SPECIAL

Newsletter No. 4 -Special Issue
2015. 6. 30

[THE DEVELOPMENT OF SYNTHETIC BIOLOGY IN DIFFERENT COUNTRIES]

Welcome To Our Newsletter

By: Amoy & Paris Bettencourt

00 CONTENTS

Dear All,
Here comes the fourth issue.
This special issue is about the present situation of synthetic biology in different countries.

Thanks to the following twelve teams from nine countries:
ETH-Zürich, IONIS Paris, NAIT_Edmonton,
Missouri_Rolla, NJU-China, NYMU-Taipei,
Tec Monterrey, Toulouse, TU Eindhoven,
Slovenia_HS, WLC, Zamorano

Thanks to all of you for your devotion!

Any questions or suggestions?
We can always find us at igemxmu@gmail.com

All the best! Cheer for the summer!

iGEM Amoy

2015-6-30

01

[CANADA] NAIT_EDMONTON

GENETIC ENGINEERING NOW:

AN INTROSPECTIVE LOOK AT SYNTHETIC BIOLOGY IN **CANADA BY TEAM NAIT_EDMONTON**

Synthetic Biology (SynBio) is a multidisciplinary branch of science that combines biotechnology; evolutionary, molecular and systems biology; biophysics; and electrical engineering. In many ways, it is related to transgenesis; however, unlike transgenesis, which exchanges existing genes from one organism to another, synthetic biology allows scientists to write and synthesize novel genetic codes and insert them into a living organism (The Canadian Biotechnology Action Network, n.d.). Organisms that express the new genetic codes can then be used to create a molecule of human interest. From cleansing our environment to producing novel medications to treat currently incurable diseases, these genetically engineered organisms can potentially help us solve a multitude of pertaining problems in the future.

However, since synthetic biology is a novel field in research, it needs to gain the trust of the public in order to be successful (Bubela, Hagen, & Einsiedel, 2012). Public awareness and involvement in synthetic biology will help facilitate its acceptance into society as well as aid in focusing it in the development of specific products that are necessary for the community (Bubela, Hagen, & Einsiedel, 2012). Synbiota, a young canadian company that began as an iGEM Team, developed DNA design software that helps in the designing, assembling, testing and reiterating of genetic circuits created by its users (Synbiota, 2015). Their vision is to create an open ecosystem in which synthetic biology parts and protocols can be generated, exchanged, and be made accessible to the public (Synbiota, 2015). The transparency and public involvement in

02
NAIT_EDMONTON

CANADA-NAIT_EDMONTON-LOGO

Synthetic Biology will help to alleviate some of the misconceptions and distrust of the new, emerging science.

In addition to public acceptance, SynBio also needs to be supported in industry. Since t he year 2000, Genome Canada, a nonprofit organization that applies genomics and genomic-based technologies to create social and economic benefits for Canadians, has invested $2.3 billion CAD to decipher and understand the mechanism of economically important plant, microbial, and animal genomes (Genome Canada, 2015) (Quirion, Martin, Meulien, LePage, & Bell, 2014). Moreover, a fraction of that money has been used in developing technological toolkits that can improve the study of synthetic biology (Quirion, Martin, Meulien, LePage, & Bell, 2014). With regards to research centres, the Concordia Centre for Applied Synthetic Biology (CASB), in Montréal, is the first dedicated SynBio centre in Canada. Its main goals are to discover and understand the mechanisms of this novel science, and to research and develop tools, protocols, and technologies that allow the scientific community come up with solutions for current environmental and health matters (Concordia University, n.d.). It additionally deals with societal, legal, and ethical concerns with regards to SynBio in order to allow the conscientious development of this scientific field (Concordia University, n.d.). For synthetic biology to become a successful discipline, multiple areas of expertise must synergize (Quirion, Martin, Meulien, LePage, & Bell, 2014). Along with biotechnology, research in law, business, social sciences, and humanities is necessary to resolve the ethical, supply chain management, societal, and cultural adaptation issues that will arise with the current and future development of synthetic biology (Quirion, Martin, Meulien, LePage, & Bell, 2014).

