



FACULTY OF | UNIVERSITY OF  
MEDICINE | CALGARY

O'Brien Centre for the   
BACHELOR OF HEALTH SCIENCES PROGRAM

Health Sciences Centre  
3330 Hospital Drive NW  
Calgary, AB T2N 4N1

To whom it may concern,

We are writing you on behalf of the University of Calgary iGEM team. We are a group of undergraduate students who are working this summer on a project in what is known as synthetic biology in order to compete in the prestigious international Genetically Engineered Machine (iGEM) competition ([www.igem2007.com](http://www.igem2007.com)) at the Massachusetts Institute of Technology (MIT).

We are soliciting monetary and in-kind donations to support the UofC team's efforts. We have been awarded financing through grants to cover student stipends but require funds towards team expenses such as lab materials, travel, commercial DNA synthesis and sequencing costs.

iGEM is an annual international competition which involves undergraduate students from around the world in the nascent field of **synthetic biology**, the engineering of circuits like the ones in electronic devices only on the molecular scale, and built from proteins and DNA. Last year we put together Alberta's and the UofC's first iGEM team and constructed a genetic system which allowed communication between different populations of cells and made them respond to this communication by producing fluorescent proteins that glow under UV light. After several months of intense effort we managed to make a working example of the system. We competed in Boston, Massachusetts at the MIT campus and won the First Place Award in the category of Conquest of Adversity, for building a working system despite having one of the smallest teams and only working part time on the project.

This year we are building on that success, with a larger, dedicated team. Our team is composed of students from the biomedical, bioinformatics and computer science fields to work on the project. We have designed a very interesting and ambitious system. Our project aims to create a **biomechanical printer**, including a mechanical apparatus that translates digital images into patterns of light and a biological circuit inside individual bacteria which responds to the light. The light will make the bacteria produce an enzyme which will digest a material called agar which the bacteria grow on, leaving a physical impression. The project is a proof of concept as

well as a valuable demonstration of the unique possibilities of biotechnology. We will be working the entire summer as well as during September and October in preparation for the competition in November.

iGEM has attracted significant attention in the press and our success at MIT has brought the interest of the Alberta Ingenuity Fund which has pledged to support our team. Included with this letter are descriptions of both the previous years work, what we are doing this year, a description of what materials our team requires as well as some articles which were published about the team.

You can be sure that we greatly appreciate your support and will include your company's logo and title on all our team posters, t-shirts, etc. As Alberta's premier iGEM team we intend to build an advanced biological system and showcase it on the international stage. We kindly ask for your support in this endeavor and hope you are interested in becoming involved.

Sincerely,

Vladislav Lavrovsky  
4th Year Bioinformatics Student  
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xxx-xxx-xxxx

Patrick King  
3rd Year Bioinformatics Student  
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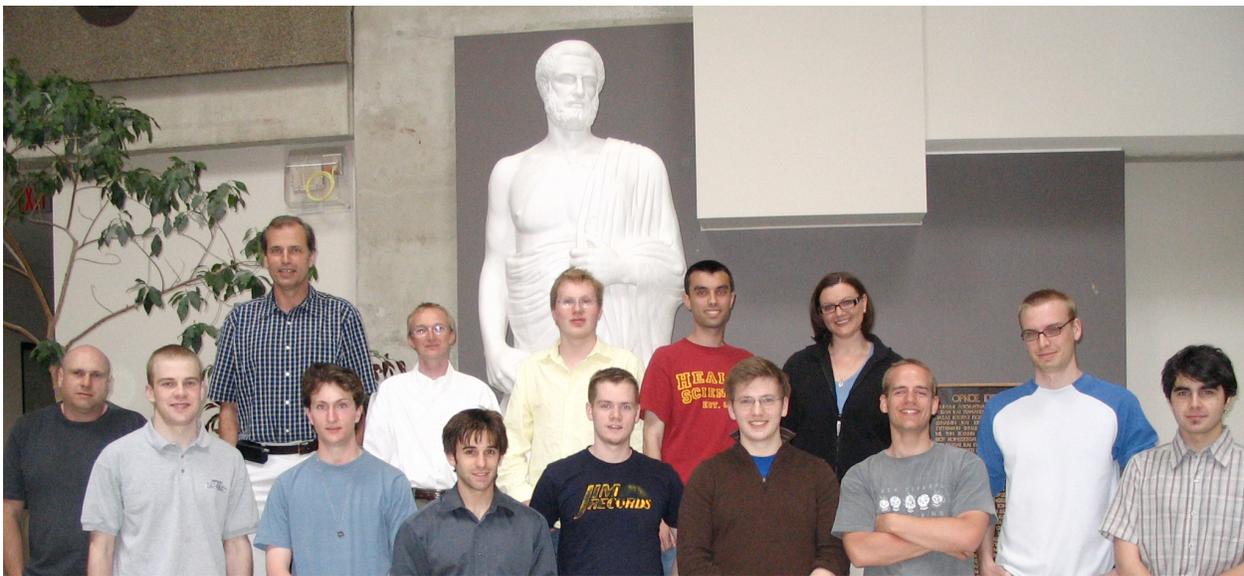
"iGEM is now recognized as the premier undergraduate educational program for synthetic biology" - Andrew Hessel MIT

