacter denitrificans. In line with considering the viability of our project, we questioned the access ordinary citizens should have to these tools. Initiating a new partnership, UCL teamed up with a group of 'biohackers' (citizen scientists in molecular biology) to create the world's first 'Public BioBrick'.

USTC-Software
Reverse Engineering for Biological Regulatory Networks

Track: Software Tools
Presentation: Room 32-155, Saturday 11:00 AM, Session 1
Poster: Session A, #SW9 (Stata)

Traditional synthetic biological design creates or uses standardized parts such as BioBricks to build the genetic circuits, and uses mathematics to model the behavior. In this approach, biological design guides both experiments and mathematical modeling, but is it possible to use experimental data to reversely engineer the mathematical model and guide backwards the biological design? This project answers the question. We use reverse engineering techniques to get mathematical models such as ordinary differential equations(ODEs), directly from the experimental data and build the feasible designs according to the models. In this sense, we not only fully connect biology, experiments and mathematics, but also get feasible designs that have certain behaviors. To realize this idea, we build a suite of applications that provide researchers with efficient workflows.

UT-Tokyo-Software
Software tools for iGEMers: BioBrick/Project Search & Tutorials

Track: Software Tools
Presentation: Room 32-155, Saturday 10:30 AM, Session 1
Poster: Session A, #SW2 (Stata)

We developed new search and educational tools to assist iGEM teams. For many teams, the majority of team members are new-comers. Our primary goal therefore is to aid these beginners get used to iGEM earlier to make project initiation swift. All of our tools are web-based and have user-friendly interfaces enabling users to gain quick access to needed information. Our project consists of the following four tools.

“BioBrick Search” improves convenience in searching BioBrick parts by a sophisticated interface and an ordering algorithm taking into acount the parts' frequency of use. With “Past Project Search”, you can run a keyword search for all past projects and access past teams' presentation material easily. “BioBrick Puzzle” and “Gene Network Game” are educational games intended for beginners to acquire knowledge about BioBricks and gene networks, which aides them to plan their projects and conduct experiments.

Utah State
ArachniColi

Track: Manufacturing
Presentation: Room 10-250, Saturday 3:00 PM, Session 3
Poster: Session B, #9 (Stata)

Spider silk is the strongest known biomaterial, with a large variety of applications. These applications include artificial tendons and ligaments, biomedical sutures, athletic gear, parachute cords, air bags, and other yet discovered products which require a high tensile strength with amazing extendibility. Spiders however cannot be farmed because they are territorial and cannibalistic. Thus, an alternative to producing spider silk must be found. We aim to engineer spider silk genes into E. coli to produce this highly valuable product. Spider silk production in bacteria has been limited due to the highly repetitive nature of the spider silk amino acids in the protein. To overcome this obstacle we are using various synthetic biology techniques to boost spider silk protein production and increase cellular fitness. After successful production, spider silk protein is artificially spun into usable fibers and tested for physical properties.

UTP-Software
Bricks, Mutagenesis and Energy Software Tools

Track: Software Tools
Presentation: Room 32-155, Saturday 3:30 PM, Session 3
Poster: Session A, #SW6 (Stata)

A program to help new IGEM teams with assembly standards selection, and site-directed mutagenesis for primers development in case of incompatibility, is this year UTP-Software team project. S2MT as we called it, applies “QuikChange Site-Directed Mutagenesis” [1] considerations for the design of mutagenic primers and gives users the resources to avoid restriction sites, making their designs compatible with IGEM standards. Our team is also interested in the development of a tool to help teams and researchers to work and study the production of bioenergy through synthetic biology. This will be done by analyzing metabolic routes from the substrates for the reactions, and then identify the responsible genes for each enzymatic reactions that could produce these biofuels.