Nonetheless, the development of this science challenges the present regulatory framework, laws, and public opinion (Bubela, Hagen, & Einsiedel, 2012). In order to constitute relevant regulations pertaining synthetic biology, policy makers must oversee every advancement made in this field and weigh out its risks and benefits (Bubela, Hagen, & Einsiedel, 2012). An analysis on the current regulations must be done to address the gaps in law, and to create new legislations that ensure that the public and scientists will both be protected (Bubela, Hagen, & Einsiedel, 2012). Currently in Canada, any product synthesized by biotechnological means is treated as any other product:

regulation is initiated based on the innovative trait of the product (European Commision, 2014). Risk evaluations are done in a scientific and product-based form by Health Canada, the government agency that assesses and manages the risks of health, food, and environmental/industrial products (European Commision, 2014).

With regards to the future of SynBio in Canada, Montré a l's Concordia University held a workshop to discuss how synthetic biology can be integrated into Canada's future, creating a rough outline of its plan of action in October 2014. This outline involved cross-sectoral alliances, and the direction of money towards research and development in this particular area. Furthermore, in November 2014, Genome Canada gathered Parliamentary representatives, senior public servants, and representatives of industry, academia, and research agencies to discuss how genomics and synthetic biology could influence the country's resource sectors and, at the same time, protect and preserve the environment (Quirion, Martin, Meulien, LePage, & Bell, 2014).

Canada is definitely making a conscious effort to advance the new field of SynBio. The First Research Excellence Fund, which was recently introduced into the Canadian Budget, aims to empower postsecondary research institutions. By helping researchers develop into a highly qualified workforce with world-leading capabilities,

CANADA-NAIT_EDMONTON-TEAM

Canada can stay internationally competitive in the research scene while remaining up-to-date with cutting-edge technology-a benefit to all Canadians (Merson, 2014). The proposed budget will deliver $200 million CAD annually by 2018, meaning that within the next decade, the fund will provide approximately $1.5 billion CAD to help establish Canadian universities and postsecondary institutions as global leaders in research and innovation. (Merson, 2014).

Like the United Kingdom and America before it, Canada has begun to see the importance of Synthetic Biology and how this new science can revolutionize the future of our societies. From eliminating world hunger to adapting to rapid climate change, Synthetic Biology has the potential to solve many of the present challenges that we face. However, many factors contribute to the success of a science in Canada; such as public opinion and lawful regulation. Although difficult to establish a new, groundbreaking science in Canada, investing in Synthetic Biology has been regarded as a necessary risk and a research priority.

WORKS CITED

Bubela, T., Hagen, G., & Einsiedel, E. (2012). Synthetic biology confronts publics and policy makers: challenges for communication, regulation and commercialization.

Trends in biotechnology, 30 (3), 132-137.
Concordia University. (n.d.). C entre for Applied Synthetic Biology (CASB). Retrieved from Concordia University: https://www.concordia.ca/artsci/research/synbio.html

European Commision. (2014). O pinion on Synthetic Biology I, Definition. European Commision.

Genome Canada. (2015). A bout Genome Canada . Retrieved from Genome Canada: http://www.genomecanada.ca/en/about/

Merson, R. (2014, February 12). C anadian Federal Budget 2014: Research and Innovation investment summary . Retrieved from Biotechnology Focus: http://biotechnologyfocus.ca/canadian-federal-budget-2014-research-and-innovat ion-investment-summary/

Quirion, R., Martin, V., Meulien, P., LePage, M., & Bell, G. (2014, November 3). How Canada is poised to revolutionize synthetic biology . Retrieved from Concordia University: http://www.concordia.ca/cunews/main/stories/2014/11/03/howcanadaispoisedt orevolutionizesyntheticbiology.html

Synbiota. (2015). About Us . Retrieved from Synbiota: https://synbiota.com/about

The Canadian Biotechnology Action Network. (n.d.). Synthetic Biology . (Tides Canada) Retrieved from The Canadian Biotechnology Action Network: http://www.cban.ca/Resources/Topics/SyntheticBiology

CONTACT INFORMATION

Twitter @TeamNAIT2015
Facebook at iGEM 2015 NAIT-Edmonton
Email: johannes.coomansingh@gmail.com

05

[CHINA] NJU-CHINA

SYNTHETIC BIOLOGY IN **CHINA**

Synthetic biology is an emerging discipline in China, which can transform basic scientific research into industrial productivity. Since the synthesis of the first human-made organism -- Synthia took place, synthetic biology has been developing rapidly in China.