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## Overview

The international Genetically Engineered Machines (iGEM) competition is a team-based competition which has grown rapidly since its inception in 2003. Last year, over 400 students from 39 universities from around the world designed and built engineered biological systems and competed at the Massachusetts Institute of Technology (MIT). This year, the competition has grown further, with over 50 teams registered already. Projects involve building novel functions into bacteria, yeast and even eukaryotic (animal) cells. Using a set of pieces of DNA 'building blocks' called the BioBricks, teams compete to implement complex biological circuits. MIT maintains a library of BioBricks called the Registry which we will use as the source of our parts. Some systems built include biological thermometers and bacteria which synthesize the smell of bananas and spearmint.

This year the University of Calgary is fielding a team of 11 students from medical science, biology and computer science. We will be working in the Bachelor of Health Science and computer science labs and have the support of several key faculty members. We are seeking funding for the UofC iGEM team to ensure both a tremendous learning experience for the team members and allow us access to the resources we require to build our system and succeed at the competition.



**The 2007 UofC iGEM Team** (from left to right)

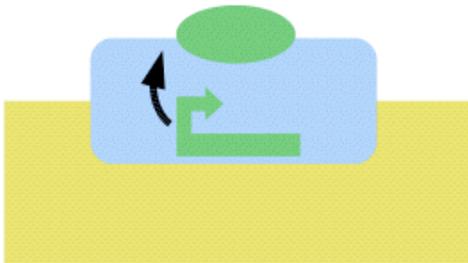
**Back Row:** Dr. Schryvers, Dr. Jacob, Scott McLeod, Boris Shabash, Sonja Georgijevic

**Front Row:** Lance Hanlen, Kevin McLeod, Patrick King, Paul Adamiak, Andrew Stagg, Vlad Lavrovsky, Sebastian Von Mammen, Chris Jarabek, Vlad Sarpe

## Goal of the 2007 Team

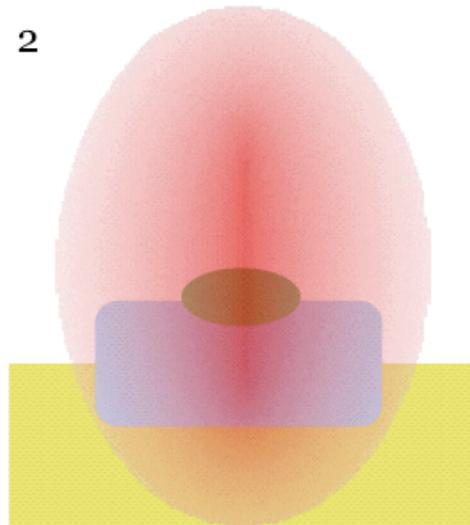
This year we are going to attempt to construct a biomechanical printer, which will translate images on a computer into patterns of gene expression in thin layers, or lawns of bacteria. The bacteria will emulate the function of a printer by producing pigments, glowing proteins or by digesting the material they are on top of. We will be able to print any image we like by programming a custom built xy plotter to trace an image above the dish of thinly spread bacteria. A laser mounted on the head of the plotter will tell the bacteria to begin expressing their response gene, and after a few minutes the trace should become visible. Other possibilities include producing fluorescent proteins or colored dyes to view the traces. Applications include high resolution (10 megapixel per inch) imaging and biological photolithography.

