



iGEM 2010 Jamboree Program

Aberdeen Scotland

The AyeSwitch: a translationally regulated genetic toggle switch in yeast

Track: New Application

Presentation: Room 10-250, Sunday, 3:00 PM

Poster: Sunday - Session B, #59 (B59)

A novel genetic toggle switch regulated at the translational level was engineered in yeast that allowed the mutually exclusive expression of either green or cyan fluorescent protein. Using cell cytometry (FACS) and fluorimetry, we demonstrated in yeast the successful expression and translational regulation of a fusion of mRNA binding protein and fluorescent protein. These results, along with published parameter values, were used to predict via deterministic and stochastic models that the probability of successful bistability for our switch was 0.96%, but this could be improved theoretically to a maximum of 51.27% by limiting the range of variation of the most sensitive parameters. The models also predicted that co-operative binding of the mRNA binding protein to its mRNA stem loop was essential for generating switch-like behaviour. These results suggest that a translationally regulated genetic toggle switch is a viable and novel engineering concept applicable to medicinal, environmental and technological problems.

Alberta

GENOMIKON: An Educational Tool Kit for Rapid Genetic Construction

Track: Foundational Advance

Presentation: Room 34-101, Sunday, 4:30 PM

Poster: Sunday - Session B, #29 (B29)

Building DNA is too hard. Democratizing Synthetic Biology will demand fundamental advances to make DNA construction easier and cheaper, thereby enabling broader access to biotechnology by the public. Our team has tackled this challenge with the design of an inexpensive self-contained kit called GENOMIKON, currently targeted for the high school and DIY communities but with clear potential for professional use. The kit contains prefabricated parts that are sequentially assembled on a solid support using cycle times of 5 min./part with a coupling efficiency of ~95%. The parts exist with sufficient diversity and quantity for hundreds of unique experiments. The kit is accompanied by an online resource that serves as lab manual, notebook, information management system and social network for the exchange of ideas. While similar in concept to our last year's project, GENOMIKON differs in most technical aspects and is far superior in performance.

ArtScienceBangalore

Synthetic and Post-Natural Ecologies

Track: New Application

Presentation: Room 26-100, Sunday, 11:30 AM

Poster: Saturday - Session A, #44 (A44)

In our second year as artists and designers at iGEM, we have decided to investigate the consequences of creating a Synthetic Ecology: an ecosystem in which organisms designed for a techno-scientific environment interact with organisms in the wild. *C.elegans* live on a diet of a variety of bacteria, *E.coli* being such strain. Genetically-modified *E.coli* can be fed to *C.elegans* which can then express any double stranded RNA of interest. The dsRNA can knock off specific genes in *C.elegans*. In our experiments, we are using *C. elegans* as a marker to express a range of external factors in two sets, temperature and IPTG. On a utilitarian level, our project investigates the use of *C.elegans* as a visual marker for changes in environmental conditions. On a more critical level, *C.elegans* is used to study the consequences of interactions between engineered organisms and the 'natural' world.

Baltimore US

DIY-GEM: a path towards low cost high throughput gene synthesis

Track: Manufacturing

Presentation: Room 54-100, Saturday, 3:30 PM

Poster: Saturday - Session A, #12 (A12)

Synthetic biology research requires more cost effective approaches toward reagents and hardware accessibility. We are developing low-cost alternatives to existing hardware and enzymes in an attempt to expand participation in biological research and development. Our project expands the accessibility of Taq Polymerase by engineering it in a form compatible with BioBrick assembly. This allows use of the over-expressed enzyme from a crude bacterial extract in a PCR reaction at a fraction of the cost of highly purified commercial enzyme. In addition, we have developed inexpensive and easily assembled lab equipment such as a gel electrophoresis apparatus and a PCR thermal cycler. Enabling researchers to synthesize their own enzymes and having access to inexpensive tools will allow for increased participation among the DIY-bio community, stretch increasingly scarce educational funds, and allow rapid scale up of large scale gene synthesis projects.

BCCS-Bristol

agrEcoli: Smarter farming through bacterial soil fertility sensors

Track: Food & Energy

Presentation: Room 34-101, Sunday, 3:30 PM

Poster: Saturday - Session A, #33 (A33)

Fertiliser production is a major contributor to global carbon emissions, and excess fertiliser can cause immense damage to local ecosystems. Our lab has developed and characterised a cheap, versatile soil fertility sensor based on an E.coli chassis. It expresses fluorescent signals upon nutrient detection, producing a high-resolution nutrient distribution map of arable land. The ratio of two fluorescent signals allows farmers to quantify soil nutrient content. agrEcoli bacteria, encapsulated within a gel container to improve visibility and prevent escape, have been shown to work on soil in lab conditions. We have explored the marketing of our device, considering public perceptions of synthetic biology. BSim, our prize-winning modelling framework, has been extended to analyse our new biobricks' behaviour within gel capsules. In addition, a new interface for BSim has improved its accessibility to the wider synthetic biology community, facilitating collaboration. agrEcoli optimises fertiliser use, saving farmers' money and reducing environmental damage.

Berkeley

Choachoa's Delivery Service

Track: New Application

Presentation: Room 26-100, Sunday, 12:00 PM

Poster: Saturday - Session A, #53 (A53)

Single-celled phagocytic eukaryotes like Choanoflagellates are of great interest to developmental biologists because they may be the last living immediate precursor on the evolutionary tree to animals. These easy to culture and robust organisms are also a desirable eukaryotic chassis for synthetic biology, but there are few tools for delivering biomolecules into these organisms. So, we engineered E. coli to deliver proteins and/or DNA payloads into these bacteria-devouring eukaryotes. Once ingested, our E. coli are programmed to self-lyse and porate the phagosome, releasing their payloads into the cytosol. This delivery mechanism has the potential to deliver payload to any phagocytic organism with a cholesterol-based membrane. As part of our parallel software effort to rework the Clotho plugin environment and API, we made automatic biosafety handling an intrinsic feature of the core. Together, these tools provide a foundation for metazoan synthetic biology and a framework for improving safety in our field.

Bielefeld-Germany

MARSS - Modulated Acetosyringone Receptor Sensor System Defining Spiciness since 2010

Track: Food & Energy

Presentation: Room 34-101, Saturday, 2:00 PM

Poster: Saturday - Session A, #36 (A36)

The iGEM-Team Bielefeld is going to modulate an Agrobacteria receptor in Escherichia coli in order to detect capsaicin which is responsible for the hot taste of chillies. The intention is to make the spiciness in fare visible using a gradient light signal. The original receptor is the acetosyringone detection system of Agrobacterium tumefaciens. By using directed evolution, we aim to modulate the receptor binding domain to enable the interaction with similar

phenolic substances like capsaicin. Brought into *E. coli*, this modulated system will induce light effects of different intensities - depending on the concentration of capsaicin respectively the spiciness of the sample. The capsaicin detection is a proof of principle concept. We aim to establish a system, which is characterized by a high sensitivity and specificity and is capable to replace slow and high priced diagnostics or analytic methods. The targets of the system could be allergy-triggers, explosives and toxins.

BIOTEC Dresden *SensorBricks*

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 10:30 AM

Poster: Saturday - Session A, #52 (A52)

SensorBricks is a reliable and modular system for antigen recognition, signal amplification and quantification. Initial steps of SensorBricks will focus on the detection of CD33 and other leukemic markers to increase diagnostic stringency. There are three major components in SensorBricks: (i) monoclonal antibodies that bind to an antigen of interest, (ii) a LuxI-Protein A fusion construct which non-specifically binds antibodies and produces the autoinducer N-Acyl homoserine lactone (AHL), and (iii) a *Escherichia coli* based biosensor which strongly amplifies the production of a fluorescence protein in the presence of AHL. By coupling signal detection to a genetic circuit, we would be able to amplify the signal in a quantifiable manner, allowing the identification of cancer markers expressed in minute quantities.

British Columbia

A Multi-pronged Approach to Eliminating Staphylococcus aureus Biofilms Using Recombinant Bacteriophage and Biofilm-Degrading Enzymes

Track: Foundational Advance

Presentation: Room 32-123, Sunday, 9:30 AM

Poster: Saturday - Session A, #34 (A34)

Biofilms are ubiquitous microbial communities that often display greater resistance and pathogenicity compared to individual microbes. Biofilms commonly cause complications in both industrial and medical settings and represent a significant source of morbidity and mortality. A synthetic biology approach to tackling biofilms has only recently been applied to *Escherichia coli* biofilms. To eliminate the more clinically relevant *Staphylococcus aureus* biofilms, our team aims to break new ground at iGEM by using *S. aureus* as a model host and developing a standard for genetically engineering bacteriophages. Our design incorporates DspB, a biofilm matrix-degrading enzyme into the ϕ 13 phage genome, which is altered to operate under the regulation of the *S. aureus* agr quorum sensing pathway and thus upon contact with biofilms. As a complement, we have also developed a mathematical model that simulates the dynamics of our system under different conditions.

Brown

Light Pattern Control of Cell Circuits

Track: Manufacturing

Presentation: Room 54-100, Saturday, 3:00 PM

Poster: Saturday - Session A, #2 (A2)

Biological manufacturing of complex compounds often requires the synthesis of many intermediate products. Production of these intermediates is currently triggered by inefficient methods, such as chemical inputs (tetracycline, estrogen-analogs, arabinose, etc) or drastic changes to the cellular environment (pH, oxygen levels, temperature, etc). On an industrial scale, this chemical induction requires large quantities of reagents and extensive purification, while environmental induction requires conditions that can adversely affect cell vitality and yield. To this end, we have designed an *E. coli* genetic circuit that can pass through four stable states of protein production triggered solely by ON/OFF patterns of light. To efficiently test the components of our circuit, we have also created a system for the transient delivery of transcription factors through the cell and nuclear membranes. With this production method, we can link multiple synthesis steps to a single, clean and rapidly scalable input.

Calgary

Translating Stress Into Success

Track: Foundational Advance

Presentation: Room 34-101, Sunday, 12:30 PM

Poster: Saturday - Session A, #28 (A28)

The majority of projects in synthetic biology involve the over expression of recombinant proteins in microorganisms. A major stumbling block however, is often an inability to express functional protein. This situation is difficult to manage and troubleshoot as it is often unclear why expression is failing. We have designed a system that can accurately and visually report whether a gene is being transcribed and/or translated. The system also differentiates whether expression is failing due to misfolding in the periplasm or cytoplasm. In the case of misfolding, our system can also fine tune expression levels of a given protein to optimize production, increasing the likelihood of obtaining functional protein. To further understand protein misfolding we have built an equation-based, multivariant model of inclusion body formation. Finally, we used a series of podcasts to explore the social implications of our project in the context of the growing synthetic biology industry.

Caltech

Towards the Production of a Bioplastic Bioprinter and Design for a General Printing Framework

Track: Manufacturing

Presentation: Room 54-100, Sunday, 4:30 PM

Poster: Sunday - Session B, #2 (B2)

Our goal for the was to create and print a bioplastic, polyhydroxybutyrate (PHB), from soybean oil using *E. coli*. Our proposed design uses a radical crosslinking reagent to crosslink PHB monomers in cell lysate, released upon a light-induced lysis gene network. We hope to apply this printing ability to three-dimensional printing, offering a cheap alternative to current rapid-prototyping technologies. Our work involves characterizing an infrared promoter for light-lysis, experimenting with PHB production in cells, and the design of a dual-wavelength printing system. We discuss how this system could be generalized to create a framework for actuating groups of cells in any 3D volume to theoretically modulate behavior more complex than lysis. We also plan to apply special consideration to the ramifications of possible commercial enterprises developed in iGEM competitions with open source biological materials, such as BioBricks™.

Cambridge

E.glowli: a bioluminescent future

Track: New Application

Presentation: Room 26-100, Saturday, 3:00 PM

Poster: Saturday - Session A, #55 (A55)

Bioluminescence is one of the most striking spectacles in the natural world. Taking genes from fireflies and *Vibrio fischeri*, the Cambridge team have constructed BioBricks which allow light output at a wide range of wavelengths. Firefly luciferase is already used as a reporter, but requires continual addition of the expensive substrate luciferin. We have created codon-optimised operons combining luciferase with a luciferin regenerating enzyme (LRE). This allows recycling of luciferin for sustained light output. In addition, we have submitted the first lux operon to the registry, taking genes from bacteria which form symbiotic relationships with squid. This is the first BioBrick to emit light without addition of substrate and can be used as a reporter with any promoter. These two approaches will allow cheaper assays with brighter signals. We also hope they will lay the foundations for natural light sources that help to address the energy crisis facing our planet.

CBNU-Korea

Design and Construction of Synthetic Minimal Chromosomes

Track: Foundational Advance

Presentation: Room 32-123, Sunday, 10:30 AM

Poster: Saturday - Session A, #32 (A32)

Most of all bacteria have single circular chromosome. But some bacteria have two or more circular chromosomes. In *Vibrio cholerae*, there are two circular chromosomes, chromosome I and chromosome II, and each perfectly works as a chromosome. We've been motivated by *V.cholerae*'s two chromosome system. So we employed some essential genes, *parA*, *parB*, *parS*, *dif*, and origin of chromosome II and constructed a tiny miniature of *V.cholerae*'s two chromosome system in *E.coli*, using BioBrick assembly method. Also, we built software and database of essential genes for designing of minimal synthetic chromosome and genome. Essential gene informations were gathered from some databases, DEG, EGGS, NCBI and java language was used. Our final goal is making useful, safe and stable synthetic minimal genome for Synthetic Minimal Cell. Although our project is feeble, we extremely believe that our project in this year will be worth first step for that.