At present, synthetic biology in China stays in the early stage of development, which is limited mainly to bioengineering field, such as genetics, microbiology or applied biology. The aim of synthetic biology is mostly focused on production of biofuel and reduction in environmental pollution.

Synthetic biology is highly supported by the nation and universities, receiving large amount of funding from the government each year, such as 863 project, 973 project and Natural Science Foundation of China. Universities are also encouraging students to take part in synthetic biological competition such as iGEM. Many universities support more than one team each year. In addition, some biofuel companies are investing in synthetic biology field, seeking to find a cleaner and more efficient way to produce energy.

Despite the support from the nation and companies, however, synthetic biology has encountered some obstacles. The first one is ethics and morals. Since human can create a new species as their wish, in theory, many people are questioning that whether human is replacing the position of god, which is extremely unacceptable for theists. The second consideration is biosafety and biosecurity. During the process of creating a new creature, we cannot predict what side effects would take place. Pollution, toxicity, uncontrolled growth can all threaten human safety. Based on these worries, the public in China is generally opposed to development of synthetic biology, similar to the situation of transgenetic organisms.

To solve these problems, legislation should be reinforced concerning biosafety and biosecurity. In the meanwhile, communication with the public is also important. Letting them know more facts about synthetic biology, both advantages and potential disadvantages, will give them a more accurate impression of it, instead of opposing it blindly.

CONTACT INFORMATION

Email:
zhouyu1992nju@outlook.com

07

[CHINA] NYMU-TAIPEI

CHINA

NYMU-TAIPEI

CONTACT INFORMATION

Wiki:
http://igem.ym.edu.tw/

Facebook:
https://www.facebook.com/pages/NYMU-iGEM-Team/244897845537138

E-mail:
2015nymuigem@gmail.com

SYNTHETIC BIOLOGY'S FUTURE

Synthetic biology is bringing together engineers and biologists to design and build novel bio-molecular components, networks and pathways, and to use these constructs to rewire and reprogram organisms will change our lives over the coming years, revolutionizing our lifestyles. Using stored information and basic materials to grow very complex things, synthetic biology strives to make molecular biology more like engineering, with characterized materials and parts put together in predictable ways. One of the most amazing things about synthetic biology is how advanced the tools and components of its trade have already become. A continuously growing collection of genetic parts that can be mixed and matched to build synthetic biology devices. With demonstrations on synthetic cells, scientists now have a lot of tools to edit an existing genetic sequence on a computer, use DNA synthesizing machines to create it in fragments,and stitch these together in the lab. However, it's still

NYMU-TAIPEI-LOGO

difficult to predict what cells will do after they're altered. Researchers are often stymied by cells' natural drive to grow and live as they please, which in many cases must be overcome to harness them for certain use in an efficient method.

One of the biggest hurdles lies in the creation and assembly of starting materials, modular bits of DNA that code for a particular function and are synthesized in the lab. Creating this DNA is time consuming and expensive. Like any commercial product, it must be designed, built, and tested. Even making relatively small changes can take a lot of work, time and money.

DNA synthesis has to be cheap, fast, predictable, accurate, and open to all, including researchers whose labs lack equipment or funding.

The engineering of genetic circuits, biological modules, and synthetic pathways is beginning to address these crucial problems and is being used in related practical application. If human beings could similarly learn to build and control novel living systems, synthetic biology could then trigger a biotech revolution.