1



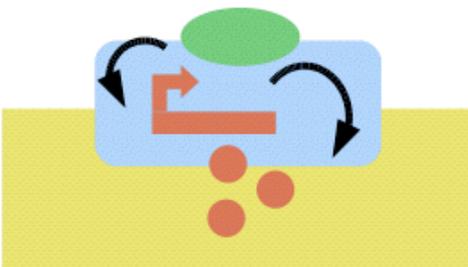
Each engineered cell (blue capsule) has genes (green box with arrow) for a light sensing protein (green oval).

2



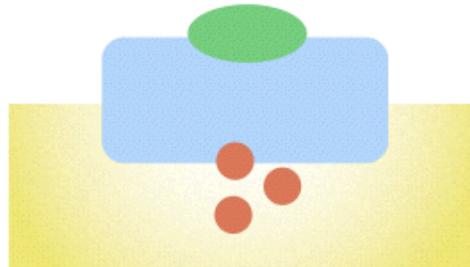
The light sensor is activated by passing the beam from a laser pointer over the petri plate.

3



The light sensor controls another gene (red box with arrow), for the protein agarase (red circles). Once activated by the laser pointer, the light sensor activates the agarase gene.

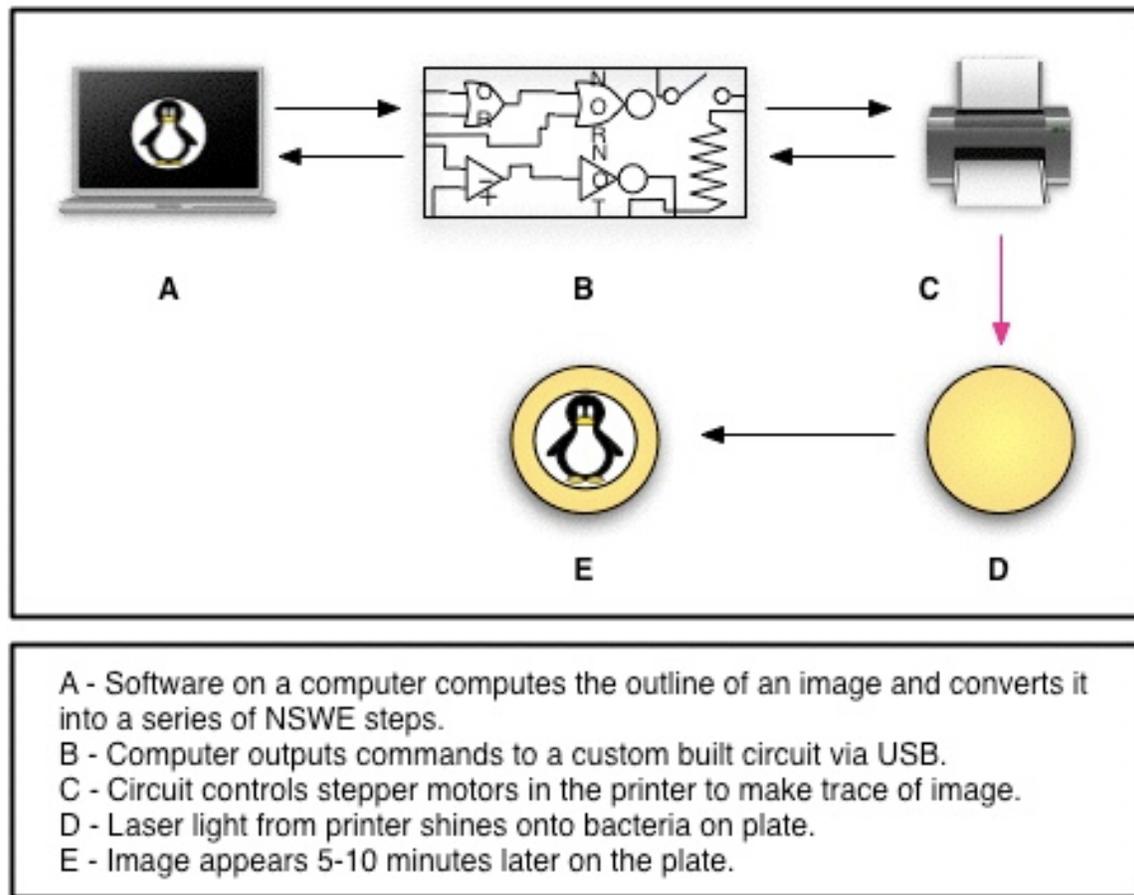
4



Agarase breaks down the jello-like matrix of that the cells rest on. When many cells produce agarase, a depression becomes visible on the petri plate.