Virginia
Genetically engineered bacteriophage for diagnosis of whooping cough

Track: Health & Medicine
Presentation: Room 34-101, Saturday 3:00 PM, Session 3
Poster: Session B, #16 (Stata)

Whooping cough, the infectious respiratory disease caused by Bordetella pertussis, is diagnosed in tens of millions of people and results in almost 300,000 deaths globally each year. Low-income and unvaccinated individuals as well as infants are especially susceptible. Current diagnostic procedures are complicated, costly, and can take up to a week, by which time the disease may have progressed or spread. The enormous impact of this disease urgently motivates the development of a faster, cheaper, and more reliable diagnostic test. Our epidemiology models suggest that earlier diagnosis could drastically reduce the incidence and impact of the disease. We propose an engineered bacteriophage diagnostic system for rapid clinical detection of pertussis. We first engineered T7 bacteriophage to demonstrate this approach in E. coli. Our modular diagnostic approach can be applied to the high-sensitivity detection of other bacteria.

Wageningen UR
A standardized tool for site specific drug delivery using Virus-Like Particles

Track: Health & Medicine
Presentation: Room 32-123, Saturday 1:00 PM, Session 2
Poster: Session B, #27 (Lobby 13)

Medicines are generally active in a non-site-specific fashion, affecting the whole patient, including healthy tissue. Therefore, we attempt to specifically target diseased areas by packaging medicines inside Virus-Like Particles (VLPs). VLPs are not infectious, as they are built solely from viral coat proteins. We designed a modular Plug and Apply system that enables modifications to these coat proteins. The system facilitates the linkage of numerous ligands to the coat protein, thereby creating site-specific carriers. After expression of coat protein genes in Escherichia coli the VLPs were assembled in vitro, yielding modified Virus-Like Particles. Medicines can be packed using the Plug and Apply system or simply by addition during VLP assembly. Concluding, VLPs can be used as universal carriers for site-specific drug delivery, allowing customization to a variety of diseases while decreasing side effects for patients during treatment.

Wellesley HCI

Enhancing Bio-Design with Touch-Based Human-Computer Interaction

Track: Software Tools
Presentation: Room 32-155, Saturday 3:00 PM, Session 3
Poster: Session A, #SW8 (Stata)

Synthetic biology will require a multidisciplinary, collaborative design environment in order to engineer the complex biological systems of the future. Our team created a collection of software tools, which address specific technical synthetic biology challenges while advancing the way in which users interact with computing environments. We also utilize advances in human-computer interaction (HCI) to communicate core concepts of synthetic biology to the public. Synbio Search is an online tool that generates data sheets for biological parts by aggregating data from various publicly available resources. MoClo Planner visualizes the Golden Gate Modular Cloning process and facilitates hierarchical design and production of multi-gene constructs. SynFlo is an interactive installation that utilizes tangible and tabletop HCI techniques to illustrate core concepts of synthetic biology in outreach programs. The application of novel HCI techniques to synthetic biology fosters the development of more effective, collaborative, and intuitive software tools, which enhance the design-build-test methodology.

WHU-China

E. coslim: Synthetic Probiotics Help Defy Obesity

Track: Health & Medicine
Presentation: Room 34-101, Saturday 2:30 PM, Session 3
Poster: Session A, #10 (Stata)

Utilizing human microbiota to tackle diseases has long been the keen desire of scientists. This year, we WHU-China team engineered a probiotics “E. coslim” from Escherichia coli, hoping to provide a new approach for treating obesity. Specifically, three genetic devices were designed. The first two devices were assembled to sense and response to fatty acids and glucose. To achieve these goals, promoters repressed by FadR and CRP were devised and synthesized respectively. When functional genes are placed downstream of these promoters appropriately, the two devices are supposed to degrade fatty acids and convert glucose into cellulose rapidly, thus preventing excessive calorie intake as well as producing prebiotics. Meanwhile, the third device was designed to control the densities of “E. coslim” and forestall horizontal gene transfer in future applications. As a whole, by simulating, we are developing “E. coslim” to regulate the microbiome composition in intestine to reduce risks of obesity.