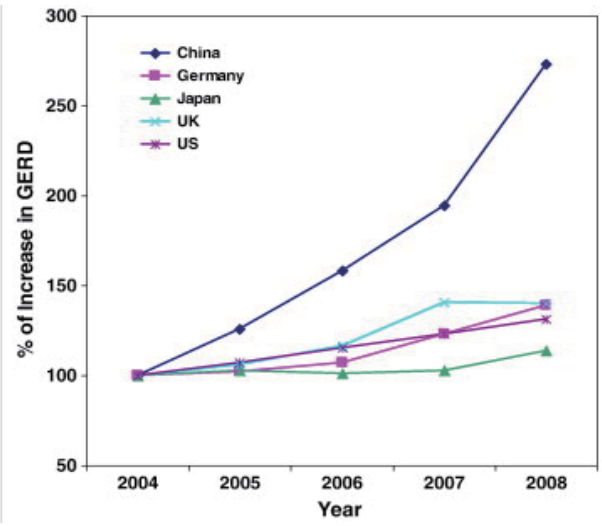
DISTRIBUTION OF IGEM TEAMS

The United States, followed by China, Germany, the United Kingdom, and Japan, respectively, has the greatest scientific output in the field of biochemistry, genetics, and molecular biology. With a few exceptions, countries with the most paper published in this field also has the highest number of iGEM teams. However, the country currently with the most iGEM teams is China, not the US. Although the US is the origin of iGEM and has increased steadily in participation, the growth rate of Asia's participation is substantially faster than US's.

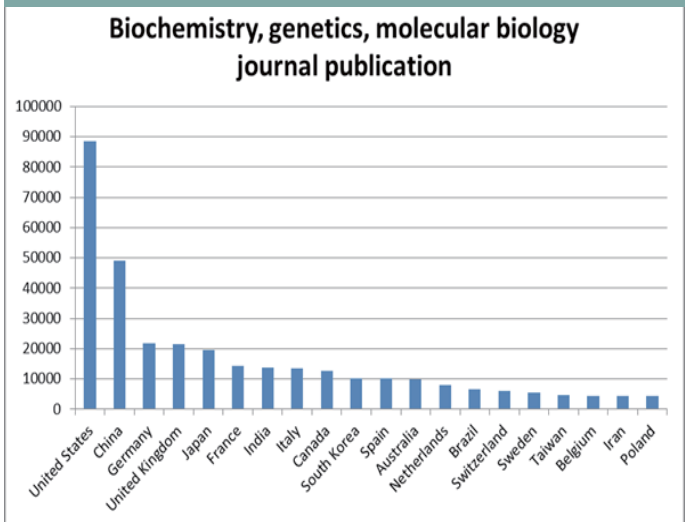
By comparing the number of iGEM teams in different countries and regions in 2015, we are able to deduce two factors that influence the abundance of iGEM teams: economy

APPENDIX A

APPENDIX B



SCIMAGO JOURNAL AND COUNTRY RANK



and education. The hypothesis of population directly correlating to the number of iGEM teams is incorrect, as demonstrated in the iGEM population in Asia. With a total of 102 teams in Asia, China with 55 teams, Japan with 9,and Taiwan with 9, are the three Asia countries with the most iGEM teams. Although China has one of the largest populations in the world, however, Japan and Taiwan have considerably less. This shows that the number of iGEM teams is not directly correlated to population. On the other hand, economy is strongly correlated to the number of iGEM teams. GDP, or Gross domestic product, is commonly used as an indicator of the economic health of a country. Gross domestic product, is commonly used as an indicator of the economic health of a country. According to trading economics, China had a GDP of 9240.27 (USD billion) in 2014, no doubt the largest GDP value in Asia.Japan in 2014 had a GDP of 4901.00,easily standing as the second Strongest economy in Asia. Taiwan, although with GDP of 489.21, however, it is experiencing a steady GDP annual growth rate of 3.47% in 2013, and 3.38% in 2014. Egypt and South Africa both have a significantly larger population than Taiwan and Japan, yet they only have one iGEM team each. Looking into their GDP value, Egypt had a GDP of 271.97, with a decline of GDP annual growth rate. South Africa's GDP was 350.63, with a low GDP annual growth rate.