Chiba

Eliminating the False-Input ~Genetic Double-Click System~

Track: New Application

Presentation: Room 26-100, Saturday, 11:00 AM

Poster: Sunday - Session B, #55 (B55)

We daily double-click the icons to open the files or to exert the program: this is clearly distinguished from the single click, which is often for selecting or highlighting the program. This year, iGEM CHIBA is constructing genetic double-click system whose output is released only when the input (inducing agent) is given twice within a limited time. To discriminate double-click from two separated single-clicks, the 1st input is to be memorized temporarily. If the 2nd input is added before the memory gets lost, output will be produced. If the 2nd input is not added within the given time, the system will be reset to the original state. This mechanism could work as a sort of safety device; by requiring the 2nd 'confirmation' input, one can drastically reduce, or even eliminate, the frequency of false-inputs. This system could be useful in operating the potent or potentially-hazardous biochemical processes.

Cornell

OMG OMVs!

Track: Health & Medicine

Presentation: Room 10-250, Sunday, 12:30 PM

Poster: Saturday - Session A, #40 (A40)

Outer membrane vesicles (OMVs) are natural secretions by gram-negative bacteria that can transport various proteins, lipids, and nucleic acids in interactions with mammalian host cells. OMV technology presents an affordable, non-toxic, and direct method of drug delivery and antigen tracking. We have designed a method for visualizing the interactions of mammalian cells with outer membrane vesicles by utilizing the ClyA surface protein as an attachment site for fluorescent proteins. The current goal of this project is to characterize the distribution of varying ClyA-fluorescent protein complexes on OMVs. Future work will be to develop a tracking system employing a ClyA-fluorescent protein construct for in vitro microscope imaging. An antibody fragment will also be attached to another ClyA complex, allowing the OMV tracking system to target specific regions of an organism. This method allows in vitro characterization of OMVs and provides integral data for developing a future OMV delivery platform in vivo.

Davidson-MissouriW

Foundational Advances in Biology and the Knapsack Problem

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 10:30 AM

Poster: Saturday - Session A, #24 (A24)

We focused on the Knapsack Problem which asks, "Given a set of weighted items and a knapsack of fixed capacity, is there some subset of these items that fills the knapsack?" Weighted items are represented by TetA alleles that confer measurably distinct levels of tetracycline resistance in *E. coli*. Excess TetA kills the cells; insufficient TetA can be screened by plating on tetracycline plates. Each TetA allele is coupled with a distinctive fluorescent gene, and both are flanked by variant lox sites. Cre protein can invert or excise floxed DNA, yielding different combinations of expressed TetA alleles. We constructed different TetA alleles by altering codon optimization and characterized the consequence of changing the order of two genes (TetA and RFP). Furthermore, we designed and tested a total of 11 new lox sites for site specific recombination. We developed several open access software tools for the wider synthetic biology community.

Debrecen-Hungary

The lipid sensor eukariotic toolkit

Track: Food & Energy

Presentation: Room 34-101, Saturday, 1:00 PM

Poster: Saturday - Session A, #22 (A22)

Eukaryotic synthetic biology has huge potential, yet it is still in need of more diverse molecular tools for defined gene regulation. Nuclear receptors are a conserved family of proteins responsible for sensing lipids; they may be viewed as lipid activated transcription factors. We have successfully developed a kit with a variety of lipid responsive domains (from *H.sapiens*, *D.melanogaster* and *C.elegans*) for the rational construction of synthetic transcription factors. The

domains respond only to predefined lipids and selectively activate predetermined gene expression. To characterize these domains, we used standardized protocols for comparable measurements. In vivo gene expression was measured as a function of ligand concentration using luciferase activity. The potential for these tools is immense; e.g. from the ultra sensitive detection of lipid contaminants in the environment to the opportunity of titration specific gene expression changes in patients undergoing gene therapy.

DTU-Denmark

Bi[o]stable – Engineering a bistable switch

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 4:00 PM

Poster: Saturday - Session A, #23 (A23)

The aim of this project is to engineer a genetic bi-stable switch that produces two different, mutually exclusive outputs when given two different inputs. The switch is based on the repressor-anti-repressor system of the salmonella phages Gifsy1 and Gifsy2 and the λ -phage anti-termination system. The latest induced output will remain stable through generations, even once the input ceases, due to the phage regulatory systems. We present the framework for this development and characterize the regulatory mechanisms by using fluorescent proteins as the reporter (outputs). The dynamics of the system have been modeled and we have also attempted to characterize and submit the promoters, repressors and anti-repressors from the salmonella phages, as well as the two anti-terminator proteins from the lambda phage, as BioBricks. We have hereby demonstrated the engineering of a multipurpose bi-stable switch sensor/reporter tool that can have numerous applications.

Duke

Engineering a Robust Genetic Switch

Track: Foundational Advance

Presentation: Room 32-123, Saturday, 2:00 PM

Poster: Sunday - Session B, #32 (B32)

Our project aims to produce a genetic transistor which, unlike most bistable switch mechanisms available to synthetic biologists, does not exhibit basal regulatory noise. The transistor will be based on a protein sequestration pathway that uses leucine zippers (bZIPs) Fos and Jun alongside synthetically designed dominant negatives thereof, eliciting a response dynamic similar to a signal titration. Furthermore, we intend to apply such transistors to function as signal amplifiers due to the ultrasensitive responses that can be generated in this mechanism. For the application of this project and others, we are also developing a high throughput gene expression screen for synthetic gene libraries and codon variants, allowing for the possibility of tunable gene expression levels.

Edinburgh

Communicating Through Bridges: Bridging with Biology, Bridging with Light, Bridging with People

Track: Foundational Advance

Presentation: Room 32-123, Sunday, 10:00 AM

Poster: Sunday - Session B, #36 (B36)

The engineering equivalent of Genetic Engineering is to get a bunch of concrete and steel, throw it into a river, and if you can walk across it, call it a bridge. Synthetic biology and iGEM have long attempted to refine this process of 'bridge-building'. The 2010 University of Edinburgh team has applied this idea comprehensively throughout their project. The BRIDGE protocol (BioBrick Recombineering In Direct Genome Editing) is a protocol for markerless insertion of BioBricks onto the bacterial chromosome, which will bridge ideas and reality in synthetic biology. Bacterial BRIDGES aim to foster non-chemical means of communication between bacteria by pairing light-producing and light-sensing BioBricks; future teams may make use of them in a variety of novel applications. Finally, human BRIDGES examine synthetic biology as ways of thinking and the permeation of human aspects, bridging the so-called 'divides' between disciplines and individuals. The question is... how do you think?

EPF Lausanne

Asaia, the pink force against malaria

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 10:00 AM

Poster: Saturday - Session A, #54 (A54)

Malaria is a tropical disease that kills more than 1 million people each year and no effective cure or vaccine exists yet. The EPFL iGEM project aims to stop malaria propagation by acting on the vector: the mosquito. We are engineering Asaia, a bacterium that naturally lives in the mosquito's gut, to express an immunotoxin that can prevent the malaria agent *Plasmodium falciparum* from infecting the mosquito, thereby eliminating the transmission of this parasite to humans. Asaia is an organism that is easy to grow and genetically manipulate. We are establishing Asaia as a new chassis so that future iGEM teams can quickly and efficiently engineer new and more potent Asaia strains. This will provide the synthetic biology community with a useful tool in the fight against malaria and other mosquito-borne diseases.

ESBS-Strasbourg

A light-controllable specific protein degradation system as new standard for synthetic biology

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 10:00 AM

Poster: Sunday - Session B, #38 (B38)

The aim of our project is to engineer a new fundamental component that could be universally used to build more complex or more controllable biological circuits inside chassis organisms. This new component consists of the *E. coli* protease ClpXP to which the phytochrome B (PhyB) of *Arabidopsis thaliana* is fused. Any given protein can be degraded as long as it is fused with the Phytochrome Interacting Factor (PIF)-degradation tag biobrick. The activity of this system is tightly controlled and switchable by light inducement.

ETHZ Basel

E. lemming – a remote controlled living robot

Track: Information Processing

Presentation: Room 54-100, Saturday, 1:00 PM

Poster: Saturday - Session A, #7 (A7)

We control the movement of a single *E. coli* cell by light. In wild type *E. coli* flagella movement is controlled by proteins of the chemotaxis pathway, so called Che proteins. In our engineered cells one of these Che proteins is fused to a synthetic light-sensitive localization system. Two external inputs – red light and far red light - induce the relocation of the fused proteins, thus reversibly changing flagella movement direction. Cells, imaged by bright field microscopy, are automatically detected and tracked while a closed loop controller guides the cell into a user defined direction by autonomously sending light inputs. This makes our engineered cell the smallest remote controllable living robot on earth.

Freiburg Bioware

A Modular Virus Construction Kit for Therapeutic Applications

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 9:30 AM

Poster: Sunday - Session B, #44 (B44)

Gene delivery using viral vectors holds great promise for the treatment of acquired and inherited diseases. The human Adeno-Associated Virus (AAV) is a small, non-pathogenic, single-stranded DNA virus gaining increasing attention being both versatile and effective. Taking current knowledge into account, we generated a recombinant, modularized, BioBrick-compatible AAV 'Virus Construction Kit'. We provide parts for modified capsid proteins, targeting modules, tumor-specific promoters, and prodrug-activating enzymes as well as readily assembled vectors for gene delivery and production of non-replicative virus particles. The viral tropism is altered by N-terminal fusion or by loop replacement of the capsid proteins. Functionality of viruses constructed from our kit was demonstrated by fluorescent protein expression in infected cells and by prodrug-induced killing of tumor cells upon viral delivery of a thymidine kinase. Incorporating multiple layers of safety, we provide a general tool to the growing field of personalized medicine and demonstrate its use in tumor therapy.

Freiburg Software

SynBioWave 2.0 – A Collaborative Toolkit for Synthetic Biology

Track: Software Tools

Presentation: Room 32-123, Saturday, 10:30 AM

Poster: Sunday - Session B, #26 (B26)

SynBioWave is an open-source, Synthetic Biology software suite based on Google's open-source communication tool Wave. SynBioWave enables research collaboration by real-time sharing of parts, design and documentation. Moreover, biologists can record and share the process of creating research data. Last year our team developed the basic SynBioWave robot. This year we ported the main program (Robot) to Wave API 2.0 and improved user friendliness, separated the input and output from the sequence database operations by creating a linked wave for data storage. We also provide the "blueprint-robot", a framework easing new robot development. Furthermore, we are adding new functionality by creating add-on robots that perform tasks such as BLAST-searches, ORF-finding, translation, sequence alignments and restriction site mapping. The main robot is available at SynBioWave@appspot.com, the source code at <http://synbiowave.sourceforge.net> and the homepage of the project is <http://www.synbiowave.org>.

Gaston Day School

Construction of a Biological Iron Detector in a Secondary School Environment

Track: Environment

Presentation: Room E51-151, Saturday, 3:30 PM

Poster: Sunday - Session B, #16 (B16)

Our team's project was to create a biological iron detector using techniques and procedures available to an ordinary high school laboratory that replicate methods used in university research laboratories. We constructed our reporter by combining an iron-sensitive promoter with a red fluorescent protein (RFP) coding sequence. We chose RFP because of its high visibility and easy detection. Although the assembly was successful, the resulting detector is leaky with measurable RFP even in conditions with no iron present. In our lab environment, we found that it was necessary to work with relatively high concentrations of bacteria and DNA. We developed simplified procedures for transformations, digests, and ligations, but we continue to face problems with DNA visualization and measuring the pigments from the bacteria.

Georgia State

Pichia pastoris: A Novel Chassis for iGEM

Track: Foundational Advance

Presentation: Room 34-101, Sunday, 12:00 PM

Poster: Sunday - Session B, #28 (B28)

The methylotrophic yeast, *Pichia pastoris*, is increasingly used as an alternative host for heterologous protein production. *P. pastoris* is advantageous because it is able to perform eukaryotic post-translational modifications, produce high yields of recombinant protein, and it is genetically similar to *Saccharomyces cerevisiae*. (Cereghino and Cregg, 2000). The 2010 Georgia State team believes *P. pastoris* would be an excellent chassis for the iGEM competition. The purpose of this project is to provide a tool box of parts necessary for the genetic manipulation of this organism. These parts include a variety of promoter systems, multiple selectivity options, and a plasmid backbone. In addition, the tool box will be used to produce a flu virus antigen in *P. pastoris* as a representation of the applicability of this system. These contributions will enable future users to maximize the use and further explore the incredible potential *P. pastoris* has to offer.

GeorgiaTech

Inducing a Thermogenic Response to Cold-shock in Bacteria

Track: Manufacturing

Presentation: Room E51-151, Sunday, 10:30 AM

Poster: Sunday - Session B, #4 (B4)

Alternative Oxidase (AOX) is a terminal oxidase protein found in the respiratory chain of various organisms ranging from aquatic prokaryotes to plants and animals. In the AOX pathway, electrons are transferred from ubiquinone to AOX, and then directly used to reduce oxygen. The drop in the electric potential energy of the electrons transferred from AOX to oxygen is dissipated as heat. Our project has focused on 1) cloning the AOX gene from a thermogenic plant (Sacred Lotus) into *E. coli* to induce a thermogenic response to a cold-shock, and 2) calculating a theoretical rate of heat production per bacterial colony to select for an appropriate calorimetric technique. Further, numerical methods in MATLAB will be employed to model the steady-state temperature profile of the synthetic bacterial colony, and to potentially corroborate later experimental findings. Engineering a controlled thermogenic response in bacteria could lead to improved bacterial functioning in cold shock environments.