## Current Project

### iGEM Schema



## Sponsorship

Donations will be applied towards team expenses including but not limited to the following:

1. Lab materials costs
  - 1.1. Restriction endonucleases (~\$900)
  - 1.2. High fidelity DNA polymerases (~\$1500)
  - 1.3. Various bacterial culture material (~\$200)
  - 1.4. Assorted laboratory supplies and reagents (~2000)
2. Electronics costs
  - 2.1. Stepper motors (~\$300)
  - 2.2. Integrated circuits (FX2, L293D) and other chips (~\$200)
  - 2.3. Wiring, breadboards, other assorted components (~\$200)
3. Travel expenses
  - 3.1. Flights to and from Boston for 11 students (~\$7700)
  - 3.2. Accommodations in Boston (~\$2000)

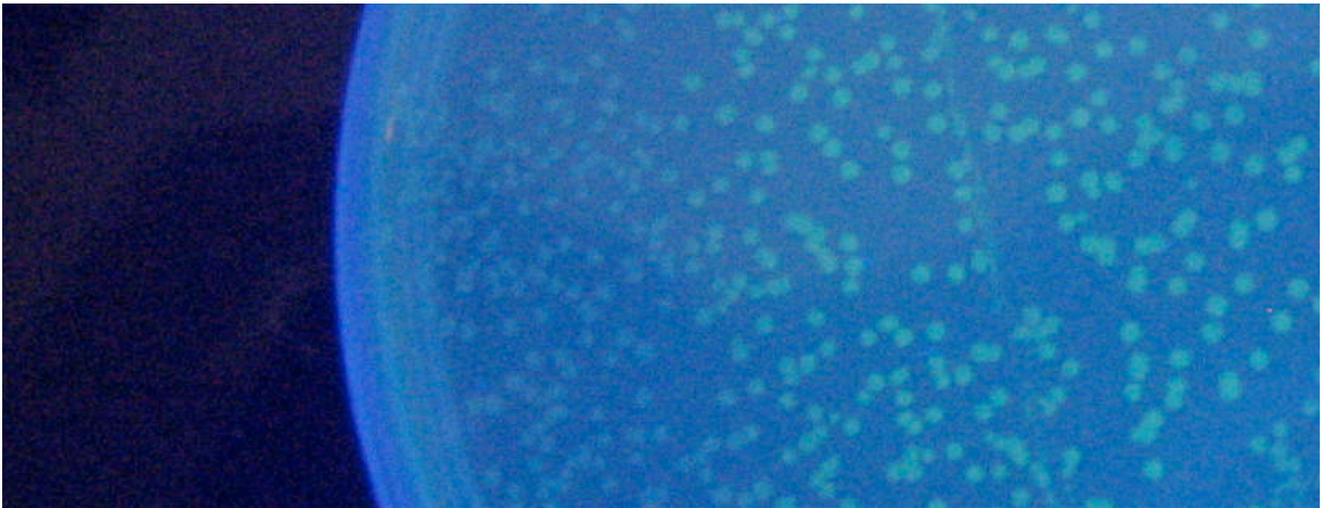
## 2006 iGEM Project

Light-AHL Induced GFP Signaling System

University of Calgary, Calgary, Alberta— iGEM 2006

As the UofC's first foray into the world of undergraduate synthetic biology a small group of students attempted to create a complex light induced signaling system. Using parts from the 2006 MIT iGEM Registry we designed a system which involved a two cell signaling system induced by light. The general schema was that there are two types of cells, Sender Cells (SCs) and Receiver Cells (RCs), on a two part media. The top layer of the media is a solid agarose while the bottom layer is low density swim media. The SCs reside on the surface of the top layer while the RCs reside within the bottom layer.

The SC would detect light which we shine on the top of the petri dish and produce AHL and aspartate. The RCs would be attracted towards the SCs due to the aspartate gradient created and the AHL would induce expression of GFP. Due to the difficulty of constructing the constructs, this was only completed partially. We managed to create a device which in the presence of exogenous AHL would result in GFP expression. We gained a great deal of experience and validated our use of PCR instead of plasmid isolation as a way of getting workable quantities of our construct components. We presented our findings at the Massachusetts Institute of Technology (MIT) and were awarded first place in the Conquest of Adversity category for bringing our project to a successful conclusion.