Another factor that contributes to the number of iGEM teams is education. This year the United States has a total of 60 iGEM teams. California with nine teams, along with New York and Massachusetts,

SOURCE: IGEM

both with six teams, are the three states with the most iGEM teams in United States. On the contrary, Oregon, Colorado, and Illinois each only has one. By comparing this data to the major universities distribution in United States (see Appendix A), the three states with the most teams – California, New York, and Massachusetts – all have a high distribution of major universities. While Oregon, Colorado, and Illinois with only one team have no major universities. The positive correlation of prestigious universities and the number of teams shows how education is an important factor.

GROWTH OF IGEM TEAMS

Over the past five years, there has been a growth of iGEM teams throughout the world. Two major factors for the growth of iGEM teams are the development of synthetic biology and the quality of education. USA has been the leading position of synthetic biology R&D ever since the early 2000s, meaning it has the most synthetic biology institutes in the world. As a result, USA has the most iGEM team every year. Other countries with advanced synthetic biology research such as Germany, France, Japan, and UK have more iGEM teams than the other countries in their regions. In fact, countries in the top ranking on GERD (gross expenditure on R&D)—US, Japan, Germany, China, and UK respectively—all have more iGEM teams than other countries do: China and Japan have the most teams in Asia; Germany and UK have the most teams in Europe in the past five years. The numbers of iGEM teams in these countries have been growing steadily as their research in synthetic biology developed throughout the years.

A ccording to Appendix B, the development and investment in GERD is proportional to the growth of iGEM teams in a country. For example, the number of iGEM teams established in China grew steadily over the past five years from 17 teams in 2010 to 55 teams in 2015. As shown in the graph below, the percent of increase in GERD has been growing rapidly in China ever since 2004, thus providing an explanation for the growth in iGEM teams.

Education also serves as a factor of the distribution of iGEM teams. According to QS World University ranking, 47 out of the top 50 university in biological sciences major have participated in iGEM in the past five years. Therefore, we conclude that higher ranking universities in biology related major tend to establish iGEM teams. Schools with better reputation and funding for biological science have more incentive to join the iGEM competition.

In conclusion, the two main factors for the growth of iGEM team numbers are the development in synthetic biology and education. Further research and improved education on biological science are incentives for school to join iGEM competition.

12

[FRANCE] IONIS PARIS

DEVELOPMENT OF SYNTHETIC BIOLOGY IN **FRANCE**

WHAT IS THE SITUATION OF SYNTHETIC BIOLOGY IN YOUR COUNTRY?

Synthetic biology in France has emerged on an informal basis since 2005. The number of laboratory which focus on it is still low compared to other countries, however more and more laboratories use synthetic biology as a tool for their research.

Despite a slow start, the development of synthetic biology intensified in France since 2008 with the organization of debates and conferences on this theme and an increasing number of researcher interested in this field.

13
IONIS PARIS

WHAT ARE THE PROBLEMS OF DEVELOPING SYNTHETIC BIOLOGY IN YOUR COUNTRY?

Until recently, the field was not really dynamic due to a lack of a dedicated policy for the discipline in France. Moreover, no funding steam was available for synthetic biology.

In addition, French people complained about the lack of transparency about genetically modified organism which have led to negative prejudices toward synthetic biology and have rose difficulties for the development of the field. Unfortunately, misunderstanding and fear are still very present nowadays.

WHAT THE INFLUENCE IGEM HAVE BRING TO SYNTHETIC BIOLOGY IN YOUR COUNTRY?

In 2007, the first French team was participating to the iGEM competition. Since then, initiatives have emerged such as the launch of a French association called "SynBio France" in order to promote synthetic biology and gather this new community (http://synbiofrance.org/page8/index.html) as well as the creation of a one year later a master's degree dedicated to synthetic and systems biology near to Paris.

The iGEM competition in France have gathered together students interested in synthetic biology and have led to the promotion of this field by the creation of association, organization of conference and debates. The IONIS iGEM team is born thank to Bio Club, an association created by Matthieu Da Costa whose purpose was to make synthetic biology more accessible and to promote this new field.