Groningen

Hydrophobofilm --- a self assembling hydrophobic biofilm

Track: New Application

Presentation: Room 10-250, Sunday, 2:30 PM

Poster: Saturday - Session A, #49 (A49)

Surface hydrophobicity is a useful property and has many applications. Hydrophobicity keeps a surface clean and dry preventing micro-organisms from attaching to a surface. Most chemical coatings used presently are costly or harmful to the environment. Our idea is to engineer *Bacillus subtilis* which when applied to a surface, automatically forms a hydrophobic biofilm coating. Successful biofilm formation will serve as a trigger for the expression of hydrophobic proteins called Chaplins. The result of this process will be a rigid biofilm with embedded hydrophobic proteins, leaving a coated surface which is extremely hydrophobic. Producing a self-assembling hydrophobic biofilm is cheap, there is no high-tech treatment involved and there are no hazardous chemicals necessary to attain a hydrophobic coating. Applications of this hydrophobic biofilm range from anti-fouling coatings on ships to anti-corrosion coatings used to protect sensory equipment.

Harvard

iGarden: an Open Source Toolkit for Plant Engineering

Track: Food & Energy

Presentation: Room 34-101, Sunday, 9:30 AM

Poster: Sunday - Session B, #24 (B24)

The Harvard iGarden is a venture into plant engineering. We aim to create a toolkit for the cultivation of a personalized garden containing features introduced through synthetic biology. In addition to a "genetic fence" designed to prevent the spread of introduced genetic material, we have developed three independent features to be included in this toolkit - inclusion of novel flavors, knockdown of plant allergens, and modification of petal color. All parts are BioBrick compatible and introduced into plants through agrobacterium-mediated transformation, using existing plant vectors modified with the BioBrick multiple cloning site. The Harvard iGarden is an effort to raise public awareness of synthetic biology, production of food, and how the two can intertwine. We envision the iGarden as a medium through which the non-scientist can see the power and potential of synthetic biology, and apply it to everyday life.

Heidelberg

miBricks: DNA is not enough

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 10:30 AM

Poster: Saturday - Session A, #45 (A45)

The key to successful gene therapy is integration of tissue specificity and fine-tuned target gene expression. The iGEM Team Heidelberg 2010 unlocks the world of synthetic microRNAs, since focusing solely on DNA has often been inconvenient for medical purposes. We engineered a toolkit for standardized measurements of interactions between artificial miRNAs and their binding sites. From this data we were able to compute an in silico model integrating binding site properties and knockdown percentages. Thus, the expression level of any gene of choice could be arbitrarily adjusted by employing the corresponding binding site design. To produce tissue specific miRNA gene shuttles, we developed an evolution-based method for synthesis of new adeno associated viruses. This enabled us to overcome the natural limitations of virus selectivity. In the future, miBricks could be applied for treatment of diseases like Diabetes and Hemophilia, opening the doors to new Synthetic Biology based medical approaches.

HKU-Hong Kong

The bio-safety net

Track: Manufacturing

Presentation: Room 54-100, Saturday, 10:30 AM

Poster: Saturday - Session A, #13 (A13)

Our team's project is a "bio-safety net" that limits the survival of bacteria according to tailored conditions. Bacteria could be designed to perform promising tasks, such as the biodegradation of oil to clean up oil spills. Yet, there are risks associated with the possibility of living bacteria performing undesired activities. Our goal is to introduce a "bio-safety net" that will be applicable to virtually all genetically engineered bacteria as a vital termination step after their

tasks have finished. We have made this possible by introducing a "suicide" mechanism, that will be triggered under specific conditions. By combining different promoters, the system can respond to changes in environmental factors and control expression specific to chosen factors. Such mechanism can be easily assembled and incorporated to bacteria through the use of biobricks.

HKUST

Engineered Lactobacillus against S. aureus Infection

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 3:30 PM

Poster: Sunday - Session B, #52 (B52)

Our project aims at establishing an interspecies quorum quenching system in which engineered Lactobacillus can sense and reduce the virulence of potentially pathogenic Staphylococcus aureus. To accomplish this, we are constructing chimeric quorum sensing receptors that can localize on Lactobacillus membrane and detect autoinducing peptides (AIPs) released by S. aureus. The ligand binding to the chimeric receptor will trigger downstream plnABCD pathway and initiate the synthesis and secretion of RNAIII inhibiting peptide (RIP), a heptapeptide with proven effectiveness in attenuating S. aureus virulence. The possibility of achieving this lies in the structural homology of the catalytic domain of the quorum sensing receptors in Lactobacillus and S. aureus. Both receptors belong to the HPK10 subfamily of a two-component histidine kinase family. Attenuation of S. aureus virulence by quorum-sensing inhibitors should not yield a strong selective pressure for development of resistance, and would therefore be an attractive concept for preventive medicine.

HokkaidoU Japan

Dr. E. coli: World Smallest Protein Injector

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 3:30 PM

Poster: Sunday - Session B, #49 (B49)

Our project is on Type III Secretion Apparatus which is one of the most amazing biological devices. It can pass a whole protein molecule from a bacterial cell to a target eukaryotic cell. This apparatus which looks like a syringe is an organelle of pathogenic gram-negative bacterium such as Salmonella and Yersinia. We are aiming at making this device available for E. coli. Because it will not involve usage of pathogenic strains, it will be safer to use. To transfer T3SS functionally from Salmonella to E.coli it is essential to integrate at least 40kb of DNA fragment coding more than 20 proteins. So we will make suggestions about how to optimize E.coli transformation method for large size DNA fragments. Also we will show how to construct protein for secretion and how to measure if it is really secreted using GFP.

Hong Kong-CUHK

Bio-cryptography: information en/decryption and storage in E. cryptor

Track: New Application

Presentation: Room 26-100, Saturday, 4:00 PM

Poster: Saturday - Session A, #51 (A51)

Data encryption and storage has always been an important branch of research in computer engineering. In our project, we explored the possibility of harnessing a biological system as an alternative solution for data en/decryption and storage. By using E. coli, we engineered and devised a prototype, dubbed E. cryptor, for 1) bio-encryption and -decryption with error checking; and 2) data storage in a bacterial system. In the age of synthetic biology, designed microorganisms may carry a specific DNA barcode to be distinguished from their natural counterparts. Our system could turn such barcode into more than simply a tag. In the future, can we also store text, pictures, and even videos into these tiny bacteria and protect the contents?

IIT Delhi 1

Dr.coli

Track: New Application

Presentation: Room 26-100, Sunday, 4:30 PM

Poster: Saturday - Session A, #42 (A42)

The use of bacteria for sensing applications has been around for a while now, and they have been used to produce recombinant proteins as needed for even longer time. The current project focuses on integrating these two components to create a device capable of responding to external stimuli in the form of quantitative protein production. For this device to function, it needed to be capable of producing and secreting the protein extracellularly. Further the dynamics of elicitor interaction with the bacteria in a flow stream and concomitant product release have also been a part of the study. We believe that such a system can play a major role in drug delivery systems that treat as needed and further in creating artificial glands for diseases such as insulin.

IIT Madras

Pro-biotic Sweetener, under the control of a pseudo AND gate

Track: Food & Energy

Presentation: Room 34-101, Sunday, 3:00 PM

Poster: Saturday - Session A, #21 (A21)

We aim to use synthetic biology to engineer pro-biotic lactic acid bacteria to produce Monellin, a heat and pH stable sweetening protein. If we are successful in engineering *Lactobacillus lactis*, a Gram positive bacteria to express and secrete Monellin, we will be able to produce dairy products low in poly-saccharide-based sweeteners, radically reducing the calorific content of these products. In order to be able to control the level of expression in this system, we plan to develop a regulatory system(s) that simulates a logical AND gate in response to two biological inputs. We plan to use the decreasing pH during curdling and the addition of nisin as the two inputs. To achieve the AND gate we will be using the CRE gene in combination with loxP sites. By placing the loxP sites appropriately, we will create an expression system that will produce the Monellin in a window of conditions.

Imperial College London

Parasight – Parasite detection with a rapid response

Track: Health & Medicine

Presentation: Room 26-100, Saturday, 1:30 PM

Poster: Saturday - Session A, #58 (A58)

More than two billion people around the world live with unrelenting illness due to parasites” - WHO Director General Lee Jong-wook. Synthetic biology offers great opportunity for biosensors, however current designs require hours before useful output. To tackle this issue in the field, it's crucial that our project can respond in minutes, hence we have engineered a fast, modular sensor framework. This allows detection of a range of different parasites, and may also be used as an environmental tool for mapping their spread. We have developed two new technologies that enable our modular input/output - a novel cell surface biosensor, customisable for specific parasitic proteases, linked through quorum-sensing to a new 'fast-response' module capable of producing a detectable output in minutes. To demonstrate the concept, we've designed and fabricated *B. subtilis* to give a striking colour readout upon detecting the waterborne *Schistosoma* parasite which affects 200 million people worldwide.

INSA-Lyon

Droppy Coli : factory of PHB, application and improvement

Track: Manufacturing

Presentation: Room 54-100, Saturday, 10:00 AM

Poster: Saturday - Session A, #1 (A1)

Polyhydroxyalkanoates granules (PHAs) are universal prokaryotic storage compounds of carbon and energy. We aim to control their production in *E. coli* thanks to a new part: a strong promoter sensitive to the shaking speed and the temperature of the water bath. By controlling this production, our team focuses on two final purposes : (1) the granule as a storage system for overproduced lipids with medical applications, such as DHA or EPA and (2) the granule as self-cleaving micro-beads in order to purify a recombinant protein of interest. In bacteria, three separate monofunctional enzymes are required for PHA synthesis. In order to improve this pathway, we intend to model a single multifunctional enzyme based on the study of natural evolution of fatty acid synthesis in animals.

IvyTech-South Bend

To Swim or Not to Swim?

Track: Environment

Presentation: Room E51-151, Sunday, 12:30 PM

Poster: Sunday - Session B, #20 (B20)

Anyone who wants to enjoy bathing in natural bodies of water in or near areas populated by humans or livestock may encounter unsafe levels of enteric bacteria. Contemporary methods of assessing water quality have a slow turn-around time so we have taken steps to perfect a biosensor for rapidly indirectly quantifying the presence of enteric bacteria in natural water samples through the detection of quorum sensing factors. Previous iGEMS have exploited the LuxR/pLux system for the detection of a variety of N-acylhomoserine lactone autoinducers. We have taken steps to further perfect a biosensor based on this device by transforming a gram-positive bacteria host to eliminate any background autoinducer signal and to build-in an enzymatic "read-out" to obtain an analog output. We envision the development of a handheld monitor that uses this iGEM biosensor, immobilized on input paper strips, to rapidly detect unsafe levels of enteric bacteria in water samples.

Johns Hopkins

Synthetic Voltage Sensitivity at The Transcriptional Level in Saccharomyces cerevisiae

Track: New Application

Presentation: Room 26-100, Saturday, 3:30 PM

Poster: Sunday - Session B, #48 (B48)

If the goal of iGEM and the Parts Registry is to take the messy world of genetic engineering and transform it into something like the standardized world of electrical engineering, it may be useful if electronic systems could directly interface with biological systems. Past iGEM projects have used chemical or optical stimuli to actuate transcriptional responses. Our project, however, seeks to add voltage sensitivity to *Saccharomyces cerevisiae*. Baker's yeast was chosen because in some sense yeast have a system that responds to voltage input. With a voltage stimulus one can open the voltage-gated calcium channels of yeast, causing calcium ions to rush into the cytoplasm. This causes calcineurin to dephosphorylate Crz1, which enters the nucleus and binds various promoters. Our group presents a library of characterized Crz1-sensitive promoters of both naturally-occurring and synthetic varieties. Genes downstream of these promoters are thus voltage-regulated in media containing calcium.

KAIST-Korea

DiscoverY: universal diagnostic yeast

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 3:00 PM

Poster: Sunday - Session B, #45 (B45)

Large portion of the world is still suffering from diseases despite of the availability of treatment -tuberculosis in Africa for instance. Such trouble originates from unavailability of cheap and effective diagnostic method. Team KAIST will present DiscoverY that is capable of diagnosing multiple diseases. *S.Pombe* chassis holds FGFR1-STAT1 pathway with modification in FGFR1, which becomes fusion antibody receptor in our system. When fusion antibody receptors on the surface come in contact with antigens, the pathway is initiated. The pathway ends with GFP expression as diagnostic display. The system will be tested with tuberculosis antibody, and simple replacement of antibody will make DiscoverY the universal diagnostic yeast.

KIT-Kyoto

E.coli Pen": Draw with your own color

Track: New Application

Presentation: Room 10-250, Sunday, 9:30 AM

Poster: Saturday - Session A, #41 (A41)

Our team, KIT-Kyoto suggests an "E.coli Pen" as a new Art Tool. This brand-new pen uses no ink but medium in which genetically modified *E.coli* has been cultured. The Pen is able to express more than four colors in various intensities with single bacterial culture. This will be achieved by constructing plasmids carrying genes coding for four different fluorescent proteins under the control of seven promoters having different sensitivity to oxidative stress. The *E. coli* carrying these plasmids will produce different colors with various intensities by differentially responding to the gradient of hydrogen peroxide treatment. Different from previous passive BioArt in iGEM, the genetically engineered "E. coli Pen" provides an active and wonderful tool for us to purely enjoy the Art having a feeling for biotechnology.