Wisconsin-Madison

A tool to evaluate the translation of heterologous genes in Eschericia coli

Track: Food & Energy
Presentation: Room 10-250, Sunday 9:30 AM, Session 4
Poster: Session A, #17 (Stata)

In synthetic biology, a powerful method for the production of novel metabolites is the expression of heterologous genes inEscherichia coli. A common challenge when using non-native genes in metabolic engineering is determining if they are being properly expressed. To address this issue, we have constructed a BioFusion compatible system for testing the translation of a gene of interest. This system couples the translation of the target gene to a fluorescent reporter gene. Fluorescence will only be detected when the target gene is entirely translated. This construct enables synthetic biologists to quickly determine if a gene is being expressed without the need for costly antibodies or analytical instruments (e.g. mass spectrometry). Currently, we are utilizing this cassette to troubleshoot the expression of limonene synthase, an enzyme that catalyzes the production of limonene, a monoterpene with potential as a renewable jet fuel.

XMU-China

E.Lumoli: a shining synthetic device for digit or time-course display

Track: New Application
Presentation: Room 32-123, Saturday 11:00 AM, Session 1
Poster: Session B, #18 (Lobby 13)

We haved constructed a fluorescent digital display device with synthetic logic gates, which is able to respond to signals by displaying and switching numbers. We put GFP equipped with degradation tags in downstream to illuminate our numbers and change them quickly as well. Considering our engineering background, we accordingly employ cell immobilization to build our device. Engineering bacteria have been embedded in intra-hallow calcium alginate microcapsules and in PDMDAAC-NaCS microcapsules, respectively. In addition, 3D CAD design is performed for a perfect device. Our genetic circuits vary in length and RBS strength, leading to different durations of time delay for GFP expression. This inspired us to extend our work last year. By altering the strength of RBS at five grades, another five circuits have been built. After the induction by arabinose, the duration of response time for GFP expression increases as the strength of RBS declines, bringing about a time-course display.

Yale

Multiplex Automated Genome Engineering (MAGE) in Naturally Competent Bacteria: An Alternative to Cloning

Track: Foundational Advance
Presentation: Room 10-250, Saturday 10:30 AM, Session 1
Poster: Session B, #23 (Lobby 13)

Traditional plasmid-based cloning methods are limited by tedious protocols that make targeted genetic changes within the cell. Multiplex Automated Genome Engineering (MAGE), an alternative technique for rapidly generating genomic diversity using the recombination ability of the λ-phage ssDNA-binding protein β, has to date only been introduced in *E. coli*. These cells must be transformed via electroporation for each MAGE cycle to facilitate efficient uptake of mutagenic oligonucleotides, but this process kills a significant portion of otherwise viable cells. For our project, we designed and created a universal test cassette system to introduce MAGE to diverse bacteria as well as a library of β homologs for testing. Finally, we optimized the technique for the naturally competent organisms *B. subtilis* and *A. baylyi* to eliminate the costly electroporation step and developed computational algorithms to aid in the design and prediction of MAGE experiments.

ZJU-China

Riboscaffold

Track: New Application
Presentation: Room 10-250, Saturday 1:00 PM, Session 2
Poster: Session B, #31 (Lobby 13)

ZJU-China aims to design and realize a tunable RNA scaffold to accelerate biological pathways and turn their on and off. RNA scaffold is designed to colocalize enzymes through interactions between binding domains on the scaffold and target peptides fused to each enzyme in engineered biological pathways in vivo, which may suffered from low efficiency of production caused by relative lack of spatial organization of non-homologous enzymes. The scaffold allows efficient channeling of substrates to products over several enzymatic steps by limiting the diffusion of intermediates thus providing a bright future for solving the problem. Meanwhile, we plan to add an aptamer structure on RNA scaffold as a switch to regulate biological pathways by micromolecular ligands. Then we can control the all-or-none binding relationship between the enzymes and scaffold by whether the special ligands are presented or not.