**This is a photo of cells from the 2006 project. The glowing cells on the right are responding to a chemical signal which the cells on the left have not yet received and thus are not glowing.**

## **2007 UofC iGEM Team Profile**

The UofC iGEM team has a diverse range of students which will be crucial to our success. Our project is multifaceted and involves biochemistry, genetics, computer science and engineering and could not be done by students from a single background. Below is an introduction to the students of the 2007 iGEM Team.

### **Dave Curran**

I am a third year student in the biomedical science. I will be working in the wet lab constructing plasmids and testing out our device.

### **Chris Jarabek**

I'm am just beginning my graduate studies in ecology at the University of Calgary. I did my undergrad degrees in computer science and biology, and now I study the population structure of synchronously spawning corals in the Gulf of Mexico. For the iGem project I will be focusing on the modeling aspect of the project.

### **Patrick King**

I'm Patrick, a second going on third year bioinformatics student. I was involved in the small team that participated in iGEM 2006, and I'm now hooked on synthetic biology. I'm working mainly in the wet lab this summer, but I'm also maintaining the wiki, helping with the computer science side of the project, and generally coordinating things. I don't have a lot of benchtop experience... but that will soon change!

### **Vladislav Lavrovsky**

I am a third year student majoring in Bioinformatics in the Bachelor of Health Science program. I have worked in microbiology and biochemistry labs for the last 5 years and was one of the founding members of the 2006 iGEM team. I am very interested in pursuing synthetic and systems biology as a career and see biotechnology as one of the most crucial technologies in the coming decade.

### **Sebastian von Mammen**

I am a Ph.D. student in Computer Science. I investigate developmental swarm systems in the Department of Computer Science Artificial Intelligence lab. My field of research can be best be describes as swarm mechanics. The link between artificial life and synthetic biology has been established a long time ago. According to my background, I contribute to our iGEM team mainly from the computational side (multi-agent systems, swarm dynamics, modeling).



### **Kevin McLeod**

I am a first year student in the Bachelor of Health Sciences program at the University of Calgary, with my major as Biomedical Science. For iGEM 2007, I will be primarily working in the lab as I learn about the things iGEM is all about.

### **Scott McLeod**

Scott has just completed his third year in the Biomedical Stream of the Bachelor of Health Science program at the U of C. Currently he is working in a microbiology lab studying the bacterial pathogen *Burkholderia cenocepacia*, a pathogen which is highly detrimental to immune compromised persons and those with cystic fibrosis. This is his first year on the U of C iGEM team.

### **Andrew Stagg**

I am a third year student currently completing a degree in Computer Science and Commerce. My research interests include Embedded Systems Design, Web Crawling and Web Data Extraction. My contribution to the iGEM team is with the design and development of specialized hardware and software needed to run experiments. Specifically, I am writing drivers for Mac OS X for a custom plotter using the IOKit, CoreFoundation and Cocoa frameworks.

### **Faculty Advisors**

#### **Dr. Christian Jacob**

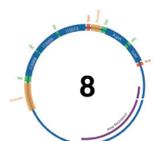
Dr. Jacob is the Director of the Bioinformatics program at the Bachelor of Health Science program at the University of Calgary. He is the primary faculty sponsor for the team and has championed the iGEM competition at the University of Calgary. His research interests are in evolutionary computing as well as synthetic & computational biology.

#### **Dr. Anthony Schryvers**

Dr. Schryvers is professor of Microbial and Infectious Diseases at the University of Calgary. His experience in bacteriology is of immense value to the team and he is a valued advisor. His research focuses on developing vaccines for pathogenic bacteria, and the structure of iron binding proteins in bacteria.

#### **Sonja Georgijevic M.Sc.**

Sonja Georgijevic is an indispensable resource to the iGEM team. As instructor for high level health science Inquiry courses she is very knowledgeable in all the methods and techniques that the iGEM team will require. She will oversee the day to day lab work and advise the team on genetics and molecular biology.