Korea U Seoul

Heavy Metal Gang Captured By Capsule Cop

Track: Environment

Presentation: Room E51-151, Sunday, 12:00 PM
Poster: Sunday - Session B, #7 (B7)

Toxic heavy metals such as arsenic, zinc, and cadmium in water are very harmful. Detecting these heavy metals is an important task. So we designed a heavy-metal-detecting *E. coli*. In order to design the system, we employed two fluorescence proteins (GFP, RFP) and aryl acylamidase as signal reporters. The aryl acylamidase converts a colorless acetaminophen (Tylenol TM) to a brown color substrate. Since the detecting *E. coli* has three heavy metal promoters, if more than two heavy metals coexist in a solution, the *E. coli* emit mixed fluorescence, so we simultaneously detect metals. Our goal is to synthetic modules put these three genes for different heavy metals in a row in *E. coli* and then utilized in the form of a lyophilized powder, which can be stored in a drug capsule to make it portable so that analysis of water is easily processed. We call it a "Capsule Cop".

Kyoto

The Fantastic Lysisbox

Track: Foundational Advance
Presentation: Room 32-123, Saturday, 1:30 PM
Poster: Sunday - Session B, #22 (B22)

Genetic engineered cell death is imperative for biotechnological usage, such as bioremediation area. For controlling cell death, we designed "Lysisbox" consists of a pair of modules: "Killer gene" and "Anti-killer gene." As the Killer gene for *E. coli*, we noted the lysis cassette [SRRz/Rz1gene] of λ phage coding for a holin and an endolysin. The holin forms pores in the inner membrane, and the endolysin access to and degrade the peptidoglycan by passing through the pores, leading the *E. coli* to death. As the Anti-killer gene, we chose Δ TMD1 coding for a dominant-negative holin that inhibits the formation of the fatal pores. The balance of these two genes expression level has a key of the *E. coli*'s life or death. In addition, such controllable membrane pores must show critical functions for all living organisms with lipid membranes. "Lysisbox" will contribute a lot to future projects, thus you must say "FANTASTIC!!!"

Lethbridge

A synthetic biology based approach for bioremediation of the tailings ponds

Track: Environment
Presentation: Room E51-151, Saturday, 4:00 PM
Poster: Saturday - Session A, #11 (A11)

The industrial methods, used to harvest the oil sands, produce contaminated water in the form of tailings ponds with many harmful chemicals such as naphthalic acids, catechol and heavy metals. We are targeting catechol for degradation into common metabolic intermediates of the Krebs Cycle by using *xylE* from *Pseudomonas putida* that codes for the protein catechol-2,3-dioxygenase. Catechol-2,3-dioxygenase is being targeted into microcompartments, formed by engineered Aquifex aeolicus protein, lumazine synthase, to reduce cross-talk and increase concentration. The complex will then be purified and applied to the tailings for catechol degradation. By funneling other pathways through catechol we can develop efficient methods for the decontamination of the tailings ponds. Mms6 from *Magnetospirillum magneticum* removes heavy metals from solution by forming nanoparticles. The Mms6 protein will be secreted from the cell into the tailings for the removal of metals such as iron and cobalt for creating an efficient bioremediation process.

LMU-Munich

Production of azobenzene derivatives in E. coli and selection of successful transformants by apoptosis

Track: Foundational Advance
Presentation: Room 32-123, Sunday, 2:30 PM
Poster: Sunday - Session B, #25 (B25)

We are engaged in two projects: Project "Pathway" involves the creation of an artificial metabolic pathway for the synthesis of azobenzene derivatives in *E. coli*. This would be accomplished by expressing the required enzymes, encased in a proteinaceous bacterial microcompartment. This construct is necessary in order to shield the cell from toxic intermediates which would otherwise make this biosynthesis impossible. Azobenzene derivatives are interesting in the field of biochemistry because of their properties as synthetic molecular switches. Project "ApoControl" is divided into three subprojects on controllable cell-death. The goal is to develop a system to improve the efficiency and specificity of gene expression in eukaryotic cell-lines and more specifically, to select cells expressing the target gene against cells that do not. Here, proapoptotic genes instead of antibiotic resistance are used as a selection marker to induce clean cell-death at different stimuli.

Macquarie Australia

Engineering a Bacteriophytochrome switch – creating a controllable E. coli chameleon

Track: New Application

Presentation: Room 26-100, Sunday, 12:30 PM

Poster: Saturday - Session A, #50 (A50)

Photoreceptors are utilized by almost every organism to adapt to their ambient light environment. Our aim is to engineer a novel, reversible molecular 'light switch' within E. coli by introducing a photoreceptor from non-photosynthetic bacteria (*Deinococcus radiodurans* and *Agrobacterium tumefaciens*). By cloning the bacteriophytochrome coupled with heme- oxygenase, an enzyme producing biliverdin, the created colonies are able to respond to red and far-red light environments. This novel approach will result in the colour of E. coli to 'switch' from blue to green reversibly. Our E. coli chameleon will serve as a fundamental 'bio-brick' for future applications by providing a simple and photo-reversible switch.

METU Turkey

E-CO Sensor

Track: New Application

Presentation: Room 26-100, Saturday, 10:00 AM

Poster: Saturday - Session A, #59 (A59)

Cells can sense and respond to the presence of various gas molecules such as oxygen, nitrogen and carbon monoxide using gas sensor proteins. CooA is a carbon monoxide (CO) sensing transcription factor. It is a member of the cAMP receptor protein (CRP)/fumarate nitrate reduction (FNR) family of transcriptional regulators. CooA switches on oxidation enzymes in *Rhodospirillum rubrum* (a purple, nonsulfur, phototrophic bacterium) which enables the bacterium to use CO as a carbon source. CO is an odorless and colorless gas which can be extremely lethal. Our aim is to develop a cell sensor which can detect a wide range of CO concentration in the environment. We are building CooA and CooA-responsive promoter biobricks which will be transformed into E.coli. Fluorescent proteins (GFP and RFP) will be utilized as dose-responsive signals of ambient CO.

METU Turkey Software

BIO-GUIDE

Track: Software Tools

Presentation: Room 32-123, Sunday, 12:30 PM

Poster: Saturday - Session A, #38 (A38)

As Synthetic Biology is on the rise, iGEM also grows up and part numbers in partsregistry increase with submission of more constructs each year. Our first milestone is to perform more useful standardization on parts-entry due to facing some difficulty while running our algorithms. We also used Software Requirements Specification, Software Design Description and Quality Plan approaches to define requirements for each part and building blocks, risks and design art elements of the designed software program. Next, we have used graph theoretic modeling to visualize relations between parts and to standardize representation of the parts as much as possible. It will help us while trying to find input-output relations between either biobrick parts or constructs. By this way, our program as a Biobrick Guide will provide alternative pathway choices to users for construction of the most reliable devices with respect to given inputs and expected outputs.

Mexico-UNAM-CINVESTAV

A very cool E. coli

Track: Food & Energy

Presentation: Room 34-101, Sunday, 10:00 AM

Poster: Saturday - Session A, #25 (A25)

We begin by proposing a biosynthetic construction that enables *Escherichia coli* to produce an antifreeze protein, AFP at less than 15 degrees Celsius. This protein prevents ice crystal formation in the cell, which in turn allows survival at very low temperatures. We develop a switch by adapting the cold-shock E. coli operon with AFP from a fish (*Macrozoarces americanus*) using a positive feedback circuit. A very important potential application we are interested in is the use of AFP in designing systems helping crops to avoid potential damage from frosts. There are other possible important applications in tissue and organ preservation.

Michigan

Algae Bioflocculation for Biofuel Production and Bioremediation of Oil Sands Tailings Water

Track: Environment

Presentation: Room 54-100, Sunday, 3:00 PM

Poster: Saturday - Session A, #5 (A5)

Our team worked on two projects this year. Our first project aims to improve the economics of algal biofuel production by creating a cost efficient microalgae bioflocculant out of *E. coli*. To achieve this, we over-express Type I pili to increase the cell's adhesiveness, and also express a chlorovirus protein on the cell surface which specifically binds *Chlorella* species, a promising algal feedstock for the biofuel industry. We are also participating in the Oil Sands Initiative and seeking to improve the biodegradation rate of naphthenic acids (NAs), a toxic by-product of the oil extraction process which can linger in the environment for decades. Two *Pseudomonas* strains have been found to synergistically degrade 95% of NAs. Our project focuses on engineering these *Pseudomonas* strains to form biofilms in the harsh tailings water environment, which can potentially increase degradation rates by two orders of magnitude, by expressing a self-associating *E. coli* protein.

Minnesota

Metabolic Engineering: In vivo Nanobioreactors

Track: New Application

Presentation: Room 26-100, Sunday, 5:00 PM

Poster: Sunday - Session B, #57 (B57)

Modern microbial engineering methods allow the introduction of useful exogenous metabolic pathways into cells. Metabolism of certain organic compounds is sometimes limited by the production of toxic intermediates. Several bacteria have evolved protein based microcompartments capable of sequestering such reactions, thus protecting cytosolic machinery and processes from interference by these intermediates. For our project, we will identify and transform the genes encoding proteins responsible for the production and assembly of bacterial microcompartment. Additionally, we will confirm the signal sequences that target enzymes to the protein compartments by fusing this sequence to reporter genes. To demonstrate the microcompartment's potential to serve as nanobioreactors, we will target genes encoding a short catabolic pathway into recombinant microcompartments assembled in *E. coli*.

Missouri Miners

The Electric Microbe: Making A Fuel Cell With E. coli

Track: Food & Energy

Presentation: Room 32-123, Saturday, 4:00 PM

Poster: Saturday - Session A, #31 (A31)

The growing need for alternative fuel sources has sparked interest and research across many scientific and engineering disciplines. The fledgling field of microbial fuel cell development has previously relied on anaerobic metal reducing organisms such as *Geobacter sulfurreducens*. This project sought to isolate genes from the electron shuttling pathway in *Geobacter* and transform them into the more manageable aerobic *Escherichia coli*. The Missouri University of Science and Technology iGEM team isolated four outer membrane cytochrome (omc) genes from *Geobacter*, vital to the extracellular transportation of electrons. The four genes; omcB, omcE, omcS and omcT, were cloned into individual plasmids. The eventual goal is to combine all four genes into one plasmid to transform into *E. coli* to create an aerobic, electron transporting microbial system.

MIT

Programmable, Self-Constructing Biomaterials

Track: Manufacturing

Presentation: Room 54-100, Sunday, 11:30 AM

Poster: Saturday - Session A, #8 (A8)

Our goal is to produce adaptive, living biomaterials that can be reliably controlled in two different systems: mammalian cells and bacteria. Our mammalian system uses newly isolated mechano-sensing promoters and a bi-stable toggle to stimulate osteogenesis via transient mechanical signals. Our bacterial system uses a toggle that takes advantage of quorum sensing and cell response to UV light and triggers the production of fluorescent proteins,

and a polymer composed of a matrix of cross-linked phage. Our systems are remarkable because they translate a macroscale input into a pattern that emerges from the growth and re-modeling of cells. This technology not only has applications in the field of self-repairing nanotechnology and medicine, but it is also shedding light on artificial differentiation and the use of phage display technology in a new and innovative way.

Monash Australia

Design and construction of a biological ethylene generation device

Track: Manufacturing

Presentation: Room E51-151, Saturday, 1:00 PM

Poster: Saturday - Session A, #9 (A9)

The Monash University iGEM team has identified that ethylene, a common organic compound, is under increasing production demands by the plastics and food industries. Current methods of production are energy intensive, and rely on processing of non-renewable fossil fuels. However many plants produce ethylene from L-methionine by use of the Yang cycle, which has lower energy requirements. We aim to introduce the genes that are required for ethylene production into *Escherichia coli* under the control of an inducible promoter, in an attempt to develop a cleaner and non-energy intensive method of production. At lower yields, this device may also provide a useful module for signal transduction between the *E. coli* and plants.

NCTU Formosa

Mosquito Intelligent Terminator, a genetically engineered, temperature controlled E. coli for killing wrigglers

Track: Environment

Presentation: Room 54-100, Sunday, 9:30 AM

Poster: Saturday - Session A, #16 (A16)

The Mosquito Intelligent Terminator (MIT) is designed and optimized to be an ecological and environmental friendly mosquito pesticide. MIT is an engineered *E. coli* secreting crystal proteins isolated from *Bacillus thuringiensis* to kill mosquito larvae, or known as wrigglers. These crystal proteins are toxic to certain types of mosquitoes and are not pathogenic to mammals. We designed a temperature-dependent genetic circuit expressing high levels of crystal proteins at room temperature only, thus production does not occur at incubation temperature 37°C. In order to make an environmentally safe insecticide, our design also incorporates a genetic circuit controlling the population size of *E. coli*. This intelligent terminator is not limited to mosquitos, as it can be custom fitted with different cry genes to other insect species. Currently, with more than one hundred crystal proteins targeting various insect species, our design may potentially serve as a promising pest control solution in the future.

Nevada

*Development of Plant Biosensors for Environmental Monitoring Using *Nicotiana tabacum* Protoplasts as Transgenic Plant Models*

Track: Environment

Presentation: Room 54-100, Sunday, 10:30 AM

Poster: Saturday - Session A, #4 (A4)

The 2010 Nevada iGEM team has three objectives for this year's competition. One, we want our highlight to be the first team to provide the iGEM registry with stress-inducible promoters to be used in plants. These promoters can be valuable tools in monitoring the environment for salt, heavy metals, temperature, and more. Second, we want to develop a real-time monitoring model of these stress-inducible promoters by having fluorescent reporters linked to their expression. Current research typically uses microarray, a technique that takes a 'snapshot' of a system, where as we want to hold a 'video camera' up to specific genes. Third, we will show the advantages of using *Nicotiana tabacum* protoplasts (NT cells). Our NT cell system provides a faster, cheaper, and safer method of obtaining a transgenic plant model than transforming an actual plant, benefits future iGEM teams may want to take into consideration.