FRANCE-IONIS PARIS-LOGO

Email:
ionis.igem@gmail.com

Twitter:
IONIS_iGEM

Facebook:
IONIS iGEM

14

[FRANCE] TOULOUSE

FRANCE TOULOUSE

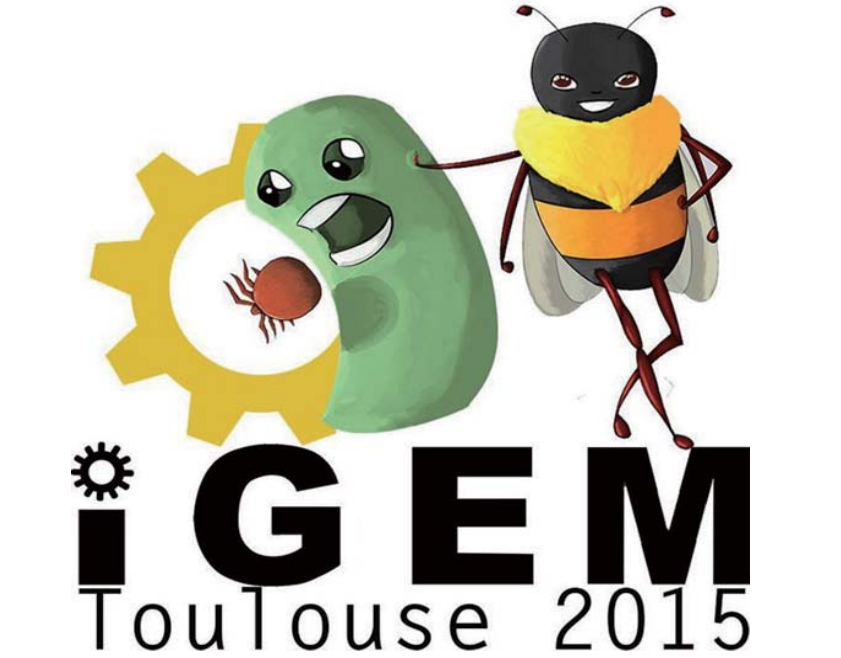
HERE IS WHAT WE THINK ABOUT THE SYNTHETIC BIOLOGY SITUATION IN **FRANCE**

Synthetic biology started to expand as a whole science from 2010 with laboratories and master programs dedicated to it, but it really began during the early 20th century, and so on with the genetic engineering. Many scientists are aware of the opportunites that this biological approach offers, for research or industrial purpose.

However, it is not that easy to talk about synthetic biology with the main people, since there is often the "GMO" label that comes through the conversations. GMOs are not well seen as such by many people in France, but this is mainly because of the GMOs used for agriculture (Corn, Soja...) they have been warned about, they often don't think about microorganisms. As an example, GMOs are banned from crop cultures in France, even if we still import some of them directly or indirectly because of the UE regulations.

Hence, bringing the matter of synthetic biology is a challenge that we, as scientists, have to overcome by educating people in the best way we can, by explaining them the biological process, the advantages and numerous prospects brought buy such a science. And also by telling

FRANCE-TOULOUSE-LOGO



them how exciting it can be, to bring solutions or new approachs to matters that we thought would not be possibly solved.

This is why ethics are very important for this kind of project, because when we have knowledge and access to technics of synthetic biology, responsability of acts and compliance to moral principles and laws must be our priorities. This is a matter that should not be taken lightly, in order to grant the success of the project. We hope that we will manage to communicate well and convince people about the importance and great assets of synthetic biology around us !

CONTACT INFORMATION

Facebook:
https://www.facebook.com/pages/iGEM-Toulouse-2015/1604834019761538

E-mail:
igemtoulouse2015@gmail.com

Twitter:
https://twitter.com/toulouse_igem

16

[HONDURAS] ZAMORANO

SYNTHETIC BIOLOGY IN **HONDURAS**

Honduras is a small developing country in Central America. It has a lot of natural wealth and beauty beyond compare. Even so, due to all the economic, social, and political problems there have not been any breakthroughs in SynBio in this country. That is until last year. When the IGEM Zamorano team came to be, we did not only make history in our university, but also in the country.