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MENU

iGem award (11-29-06)

## Student mastery of bacteria impresses judges at MIT

By Robyn Hauck  
November 29, 2006

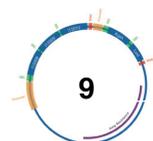


**L-R: Sebastian von Mammen, Patrick King, team supervisor Dr. Christian Jacob and Vladislav Lavrovsky.**  
/ Photo courtesy Christian Jacob

Three students in the Bachelor of Health Sciences program at the University of Calgary who harnessed the notorious E.coli bacteria and manipulated it to create art captured the imagination and the respect of judges at the Massachusetts Institute of Technology (MIT) recently.

Vladislav Lavrovsky and Patrick King from the Faculty of Medicine, and graduate student Sebastian von Mammen from the Evolutionary and Swarm Design Laboratory in the Department of Computer Science won the Best Conquest of Adversity Award.

“We were still waiting for lab testing results as we were flying to Boston for the competition,” said Lavrovsky. “These experiments are incredibly difficult and time consuming, so we needed to work day and night to make them a success.”



The three U of C students took one of the top prizes in the prestigious international Genetically Engineered Machine (iGEM) competition. The award acknowledged the students' diligence and intelligence despite having a small team compared to the average of 10 students per team. They also had very little time to prepare for the competition which challenges students to be pioneers in a new science known as “synthetic biology.”

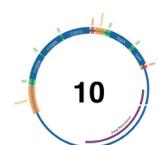
Synthetic biology may one day give scientists the ability to program cells to manufacture and deliver drugs in the human body.

The Calgary team's project used genetically engineered E.coli bacteria manipulating it to produce chemical signals which appeared as fluorescent green patterns.

This was the first year MIT invited Calgary students to compete in the annual event. Next year, the U of C's iGEM team hopes to recruit more students to compete in an effort to win the grand prize trophy.

The Faculty of Medicine at the University of Calgary is a national leader in health research with an international reputation for excellence and innovation in health research, education and delivery. Through its educational programs, the Faculty of Medicine trains the physicians and scientists who will lead the next generation of health practitioners. Through its clinical work, continuing medical education programs, and close relationship with the Calgary Health Region, the Faculty of Medicine moves new treatments and diagnostic techniques from the laboratory bench to the hospital bedside efficiently and effectively, improving patient care.

For more information visit the U of C team's [website](#).  
Find out more about the [competition](#).



# on CAMPUS

Volume 4 No. 7

NOVEMBER 24, 2006



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Winners of Lens On Learning photo contest capture campus **Pages 6 & 7**

DISCOVERY ENERGY CREATIVITY COMMUNITY



L-R: Sebastian von Mammen, Patrick King, team supervisor Dr. Christian Jacob and Vladislav Lavrovsky. / Photo courtesy Christian Jacob

## U of C team beats odds at MIT contest

By Robyn Hauck

The ability to work to tight deadlines and with an unusually small team has netted three University of Calgary students one of the top prizes in the prestigious international Genetically Engineered Machine (iGEM) competition at the Massachusetts Institute of Technology (MIT).

Bachelor of health sciences students Vladislav Lavrovsky and Patrick King, and graduate student Sebastian von Mammen, from the evolutionary and swarm design laboratory in the Department of Computer Science, competed in this invitation-only competition that challenges students to be pioneers in a new science known as synthetic biology.

The Calgary team won the "best conquest of adversity" award. "We were still waiting for lab results as we were flying to Boston for the competition," said Lavrovsky. "These experiments are incredibly difficult and time consuming, so we needed to work day and night to make them a success."

Judges acknowledged the U of C students' diligence and intelligence despite having a team of only three students—as opposed to the average of 10 students per team—and very little time to prepare for the competition.

Their project used genetically engineered *E. coli* bacteria to create art. The students manipulated the bacteria to produce chemical signals which appeared as fluorescent patterns. These patterns were used to produce paintings through computerized high-resolution drawings, a unique application of synthetic biology.

Synthetic biology will allow researchers to genetically engineer cells so they respond to commands and act like "living machines" inside cells. This kind of technology may one day give scientists the ability to program cells to manufacture and deliver drugs in the human body.

This was the first year MIT invited Calgary students to compete in the annual event. For more information on next year's competition please contact Dr. Christian Jacob at [cjacob@ucalgary.ca](mailto:cjacob@ucalgary.ca) or visit <http://obriencentre.org/iGEM?>