Newcastle

BacillaFilla: Filling Microcracks in Concrete

Track: Manufacturing

Presentation: Room 54-100, Sunday, 5:00 PM

Poster: Saturday - Session A, #14 (A14)

BacillaFilla, an engineered *Bacillus subtilis*, aims to repair microcracks in concrete, which can cause catastrophic structural failure. BacillaFilla would be applied to structures by spraying onto their surface. The *Bacillus* swims deep into the microcracks. Repair is effected by production of CaCO₃, filamentous cells and Levansucrose. CaCO₃ expands at the same rate as concrete, making it the ideal filler. A filamentous cell mesh provides reinforcement. Levansucrose glues CaCO₃ and filamentous cells in place. *B. subtilis* 168 sporulates, making it ideal for storage and transportation. The cells are naturally tolerant to concrete's high pH. We repaired 168's defective *swrA* and *sfp*, regaining motility. At the end of the crack the quorum communication peptide subtilin triggers a co-ordinated population response from a subtilin-inducible promoter. Upregulating *SR1* and *rocF* promotes arginine and urea production, increasing exogenous CaCO₃ deposition. Over-producing *yneA* induces the filamentous cell phenotype, while *SacB* converts extracellular sucrose to levansucrose glue.

Northwestern

SCIN - Self-regenerating Chitin INduction

Track: Manufacturing

Presentation: Room E51-151, Sunday, 9:30 AM

Poster: Saturday - Session A, #17 (A17)

Chitin, found in the exoskeletons of insects and crustaceans, is one of the most abundant substances in nature. Like keratin in skin, it comprises the protective outer layer of these animals. Our chitin expression platform involves generating a layer of chitin from a lawn of bacteria in response to an external molecular cue. This cue induces chitin synthesis (fast) and cell lysis (slow). This system allows for a build-up of chitin followed by cell lysis and subsequent release into the top layer of the lawn. Abrasions expose cells to the external cue for self-repair. In this way, we create a regenerative chitin biolayer with potential medical and industrial applications.

NYMU-Taipei

SpeedyBac

Track: New Application

Presentation: Room 26-100, Saturday, 10:30 AM

Poster: Saturday - Session A, #57 (A57)

For iGEM2010, our NYMU-Taipei team is interested in resolving the fundamental need of rapid reporting response from bacterial gene expression. Our goal is to speed up the reporting response of bacterial gene expression through shortening the time needed for routine iGEM experiments. We intend to construct systems aimed at reducing experimental time and increasing efficiency of construction production. To achieve the goal, our design process is split up into three parts: Riboswitch, mRNA Binding, and SsrA. (1) Riboswitch - faster production of proteins by inducing the translation of pre-transcribed RNA molecules. (2) mRNA Binding - using mRNA aptamers and split GFP/RFP-eIF4A reporter systems to show faster promoter activity or the expression of mRNA transcripts. (3) SsrA - fast, specific, and constitutive proteolysis achieved by engineering fluorescent proteins with LVA tags.

NYU

ImmunoYeast : antibody discovery and production in one simple system

Track: Foundational Advance

Presentation: Room 32-123, Sunday, 3:00 PM

Poster: Saturday - Session A, #39 (A39)

The goal of our project is to increase the speed and efficiency of the antibody discovery process. We constructed a yeast strain that is capable of screening a library of antibody fragments against an antigen of interest, processing the antibody genes through recombination and secreting an easily-purified form of antibody protein for research use. Our hope is to demonstrate the feasibility of using the yeast cell to not only discover antibodies but to provide a streamlined processing unit that can quickly and easily transition from antibody discovery to protein production.

Osaka

Continuous Greening Cycle

Track: Environment

Presentation: Room 54-100, Sunday, 2:30 PM

Poster: Saturday - Session A, #3 (A3)

Desertification all over the world causes famine, drought and suffering. We aim to develop micro-machines that can stop and even reverse desertification by recovering vegetation in these areas. We envision a 'Continuous Greening Cycle' in which engineered microorganisms decompose plant fibers into nutrients through the action of cellulolytic enzymes. They then produce water-absorbant polymers such as poly(gamma-glutamic) acid that retain water in the soil to help plants grow. When the plants die they will be decomposed to start the cycle anew. In addition to aiming for the continuous and self-expanding greening of desert areas, we hope to contribute to iGEM by developing useful BioBricks!

Panama

Standardization of Rhamnosyltransferase 1 gene (rhlAB) into a Biobrick for rhamnolipid production in E. coli

Track: Environment

Presentation: Room E51-151, Saturday, 10:30 AM

Poster: Sunday - Session B, #19 (B19)

There is considerable interest among bio-industries in bioremediation products such as Rhamnolipids. Rhamnolipids as biosurfactants are important in the remediation of oil spill areas. The cleanup of the Exxon Valdez oil spill using rhamnolipids as biosurfactants was too expensive and complicated, therefore impractical for large-scale bioremediation. However, with advances genetic engineering and synthetic biology offer a viable solution to oil spill pollution clean up. In this project we use genetic engineering as a tool to integrate genetic parts through the BioBrick assembly standard protocol of iGEM to develop a BioBrick for rhamnosyltransferase 1 complex (rhlAB) gene expression in Escherichia coli for standardized rhamnolipid production. Our BioBrick integrates a promoter, a RBS (ribosomal binding site), our part rh1AB gene sequence isolated from Pseudomonas aeruginosa, a GFP reporter and a terminator. All the parts fit into a plasmid backbone that can be transformed into E. coli strains, which can then produce rhamnolipids.

Paris Liliane Bettencourt

Every bacteria counts!

Track: Foundational Advance

Presentation: Room 34-101, Sunday, 11:30 AM

Poster: Saturday - Session A, #37 (A37)

Counting is the action of finding the number of elements in a set. Past attempts at developing counters in cells have mostly attempted to mimic the binary methods that computers use to count. Our first counter takes a new approach to counting in cells, essentially a mechanical rotary counter implemented on a micro scale. Each time the counter detects an input, it performs an excision and integration directly down-stream of the active site, turning on a reporter and rotating over one "notch" on the counter. Our second counter operates on the wholly different principle that the statistical occurrence of a rare event in a large population can be modeled. Each cell in our population harbors a construct that when stimulated has a small chance of excising a terminator and expressing a resistance gene. The number of resistant cells is thus an accurate count of the number of input stimuli.

Peking

Heavy Metal Decontamination Kit

Track: Environment

Presentation: Room E51-151, Saturday, 10:00 AM

Poster: Sunday - Session B, #1 (B1)

During this summer, our group has developed a method to engineer bacteria into heavy metal decontamination kits. First of all, we analyzed the function, structure and operation of the transcription factor MerR, a mercury-responsive regulator in detail via bioware experiments and modeling. Then appropriate topology candidates for proper bioreporters were carefully searched. We selected a candidate and re-designed genetic components to accomplish certain bioreporter function in need, which was verified by following bioware experiments. For bioabsorbents, we engineered MerR into a metal binding peptide. This was followed by inductive expression of engineered peptide on surface, periplasm and cytosol of E.coli. This reverse engineering method was then expanded to lead-responsive regulator, PbrR, to confirm the validness of this method. Results demonstrated that the procedure mentioned above is streamlined enough to construct valid whole-cell bioreporters and bioabsorbents of various heavy metals for field application in the near future.

Penn State

Bacterial Fireworks: Oxygen Bio-sensing and Signal Amplification

Track: Food & Energy

Presentation: Room 34-101, Sunday, 2:30 PM

Poster: Saturday - Session A, #26 (A26)

Oxygen contamination can be a challenge for many anaerobic processes. To monitor these processes we created an oxygen bio-sensor in *E. coli* which produces an anaerobic fluorescent protein. The task of creating an oxygen bio-sensor is compounded by the fact that oxygen diffusion through many substances is very limited; so oxygen contamination can be undetected due to a response which is too "soft". To combat this, we enabled our sensor to induce this response in non-oxygenated bacteria via the lux system; thus amplifying the signal and producing a bio-alarm which is sufficiently "loud" to not be missed. To accomplish this goal we characterized the response characteristics of the many different Lux components in the parts-distribution. This system can be easily inverted to monitor oxygen depletion in oxygen dependent processes.

Purdue

Development and Characterization of Hypoxic Stress Response Systems in Mammalian and Plant Models

Track: Food & Energy

Presentation: Room 32-123, Saturday, 3:00 PM

Poster: Sunday - Session B, #21 (B21)

From water-logged soils to overpopulated regions of tumors, low-oxygen environments distress plant and mammalian systems. Plants with inadequate levels of oxygen move from aerobic respiration to alcohol fermentation to sustain their metabolism. This switch causes the accumulation of byproducts that are detrimental to the plant. A synthetic biological circuit, centering on the alcohol dehydrogenase (Adh) promoter, has been developed indicating when low oxygen levels (< 5% O₂) are present in plants. Similarly, low oxygen zones can develop in solid tumors in numerous mammalian cancer models. Substantial evidence indicates that hypoxia in tumors initiates angiogenesis, a process that aids in tumor proliferation. Accordingly, an additional hypoxia-sensitive circuit that up-regulates the activity of a reporter protein in low oxygen (<1% O₂) environments has been created for mammalian systems. The development and characterization of these circuits will provide tools to explore the consequences and identity of hypoxic environments in mammalian and plant systems.

Queens-Canada

WormWorks: Introducing the nematode *C. elegans* as a multicellular chassis

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 11:00 AM

Poster: Sunday - Session B, #23 (B23)

Historically, the iGEM competition has tended away from working with eukaryotic and multicellular organisms, limiting prospects for higher levels of project complexity in favor of simpler and easier-to-understand bacteria. The nematode worm *Caenorhabditis elegans* was examined as a prospective chassis for use in the competition. Once it was decided that the opportunities presented by the organism appeared to outweigh the challenges involved in working with it, a foundational library of parts was built and tested within the organism. This collection includes useful promoters, reporters, effectors, and a terminator. An educational resource specifically targeted at iGEM participants was written and incorporated into the team wiki in order to assist future teams in learning about and exploring the possibilities offered by *C. elegans*.

RMIT Australia

A Recombinant Peptide Expression System That Exploits Taq Polymerase as a carrier Molecule

Track: Health & Medicine

Presentation: Room 10-250, Sunday, 12:00 PM

Poster: Sunday - Session B, #42 (B42)

The RMIT 2010 iGEM team has attempted to create a biological system that will produce peptides at a low economic cost. This biological machine includes the use of a T7 promoter regulated by the Lac elements to express a soluble thermostable protein carrier molecule with an attached peptide of interest. Taq polymerase will be attached to this peptide via a thermolabile bond allowing the peptide to be cleaved using just temperature. The polymerase has

furthermore been mutated in such a way to avoid interactions with nucleic acids, thus diminishing the effects it may have in the bacterial host cell. This system can be adopted and enhanced to produce libraries or large scales of peptides/drugs without the high price tag attached to then be distributed to large communities that otherwise cannot afford the cost of research nor treatment.

SDU-Denmark

Flow-E, a bacterial flow inducer

Track: New Application

Presentation: Room 10-250, Saturday, 1:00 PM

Poster: Sunday - Session B, #43 (B43)

When generating flow through a microcapillary tube, engineers are met with problems in generating force and keeping fluids mixed or separated. Inspired by an article by Kim et al on bacterial carpets that could generate flow, we have designed a biological system in *E. coli* that can induce flow and increase mixing in a fluid, essentially working as a microscopic flow actuator. The actuator uses *E. coli*'s flagellas and can be switched on and off using light. Our system is composed of several novel parts: a photosensor, that controls the tumbling frequency of *E. coli*'s flagella via chemical pathways; a hyperflagellation part, to increase the number of flagella and the power of the system; a retinal producing part, that works with the 2009 Cambridge's iGEM team's β -Carotene brick, which we have helped further characterize. Our human practices focused on watermarking synthetic genetic material and improve security in synthetic biology.

Sheffield

iCOLI: A water-borne pathogen detection system and an exploration of identity in synthetic biology

Track: Environment

Presentation: Room E51-151, Sunday, 4:30 PM

Poster: Sunday - Session B, #13 (B13)

The Sheffield iGEM 2010 team organised its activities around a general theme: 'identification'. This notion, for instance, is at the heart of the scientific and modeling projects, which have made steps towards the design and production of a multi-target, water-borne pathogen detection system. Identification is also central to the human practices projects, which explicated and analysed the concept of identity in relation to the disciplinary backgrounds brought together in the project and the field of synthetic biology itself. *Vibrio cholera* was chosen as a test-case, giving us two potential routes to engineer *E. coli* to recognise the pathogen: 1. Fusion of cholera's receptor (CqsS) for its quorum sensing molecule (CAI-1) with the internal apparatus of one of *E. coli*'s general stress detecting systems (BarA). 2. Engineer the whole cholera quorum sensing system into *E. coli*. Each of these would then be connected to a representation system (GFP or *E. chromi*) to visualize the pathogen.

SJTU-BioX-Shanghai

Synthetic-biological Approaches to Osteoarthritis

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 4:00 PM

Poster: Sunday - Session B, #41 (B41)

Osteoarthritis (OA) is a chronic disease in which joint matrix is degraded and chondrocytes undergo disordered and hypertrophic differentiation, symptoms including joint pain, tenderness and stiffness. We proposed two synthetic-biological approaches to OA, one with a eukaryotic genetic circuit and another prokaryotic. Both circuits are composed of three systems: "Detector", "Actuator" and "Supervisor". As for Detector, we built tissue-specific promoters in the eukaryotic circuit, while inflammation factors are employed as signals of OA in the prokaryotic circuit. The same Actuator shared by two circuits generates proteins *col2a1*, which replenishes the degraded matrix, and *oct4*, which reverses the disordered differentiation. The eukaryotic Supervisor part has an original design in which a photo-sensitive cation channel crosstalks with certain cellular signaling pathways, resulting in the light-controlled expression of *col2a1* and *oct4*; in the counterpart of prokaryotic circuit, both injected inducers and over-population lead the engineered bacteria to suicide, thus attenuating possible side effects.

Slovenia

DNA coding beyond triplets

Track: New Application

Presentation: Room 10-250, Saturday, 2:00 PM

Poster: Sunday - Session B, #53 (B53)

Slovenian iGEM team is designing a cell based system in which we will be able to control the sequence of steps in a multi-step biosynthetic pathway. Our novel approach is designed in such a way that it will enable control of the order and sequence of reactions in a particular biosynthetic pathway. Our goal is to use synthetic biology approach to significantly increase the speed, efficiency or direction of a particular biosynthetic reaction. We will also attempt to use our approach to create a novel chemical product of the existing biosynthetic reactions. This novel cell based device represents a universally applicable principle and offers a significant improvement of current industrially important biotechnological processes. Similar approach will be applied to demonstrate the advantages for cell based oscillators and information within the cell.

St Andrews

Tackling Vibrio cholerae by introducing genetically re-engineered Escherichia coli to the human alimentary tract

Track: Health & Medicine

Presentation: Room 26-100, Saturday, 2:00 PM

Poster: Sunday - Session B, #40 (B40)

Every year five million people are infected by cholera. An effective vaccine has yet to be found. Our aim is to confer resistance to cholera by taking advantage of quorum-sensing regulated pathogenicity. CAI-1, the cholera autoinducer, is produced by the enzyme, CqsA. E. coli engineered to express CqsA could grow along with regular gut flora and render V. cholerae avirulent by maintaining high CAI-1 concentrations. To lessen its metabolic burden, the system should respond to low concentrations of autoinducer produced by V. cholerae and co-ordinate this response using the Lux quorum-sensing system. We have explored rearranging the network architecture of the Lux system to give bistable expression. A model to describe bistability was formed using ODEs and implemented in C++. To assess the perception of synthetic biology, software was written to gather data from social networking and news sites and quantify the change in opinions with time.

Stanford

EscheRatio coli: Novel Sensors to Detect a Ratio of Environmental Inputs

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 3:30 PM

Poster: Sunday - Session B, #39 (B39)

The majority of sensors currently used in synthetic biology respond to the absolute concentration of a chemical. However, many important biological processes are governed by the ratio between the concentrations of multiple chemicals. To create systems capable of responding to more complex input data, the Stanford team designed two types of ratio-measuring sensors. The first sensor utilizes two unique small RNAs to inhibit the transcription of two operons, each responding to an environmental factor and having a specific fluorescent protein (or output gene). By manipulating the number of small RNAs produced, a tipping point between outputs can be established for different input ratios. The second sensor uses a phosphorylatable protein to control the transcription rate of an output promoter. By linearly associating two chemical inputs to the production of a kinase and a phosphatase, the ratio of the two environmental factors indirectly dictates the activity of the output promoter.

Stockholm

Spot on Treatment

Track: Health & Medicine

Presentation: Room 10-250, Sunday, 4:30 PM

Poster: Saturday - Session A, #56 (A56)

For our first participation in iGEM, Team Stockholm have explored the possibilities to fight skin disorders using novel cell-penetrating peptides. We have focused on vitiligo in where pigment cells are destroyed, resulting in white patches on the skin. Studies have shown that vitiligo patients have decreased levels of antioxidants and elevated levels of antibodies targeting the pigment cells in the skin. We have used synthetic biology to fuse cell-penetrating peptides to proteins that are deficient in skin of vitiligo patients. The cell-penetrating peptides will aid in passing the proteins through the skin and target the pigment cells to reach repigmentation. Currently there are no treatments like ours for vitiligo patients. However, we strongly believe that synthetic biology can help bacteriotherapy getting a major role in fighting several skin disorders in the future, and that our first explorations in this field inspires others to continue exploring.

Tec-Monterrey

Development of a genetic frame for the creation of a concentration-sensitive bacterial sensor

Track: Environment

Presentation: Room 54-100, Sunday, 3:30 PM

Poster: Sunday - Session B, #3 (B3)

Bacterial reporters or whole-cell bacterial sensors have always been an area of application for genetic manipulation and synthetic biology. The first bacterial reporters appeared 20 years ago, although these early tests didn't use genetically modified microorganisms. Further research and development in the area of genetic engineering has resulted in newer and more sophisticated bacterial sensors, capable of detecting the presence of contaminants, sugars and amino acids in different media such as soil and water. However, most bacterial sensors can only detect the presence of a compound at a certain concentration and currently there are few documented bacterial sensors that can detect and report different concentrations of the compound of interest. Our objective was to develop a genetic frame, compatible with the BioBrick standard, for the creation of a concentration-sensitive bacterial sensor. In the process we also developed and characterized BioBricks for two new families of phage activators.

The Citadel-Charleston

Appetuners: A System for the Expression and Control of Appetite Regulation Peptides in E.coli

Track: Health & Medicine

Presentation: Room 10-250, Sunday, 5:00 PM

Poster: Sunday - Session B, #56 (B56)

Appetite can shape a person's life, from body composition to mood (to budget!), yet the means for controlling appetite are very limited. Imagine if a complex neurological state such as the desire to eat could be influenced by an engineered strain of intestinal microflora. In this regard, Peptide Tyrosine Tyrosine (PYY) and its associated molecules offer a unique opportunity for synthetic biologists. These peptides permit microorganisms native to the gastrointestinal tract to interact with the central nervous system and to influence the perception of hunger. The Citadel-Charleston Team is working to express the PYY family of peptides in E.coli, to implement a secretion pathway for those peptides, and to ensure that their expression is strictly controlled by means of a cellular population limit.

Tianjin

Lignin degradation yeast

Track: Environment

Presentation: Room E51-151, Saturday, 3:00 PM

Poster: Saturday - Session A, #15 (A15)

We make some *Saccharomyces cerevisiae* which could synthesize lignin degrading enzymes and put them on the out surface of the yeast through the yeast surface display technology. Those cells, which propagate themselves rapidly, could affix to the wood cellulose material and begin to degrade the lignin quickly with the enzymes of their surface. This yeast will make the lignin degradation pretreatment more secure to our environment and lower the cost. The products of this process are cellulase and hemicellulase, which could be used to produce alcohol fuels and papermaking in the next steps. Yeast pharmacist: What we want to design is a model which can facilitate the discovery of various drugs in the traditional Chinese Medicine, the active components of which are usually unknown. Since nicotine receptor is the target of many medicines, especially medicines for smoking cessation, our system aims at helping to find medicines that could act as partial agonist.

Tokyo Metropolitan

Life Design: Fine Clothing, Color Housing and Delicious Food by using E. coli

Track: Manufacturing

Presentation: Room E51-151, Saturday, 1:30 PM

Poster: Sunday - Session B, #5 (B5)

Our team theme is "Life Design." We make our life comfortable by following three projects. [E. coli Fiber Project – Fine Clothing] Bacteria cellulose is very useful material. People try to get bacteria cellulose. But it is high cost and low

efficiency. Aim of our project is to make low cost and high efficiency cellulose factories where E.coli works! [E. coli Pattern Formation Project – Color Housing] Give an experimental proof of Turing pattern. We use two kinds of E. coli and make various patterns! The patterns are dynamic and stereoscopic! [E. coli Rice Master Project – Delicious Food] Japanese like rice, our staple food. We are particular about the quality of rice. Rice Master of E. coli judges the quality of rice. In future, other kinds of food “Master” provide us some information about quality of foods.

Tokyo Tech *The “Wolfman” Coli*

Track: Information Processing
Presentation: Room E51-151, Sunday, 3:00 PM
Poster: Sunday - Session B, #17 (B17)

Have you heard the legend of “The Wolfman”? They’re ordinary man at daytime, but suddenly transform into a ferocious wolf in the full-moon night. Our project aim to imitate the character of Wolfman, more specifically, designing two types of E.coli that help each other to survive at daytime, whereas competing at nighttime when cocultured. Firstly, two cells have different types of antibiotic-resistance, however this expression is repressed in absence of outer stimulation. Two factors of stimulation, cell density and light, are required at once to activate the antibiotic resistance. We took advantage of photoregulation system (Cph1-EnvZ) to make sure downstream promoter is activated with light. This promoter is followed by circuit designed to sense the cell density of its counterpart and activate the counterpart cell’s antibiotic-resistant gene. With this entire system, we could observe the “Wolfman” Coli in our laboratory working by AND gate of two stimulation.

Tokyo-NoKoGen *An EcoTanker for the easy collection and delivery of target compounds*

Track: New Application
Presentation: Room 10-250, Sunday, 3:30 PM
Poster: Sunday - Session B, #58 (B58)

We propose an entirely new Escherichia coli micro machine that behaves like a tanker, the EcoTanker. The EcoTanker takes up a target compound from the environment and delivers it to a desired location for easy harvesting. The target compound is taken up and stored inside the cell in an EcoTank, a bacterial microcompartment (pduABJKNU). Blue light then directs the delivery of the “cargo” to a desired destination by phototaxis, using the N. pharaonis blue light responsive domain (NpSR11-NpHtr11-Tar) linked to an E. coli two component system. The EcoTankers are then signaled by green light to self-aggregate and autolyse in response to quorum sensing. We can then easily collect the EcoTanks filled with the target compound, which could be an environmentally toxic substance or an industrially desirable chemical. We expect that EcoTanker to be a powerful machine in various bioremediation and industrial applications.

Toronto *Enhanced Catechol Degradation via Metabolic Channeling in E. coli*

Track: Environment
Presentation: Room E51-151, Sunday, 11:30 AM
Poster: Sunday - Session B, #14 (B14)

Oil sands, consisting of a mixture of clay, sand and bitumen represent a significant fraction of remaining petroleum reserves. However, extracting the hydrocarbons requires large volumes of water which are then contaminated with naphthenic acids, heavy metals and residual hydrocarbons. These ‘tailings’ are acutely toxic to higher organisms, though some bacteria and algae can survive in these environs. Our knowledge of metabolic pathways capable of degrading such contaminants (bioremediation) is limited. However, the known pathways tend to be slow and inefficient. The breakdown of many polycyclic aromatic hydrocarbons generates a common intermediate, catechol that is further degraded to Acetyl-CoA. Metabolic channeling is an effect whereby intermediates are shuttled between enzymes in a pathway circumventing free diffusion into the cytosol. Here, we present a design, modeling and baseline experiments aimed at demonstrating optimization of catechol degradation using the principle of metabolic channeling in an E. coli proof of concept system.

Tsinghua *E. immunology: Bacteria-based Antibody Production System*

Track: New Application

Presentation: Room 10-250, Saturday, 1:30 PM

Poster: Sunday - Session B, #46 (B46)

Tsinghua iGEM 2010 team focus on simulating antibody generation and selection technology with Bacteria, thus develops a new Antibody Production Method. Traditional antibody production method is expensive and time consuming. Thanks to the simple and easy-to-industrialize nature of prokaryotic systems, our antibody production system, once established, will facilitate the cheap and efficient production of antibodies. Production of antibodies in the mammalian immune system involves two steps: Random production of a large numbers of antibodies; Selection of a specific antibody matching the antigen. Therefore, our Antibody Production System would be composed of two devices: Module I: Generation of antibody library; Module II: Selection of specific antibodies.

TU Delft

Alkanivore: Enabling degradation of hydrocarbons in aqueous environments

Track: Environment

Presentation: Room E51-151, Saturday, 11:00 AM

Poster: Saturday - Session A, #10 (A10)

Pollution of soil and water environments by crude oil has been, and is still today, an important environmental issue. This was once more confirmed with the oil-spill in the Gulf of Mexico, but is also an issue that has to be faced continuously during the process of oil extraction from oil sands. Cleaning has proven to be challenging, but synthetic biology may hold the key to sustainable bio-remedial solutions for the future. What if we could design a small, autonomous, self-replicating, inexpensive method to remove oil from aqueous environments? The TU Delft iGEM 2010 team spent their summer designing a system that can tolerate, sense, dissolve & degrade hydrocarbons in aqueous environments, which could open new doors for the oil-industry.

TU Munich

bioLOGICS: Logical RNA-Devices Enabling BioBrick-Network Formation

Track: Foundational Advance

Presentation: Room 32-123, Saturday, 1:00 PM

Poster: Saturday - Session A, #29 (A29)

Among the goals of iGEM is the creation of synthetic biological parts and their utilization to achieve novel features and behavior in biological systems. The emphasis of our project is put on this latter, "systems" aspect of iGEM. More precisely, we aim at the development and experimental demonstration of a scalable approach for the realization of logical functions in vivo. By developing a computational biological network based on RNA logical devices we will offer everyone the opportunity to 'program' their own cells with individual AND/OR/NOT connections between BioBricks of their choice. Thereby, BioBricks can finally fulfill their original assignment as biological parts that can be connected in many different ways. We will achieve this by engineering simple and easy-to-handle switches based on predictable RNA/RNA-interactions regulating transcriptional termination. These switches represent a complete set of logical functions and are capable of forming arbitrarily complex networks.

TzuChiU Formosa

Nutrient synthesizer

Track: Food & Energy

Presentation: Room 32-123, Saturday, 3:30 PM

Poster: Sunday - Session B, #37 (B37)

Global nutrient deficiency issue has never been solved for centuries, 5.6 millions children died from malnutrition and hunger yearly (UN statistics). We aim to create a synthetic biological device to produce nutrient for people who needed. The device contains sensing, synthesis, and lysis system which is operated in E.coli. When the device senses appropriate signal, it will activate synthesis system to produce nutrient. When products reach a critical mass, the lysis system will take over to release nutrient. We take β -carotene as one of our source of nutrient, as it is the precursor of vitamin A. 40 millions people worldwide suffer night blindness each year because vitamin A deficiency. In our device, we use hydrophobic promoter as our sensing system (β -carotene is lipid soluble), and lysogenic enzyme as our lysis system. Our next step is to transform our synthesizer to lactobacillus which is harmless to human so we could solve the global food crisis problem.

UC Davis

Engineering a Spatial Oscillatory Network for Spontaneous Two-Dimensional Pattern Generation in E. Coli

Track: Manufacturing

Presentation: Room 54-100, Sunday, 12:00 PM

Poster: Sunday - Session B, #12 (B12)

Genetic circuits regulating spatial pattern formation play vital roles in organismal development throughout the eukaryotic domain. We believe that we can use related design principles to synthesize spatial patterning in bacterial populations. Previous genetic devices have allowed bacterial lawns to faithfully reproduce spatial patterns and, with the inclusion of cell-cell communication, to construct a bacterial edge detection device. Our device builds on these ideas but differs significantly by aspiring to produce complex spatial patterns in response to simple stimuli rather than by copying the input stimulus. This genetic circuit could drive the creation of biological systems capable of generating spatially varying gene expression profiles in response to simple chemical stimuli. Such devices should have application in fields such as nanofabrication, environmental engineering and tissue engineering.

UCL London

Hypoxon: Improved manufacturing of biopharmaceuticals by process-triggered positive-feedback loop in E. coli.

Track: Manufacturing

Presentation: Room 54-100, Sunday, 12:30 PM

Poster: Sunday - Session B, #6 (B6)

Biopharmaceuticals are commonly synthesized using E. coli as production chassis. Typically, the production of biopharmaceuticals is triggered by the addition of an induction agent, often IPTG, during the bioprocess. The UCL iGEM team aims to create "independent" cells in which the production phase is triggered by an external stimulus, removing the need for IPTG. The stationary phase growth in bioreactors is preceded by a dip in dissolved oxygen tension (DOT) followed by a DOT spike. We have developed a genetic circuit in which a series of promoters will cause the production to be triggered by the hypoxic condition. This auto-induction promises an economically and manufacturing improved production of biopharmaceuticals. There is the potential of applying this "Pavlovian" circuit principle in near future to yeast, mammalian or other expression systems for the production of complex biomolecules for the treatment of major diseases.

UCSF

Synthetic Killers - engineering immune cells for cancer therapy

Track: Health & Medicine

Presentation: Room 26-100, Sunday, 2:30 PM

Poster: Sunday - Session B, #54 (B54)

Cytotoxic cells of the immune system (Natural killers and cytotoxic T cells) identify cancer and virally-infected cells and kill them. These potent killers travel throughout the body, recognizing proteins and other molecules on the surface of target cells. If the target cell is deemed potentially dangerous, the cytotoxic cell grips the target cell tightly and creates an immunological synapse at the site of adhesion. Within this immunological synapse, the killer cell releases cytotoxic granules to kill the target cell without harming any nearby cells allowing for a direct, apoptotic death. Our team will focus on improving the specificity and killing efficiency of cytotoxic cells towards certain cancer types. By using synthetic biology tools and logic gates' design, we hope to create powerful killing biomachines for the fight against cancer. Our newly engineered synthetic devices would have the potential to enhance current adoptive cell-based immunotherapy for cancer patients.

UIUC-Illinois

sRNAs in Artificial Gene Circuits and Bioremediation Applications

Track: Information Processing

Presentation: Room 54-100, Saturday, 2:00 PM

Poster: Saturday - Session A, #20 (A20)

Previously, the majority of engineered, genetic regulation within bacteria has been achieved through the use of transcriptional regulators. However, the recent explosion of interest from the emerging field of RNA regulation provides new insights into the dynamic nature of genetic regulation. Small non-coding RNAs (sRNAs) comprise the chief regulatory mechanism for eliciting primary responses to environmental stresses. Acting in conjunction with proteins such as hfq (RNA chaperone), sRNAs provide a cost-effective, specific and rapid response that is essential

in targeting gene transcripts for regulation. The Illinois iGEM team has worked to create a set of endogenous and artificial sRNA regulator Biobricks to be used in cellular stress responses and which contribute to bistability in artificial gene circuits. A bacterial metal detection system of arsenic and gold demonstrates the capacity of sRNA regulation in artificial gene circuits.

UIUC-Illinois-Software

BioMORTAR

Track: Software Tools

Presentation: Room 32-123, Sunday, 12:00 PM

Poster: Saturday - Session A, #35 (A35)

In order to facilitate the design process for novel bacterial metabolism, our team has created a tool suite known as BioMortar which will automate plasmid design for metabolic processes as well as model cell growth. BioMortar begins with a much improved version of IMPtools, which uses an algorithm over a network generated by the KEGG database, to determine the optimal metabolic pathway according to specified conditions. At this point, it accesses the DNA sequences for each recommended enzyme for each reaction and searches the BioBrick database for related gene sequences. Then, BioMORTAR designs and displays the advised, usable plasmid(s) in BioBrick format for the user. Finally, the program models the growth of the organism, with the addition of the new metabolic pathway(s). By automating the design process, BioMORTAR streamlines the process of designing bacteria with new metabolic processes.

ULB-Brussels

Hydrocoli : How to make wastewater our new green energy source

Track: Food & Energy

Presentation: Room 34-101, Sunday, 10:30 AM

Poster: Saturday - Session A, #30 (A30)

Current hydrogen production processes are not sufficiently energy-efficient to provide a viable source of green energy. Our project is to design a genetically engineered Escherichia coli which could be used for hydrogen production. To offset the low yields of hydrogen production through dark fermentation, the substrate would be the organic compounds found in wastewater. The mixed acid fermentation pathway, leading to hydrogen production, can be improved by both the overexpression and the deletion of several genes involved. In addition, we would like to implement various features to enable the strain to perform other tasks related to wastewater treatment, such as biosensor, eliminating nitrogen compounds, or hindering hydrogen consumption by methanogenic bacteria, as well as a planned death system in order to prevent its proliferation in the environment. We also plan to adapt to iGEM standards the homologous recombination tool used for the deletions.

UNAM-Genomics Mexico

WiFi Coli, a Communicolight System

Track: Information Processing

Presentation: Room E51-151, Sunday, 5:00 PM

Poster: Sunday - Session B, #18 (B18)

Synthetic Biology has been enabling changes in all bio-domains, one such being communication. Traditional cellular communication has relied since time immemorial on chemical messengers to exchange information. Regardless of their scope, these messengers are constrained to a system; eg: even far reaching couriers such as hormones are bound within the chemical structure that is the human body. But this is about to change. In this project, our goal is to render the chemical barrier deprecated by using a non-chemical herald: photons. These will transport information between our engineered cells, creating a photon-based inter-cellular communication system. These messengers are produced through bio-luminescent reactions, and are quite capable of traversing multiple environments. This enables the transmission of information beyond the chemical, biological, and even spatial limitations. As the courier is effectively decoupled from the chemical layer, it is an innovative step in establishing communications between organic-based and silicon-based systems, such as computers.

UNIPV-Pavia

ProteinProgress: a cellular assembly line for protein manufacturing

Track: Manufacturing

Presentation: Room 54-100, Saturday, 11:00 AM

Poster: Saturday - Session A, #6 (A6)

Large-scale production and purification of recombinant proteins by cell cultures represent a key-area in manufacturing field. The production process still has several drawbacks affecting cost/efficiency. In this work, three modular systems were designed to overcome some of these bottlenecks. A library of self-inducible promoters was built and characterized to start the peptide production at a desired culture density, without expensive inducer molecules. Two standard integrative vectors were realized to insert BioBrick parts in user-defined positions of *E. coli* or *S. cerevisiae* genome, to ensure genetic stability without using selection markers. Finally, two promising techniques were combined for an "in-cell" protein purification: PolyHydroxyAlkanoate (PHA) granules were used as a substrate for PHA-binding peptides (Phasins) fused to the target protein, thus replacing affinity resins/columns and tags, while a pH-based self-cleaving peptide (Intein) was used instead of a protease cleavage site. These solutions are modular and provide useful BioBrick parts for other applications.

uOttawa

Characterization of toggle switch components for use in engineered, tunable networks

Track: Foundational Advance

Presentation: Room 34-101, Sunday, 5:00 PM

Poster: Sunday - Session B, #34 (B34)

The generation rate of complex genetic networks has slowed in the past decade due to a lack of characterized components. We aim to solve this issue by contributing a library of well-characterized yeast toggle switch components with varying dynamics. In order to characterize these switches, each of the two repressors, driven by mutually repressible promoters, is tagged with a distinct fluorescent protein that can be detected and quantified using flow cytometry. To expand the BioBrick database we will submit functionally-tested yeast-enhanced fluorescent proteins, repressors, and a library of repressible promoters. Furthermore, to demonstrate the applicability of these components in fine tuning genetic networks, we hope to use these toggle switches to build a DNA damage sensor with varying levels of sensitivity. We also describe novel methods for BioBrick construction based on natural homologous recombination mechanisms in *S. cerevisiae*.

UPO-Sevilla

Bacterial Crowding

Track: New Application

Presentation: Room 10-250, Sunday, 10:00 AM

Poster: Sunday - Session B, #51 (B51)

The possibility of specifically targeting bacteria to biological or abiotic surfaces is a promising technology of potential use in therapy, pest control and bioremediation, among others. However, since in most cases bacteria are not drawn towards their targets, the possibility of specific interaction is limited to those bacterial cells that randomly collide with the surface, thus requiring a high bacterial population to achieve efficient targeting. On the other hand, most bacteria are specifically attracted by gradients of a variety of chemicals, thus achieving high cell densities in the areas where the chemoattractants are present at higher concentration. The aim of "Bacterial Crowding" is to exploit chemotaxis for directing a relatively small population of bacteria to interact efficiently with a non-diffusible target exposed on a biotic or abiotic surface.

Uppsala-Sweden

Living Clock

Track: Health & Medicine

Presentation: Room 26-100, Saturday, 1:00 PM

Poster: Saturday - Session A, #43 (A43)

The Living Clock project aims to build a biological entity that could process a specific input signal and responds accordingly. We designed a set of concentration detectors that measures different range of the input signal and respond only to a specific concentration interval. By combining and spatio-temporal coordinating such concentration detectors we attempt to construct a biological clock that display time. The concentration band components themselves would work as a quantitative sensor that can work in combination other chemical sensors, such as toxic metals to life saving enzymes, which previous iGEM teams have come up with. Apart from this utility, we believe the concentration band detect sensor in different configurations can allow the creation of complex circuits ranging from simple oscillators to complex data processing machines which can exist on the same system without affecting other components of the system owing to its concentration band specificity.

USTC

An Integrated Platform Based on Bacterial Microcompartment for de novo Proteinaceous Artificial Organelles

Track: Manufacturing

Presentation: Room E51-151, Sunday, 10:00 AM

Poster: Sunday - Session B, #15 (B15)

In synthetic biology, we are in great need of an independent compartment and an integrated line to assemble disparate elements in cells. Thus we design, model and construct a platform for artificial organelles. The shell genes of *Citrobacter freundii* pdu bacterial microcompartment (BMC) were first constructed into BioBrick parts, assembled and expressed to form an empty porous multi-protein shell of ~100nm. Then target protein can be located either inside or outside the empty shell by fusing the protein with signal sequences, using a novel and convenient assembly standard compatible with the RFC 10. Onto this platform, artificial organelles with different functions can be constructed. With enzymes or binding proteins inside the shell, different nanoreactors or nanoreservoirs can be produced. Modifications outside the shell can be applied to build multi-protein super-complexes or facilitate downstream purification with affinity tags. Such a platform will make *E. coli* an integrated factory.

USTC Software

iGaME: Synthetic Biology for Gamers

Track: Software Tools

Presentation: Room 32-123, Sunday, 11:30 AM

Poster: Sunday - Session B, #35 (B35)

To promote public awareness of synthetic biology and introduce its basic ideas to the laymen, our team devoted to the development of an experimental video game which aims at instructing non-biologists to design and improve biological systems. Following the games-with-a-purpose paradigm in which players help solve scientific problems, we attempt to apply the human brain's puzzle-solving abilities to the complex designs of biological systems. While most of developed simulation tools are designed for experts to model the reaction networks from scratch, our game integrates a modeling environment in which users only need to submit their assembling of parts for our program to discover and generate the biological model automatically. With a mass of data for the use of modeling, we propose the Standard Biological Parts Modeling Database Language, which enables descriptions of complicated biological processes. Furthermore, previous iGEM project models will be featured to demonstrate the availability of our idea.

UT-Tokyo

E.coli solves SUDOKU

Track: Information Processing

Presentation: Room 54-100, Saturday, 1:30 PM

Poster: Sunday - Session B, #10 (B10)

Information-processing by means of cellular machinery has flourished recently, as exemplified by the creation of bacteria capable of counting or performing AND/OR boolean logic. However, the successful assembly of organisms that integrate multiple (>3) pieces of information into an elongated AND gate has yet to be seen. Our "4C3 leak-switch" realizes such a tool with the use of homologous recombination and leaky transcriptional terminators. This switch turns on only when three of four types of information are transmitted, regardless of the order of transmission, and outputs differently depending on the combinations of input. Our current project aims at creating bacteria that collectively solve the popular puzzle game Sudoku. This aim is achieved by combining this switch with our second subproject, the "signal-virus," which relays information only to the relevant targets, based on an antisense-RNA key system. This system realizes parallel-computing and we believe will greatly advance the field of information-processing.

Utah State

CyanoBricks: Genomic Engineering Tools for the Photosynthetic Cyanobacterium Synechocystis

Track: Manufacturing

Presentation: Room 54-100, Saturday, 4:00 PM

Poster: Saturday - Session A, #18 (A18)

The future of synthetic biology lies in expanding our ability to engineer genes in new organisms. Our project develops a system to engineer the genome of the photosynthetic cyanobacterium *Synechocystis* sp. PCC6803, establishes expression standards for this species, and adds a set of characterized *Synechocystis* promoters and ribosome binding sites to the BioBrick toolbox. We developed a BioBrick vector that can be used to assemble parts and devices in *E. coli*. Upon transformation into *Synechocystis*, it integrates the device directly into the genome through homologous recombination. We utilized genes that were activated under a variety of conditions, from those responding to heat stress to ones oscillating under a circadian rhythm. The promoters and ribosome binding sites were converted into BioBrick-compatible parts, and subsequently characterized. Our success will enable the use of existing parts in new species, and will expand the range of devices that can be built.

UTDallas

Enlisting E. Scherichia Holmes: A modular whole-cell biosensor for the detection of environmental pollutants

Track: Environment

Presentation: Room 54-100, Sunday, 10:00 AM

Poster: Sunday - Session B, #8 (B8)

Recalcitrant pollutants such as petroleum constituents and nitrates are regularly introduced to the environment through oil spills, natural geological seepage and eutrophication. The UN's flagship water protection initiative enumerates a host of health risks associated with these chemicals. UT Dallas iGEM addresses the eminent need to mitigate their circulation by developing novel whole-cell biosensors that can detect alkanes, aromatics and nitrates and execute combinatorial logic, feedback and noise-reduction functions inspired by synthetic biology. This work has wide ranging applications requiring a cheap chemical sensor that can dynamically process heterogeneous inputs and express a user-friendly output.

Valencia

Mad yeast on Mars

Track: Food & Energy

Presentation: Room 34-101, Saturday, 1:30 PM

Poster: Sunday - Session B, #30 (B30)

We present an intermediate scenario in the pathway towards Mars Terraformation. The project is focused in two essential conditions on this process: Increase the planet temperature, resistance of microorganism to thermal changes. The proposal is that dark yeast cells retain the arriving radiation and heat the surface. But, once the temperature reaches its optimum on the planetary surface the color production should be switched off. In order to achieve that and taking advantage of Synthetic Biology principles, a switch based on prion proteins (on mad yeast!) will be used. The work will be complemented with the implementation of the expression of LEA (late embryogenesis abundant) "antifreeze" protein. Summarizing, we are going to build a engineered yeast resistant to temperature changes and able to produce a dark pigment which will be the responsible of a global temperature increase on Mars.

VictoriaBC

Exploring AHL inducible fluorescence

Track: Information Processing

Presentation: Room E51-151, Sunday, 2:30 PM

Poster: Sunday - Session B, #11 (B11)

AHL mediated quorum sensing is utilized by many gram negative bacteria for both intra and interspecies communication. Cells containing synthetic DNA constructs that produce fluorescent proteins in the presence of AHLs could be used as in situ reporters of the AHL milieu in dynamic natural systems like biofilms and plant root nodulation. Additionally, cells that can produce AHLs could be used to alter the signalling in these systems and examine the results. Finally, different combinations and spacial arrangements of AHL inducible reporters, AHL producing cells and AHL degrading cells all regulated by the AHL milieu of the media could allow for information processing through the interactions between such nodes. Our team designed a number of AHL regulated nodes, devices that each respond to AHL levels in different ways, and attempted to build some of these nodes to characterize their behavior.

Virginia United

Quorum Sensing Amplifiers and a Codesign Approach for Information Processing

Track: Information Processing

Presentation: Room E51-151, Sunday, 3:30 PM

Poster: Sunday - Session B, #9 (B9)

Synthetic biology endeavors to create information processing systems modeled on digital electronics. The use of quorum sensing can help transform an inherently analog molecular signal into a binary response and simultaneously allow the tuning of input response thresholds and signal amplification. This project demonstrates these capabilities through experimentation and modeling. Another candidate for reapplying an electronic engineering technique is the codesign of hardware and software to implement a function. In synthetic biology, codesign might mean implementing a design spec in different expression control regimes and comparing their relative merits. Our work examines the codesign concept by constructing an AND gate in three different design domains. We explore the application of these ideas with an environmental sensor. A unique aspect of our project is the collaborative nature involving five institutions at three locations.

VT-ENSIMAG Biosecurity

Design and development of the GenoTHREAT gene sequence screening software

Track: Software Tools

Presentation: Room 32-123, Saturday, 11:00 AM

Poster: Sunday - Session B, #33 (B33)

In order to mitigate the biosecurity risks associated with the potential dual use of gene synthesis, the U.S. Government published a draft version of a "Screening Framework Guidance for Synthetic Double-Stranded DNA Providers." This document outlines a minimal DNA sequence screening protocol that gene synthesis companies are encouraged to use prior to fulfilling an order. The protocol relies on the "Best Match" method developed in response to the limitations of other screening protocols previously proposed by trade organizations. The objective of the "Best Match" method is to identify sequences which are uniquely related to Select Agents or Toxins. The GenoTHREAT software is being developed in accordance with the Government guidance and, to our knowledge, is the first implementation of the sequence screening procedure outlined in the guidance. Although software characterization has elucidated both strengths and limitations, GenoTHREAT appears to be a viable tool for sequence screening.

Warsaw

An universal platform for protein delivery to the mammalian cells

Track: Foundational Advance

Presentation: Room 34-101, Saturday, 3:00 PM

Poster: Saturday - Session A, #27 (A27)

Our project consists of two parts: BactoDHL and RBS Measurement. BactoDHL is a universal platform for protein and DNA delivery to the mammalian cells. It's based on E. coli strain expressing invasion determinants: invasin from Yersinia pestis and listeriolysin (LLO) from Listeria monocytogenes. Invasin causes uptake of the bacterium into the mammalian cell by induction of endocytosis. Bacterial cells are lysed in the endosome and then LLO is released. LLO is a pore-forming toxin which causes endosomal membrane disruption and release of the payload (either protein or DNA) into cytoplasm of the mammalian cell. In order to fine-tune expression of genes used in our project we conducted measurement of various RBS parts included in 2010 spring distribution both from Community and Anderson's collections. We used standard measurement kit composed of promoter BBa_J23100 and GFP+terminator part BBa_I130401. We performed both relative and absolute RBS strength measurement.

Washington

Antibiotics for the 21st Century

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 11:00 AM

Poster: Sunday - Session B, #47 (B47)

While vital to our quality of life, traditional antibiotics face the serious problems of widespread bacterial resistance and destruction of natural gut flora - problems which call for improved twenty-first century antibiotics. Using synthetic biology tools, we designed, built, and tested two new systems to fight infections by both broad types of bacteria - Gram-positive and Gram-negative. Our first project targets Bacillus anthracis, the Gram-positive pathogen that causes anthrax. We re-engineered an enzyme to remove the pathogen's protective coating, rendering it defenseless against the immune system. In our second project, we re-engineered and transplanted a protein secretion system capable of combating Gram-negative bacteria into E. coli. This system was designed to target Gram-negative pathogens in a modular and controllable fashion. These two systems are the vanguard of a new era of antibiotics using the power of nature harnessed with the tools of synthetic biology.

WashU

A new set of synthetic biology tools for Saccharomyces cerevisiae

Track: Foundational Advance

Presentation: Room 32-123, Sunday, 3:30 PM

Poster: Sunday - Session B, #31 (B31)

Saccharomyces cerevisiae is a model unicellular eukaryotic chassis; however when compared with Escherichia coli the available synthetic biology tools are lacking. To remedy this problem the 2010 Washington University iGEM team has introduced a synthetic alternative splicing tool, as well as designed and produced new BioBricks parts to ease transformation of synthetic constructs into S. cerevisiae. A mutually exclusive exon splicing system was formulated in which Sex-lethal interacts with the native splicing machinery to affect splice site choice. Two vectors have been designed to facilitate simple bacterial BioBrick manipulation and subsequent chromosomal integration into the yeast genome. A yeast positive selection marker BioBrick has been produced for the first time. Chromosomal integration with positive selection will stabilize and streamline BioBrick transformations into S. cerevisiae. A synthetic splicing assembly will allow for new synthetic biology techniques such as isoform engineering of proteins or combinatorial logic.

Waterloo

Staphiscope: diagnosis of S. aureus through bacterial wiretapping

Track: Health & Medicine

Presentation: Room 10-250, Sunday, 11:30 AM

Poster: Saturday - Session A, #46 (A46)

Superbugs, or antibiotic resistant microorganisms, are microbes that have become resistant to traditional treatments. These types of infections are difficult to diagnose, treat, and eradicate, making the healing process time consuming and resource intensive. The native quorum-sensing unit from S.aureus (the Agr system), will be introduced into a non-pathogenic strain of E.coli. The E.coli will then effectively have the ability to eavesdrop on the activity of the pathogenic organism and emit an indication of the magnitude of the infection in the form of RFP. Using sensitivity tuners the system can be designed such that the response will occur at an exact level, when the size of the population poses a threat to the host. Upon a positive result from a diagnosis, further tests could be done to specify whether MRSA (methicillin-resistant S. aureus) or MSSA (Methicillin-sensitive S. aureus) are present.

Weimar-Heidelberg Arts

Super Cell - the synthetic biology supermarket

Track: New Application

Presentation: Room 10-250, Sunday, 10:30 AM

Poster: Saturday - Session A, #48 (A48)

Super Cell is a fictional supermarket offering speculative products which are all based on Synthetic Biology. The Super Cell website already gives us a glimpse of the products that will be available in local stores in the near future. By putting already existing and far-out in the future applications next to each other in a familiar environment such as a webshop, the project aims to improve public awareness about Synthetic Biology and at the same time foster a debate on how we want to see it manifested in our everyday lives. This kind of discussion, we feel, is urgent to have if we as a society want to influence how this powerful science will affect our future lives.

Wisconsin-Madison

Universal Platform for Polypeptide Delivery: Intelligent Delivery of Ingestible Enzyme Treatment (iDIET)

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 10:00 AM

Poster: Sunday - Session B, #50 (B50)

We have designed a universal platform for polypeptide release within the small intestine of the human gut. Our model system release beta-galactosidase, a functional homologue of human lactase, once it reaches the duodenum to help a lactose intolerant patient metabolize lactose. The chassis for this system is the common probiotic in yoghurt, Lactobacillus acidophilus. Once the Lactobacillus acidophilus has reached the duodenum, they will lyse by either by a timed inducible/repressible system, a bile-inducible system, or an encryption system. Using DNA we can mimic the

functionality of a combination lock, and produce a "locked" gene, which can be effectively "unlocked" only after a specific sequence of inputs. Since DNA functions as a logical medium, the "locked" and "unlocked" states are heritable, which makes this system useful as the computational basis for many higher-order genetic devices from bacterial calculators to engineering of new metabolic pathways to bacterial drug delivery systems.

WITS-South Africa

Lactoguard: A commensal whole-cell biosensor for the diagnosis of sexually transmitted infections

Track: Health & Medicine

Presentation: Room 10-250, Saturday, 3:00 PM

Poster: Saturday - Session A, #47 (A47)

Whole-cell bacterial biosensors have been developed for a range of applications. In this project, the concept of a whole-cell biosensor has been adapted for medical use as a diagnostic for viral infection through engineering a commensal bacterium. Lactobacilli are the predominant commensal organisms in the human vaginal mucosa and are ideally placed to detect the presence of a sexually transmitted infection, such as Human Papillomavirus. A strain of this bacterium has been modified to produce a chromogenic reporter, which is visible to the naked eye, when 'switched on' through exposure to the input signal (viral infection). However, in order for this to be clearly visible in vivo, this signal needs to be transmitted throughout the entire bacterial population. Thus, this project focused on a) modifying a Gram-positive bacterium to produce the chromogenic reporter; b) using a heterologous quorum-sensing mechanism to propagate an auto-regulated feedback loop amongst a bacterial population.

Yale

Manufacturing electrical circuits using localized microbial metal deposition

Track: Manufacturing

Presentation: Room E51-151, Saturday, 2:00 PM

Poster: Saturday - Session A, #19 (A19)

What does it take to make bacteria produce an electrical circuit? One of the most exciting uses for synthetic biology is in the design of biological systems that can replace and improve industrial processes. By achieving industrial goals using biological processes, we predict dramatic reductions in economic and environmental manufacturing costs. Our project is a first step towards biologically synthesized electronic circuits. Based on precedence of naturally redox-capable bacteria, we generated a system in *E. coli* that reduces metal in solution. Depending on the application, this system has the ability to form a conductive copper sulfide that can be localized with high precision. In the future our bacteria could catalyze metal deposition to form electrical circuits of any desired dimension and complexity.

ZJU-China

Bach: gene composer

Track: Software Tools

Presentation: Room 32-123, Saturday, 10:00 AM

Poster: Sunday - Session B, #27 (B27)

While former iGEM software teams were mainly focusing on the assembly of biobricks into a predictable system, our software Bach targets at the coding sequence of biobrick itself. We first built a mathematical model to quantitatively predict RIPS (ribosome initiation per sec) of any given coding sequence in any organism. We then constructed three modules (synonymous substitution, optimization and RIPS design) to process input coding sequences. Bach could recompose the input sequence into an output one that better suits the host organism and performs the specific translational rate of desire. In this way, the discordant tunes of codon bias in biobricks from different genetic backgrounds could be synchronized, and the realization of a more predictable and robust system would be possible. Our work not only benefits current works involving exogenous protein expression, but also makes a big step towards standardization and characterization of biobricks.