The idea of an IGEM Zamorano team began in 2013 with the initiative of Dr. Maria Mercedes Roca, a former professor from the university, and a small group of students. The students attended classes from a higher level than theirs to be able to understand the basics on SynBio. The team was formed short after this. They worked hard and were able to bring a professor from Stanford University whom they helped to develop a bacteria that would be able to detect the presence of copper on water. As a part of the project, they presented the bacteria and their risk assessment to the National Commission of Biotechnology. The bacteria, called E. Zamofordi, was approved to be used in the entire country for educational purposes.

Last year, a guy from another university was allowed to be a part of the team. Thanks to this, this year he decided to bring IGEM to his university and began his own group. There are currently two IGEM teams in Honduras: IGEM Zamorano

and IGEM UNAH. In a way, Zamorano helped this team to be created and set the road for any other upcoming teams that want to work on the field of SynBio.

What is happening in Honduras is literally history in the making. All the people involved are changing the course of Honduran history forever. The people from UNAH University can work on many different fields under synthetic biology since there are many careers at this university. At Zamorano we have four careers. Agronomy is our field of expertise. This is why our projects involve working with things that affect this field. The copper sensor last year and the insecticide this year. Both projects can be used in Agronomy, but they also have an environmental impact which is another important aspect in our university. Since we live in a country that depends mostly on agriculture, we think our projects could be really useful in the development of the country. In the future, we could work with bigger projects in this field as well.

CONTACT INFORMATION

Facebook:

https://www.facebook.com/IGEMZAMOrANO2015?fref=ts

E-mail:

igemzamorano@zamorano.edu

18

[MEXICO] TEC MONTERREY

MEXICO

TEC MONTERREY

We would like to talk about the present situation of synthetic biology in Mexico. We live in the biology's century, this is today's technology and we are ready to start a new chapter in human history. People today all over the world studying something related to the science field, know this. Synthetic biology is now doing what just a couple of years ago we thought was not possible. New treatments against cancer, for example, like we did for the past two years; new applications capable of creating highly valuable products in the market, in a cheaper and easier way, like we are doing this year, and many other things.

Mexico is still lagging in science, biology and synthetic biology, but we know we must try to stop it. We know what we are capable of, what our country is capable of and what we can achieve with the talent of our students,of our scientists and our teachers. Thanks to the iGEM competition, we've realized we're not lagging in knowledge, but we are lagging in the technology to make our projects come true. It's hard to see that other countries can have their materials sent to their lab by the next day while we have to wait for the material to be sent to Mexico, and for it to cross the border. That is the part where most of our troubles come from. The lack of ruling about materials for investigation causes that depending on the official border that receives your material, the official has to decide if it passes quickly, if he passes the material to another officer and so on, or if it stays there indefinitely or until you send lots of information assuring the safety of it.

A whole new era is ahead of us, so for Mexico to be competitive internationally in it, we need to stop the ignorance and the apathy; this is it and this is now. The ideas are there, it is just a matter of pushing. And pushing hard. And we will do that.

19
TEC MONTERREY

This whole biology revolution gives us never ending opportunities to explore and understand life. That's actually what makes life interesting and intriguing. Our purpose as scientists is to unveil the mysteries of life. We can't believe we are supreme and that we already know everything that needs to be known. Life is a complex thing, and our job is to try to make it simple.

To fall in love with something, you need to know what it feels like not to have it before, and to fall in love with exploring life we have already experienced the unknown. What else do we need to do the unthinkable and explore what's in front of us? There is a lot of stuff we haven't seen yet, and being able to be the first ones discovering what could be tomorrow's solution to a very deadly disease, or to be the first ones to create the next device able to reduce pollution all over the world, that would be remarkable.

Also by investigating we can get to understand a little part of what we are, from where we come from, and that's the most important and priceless thing ever, knowing and understanding a little bit more about ourselves and our belonging in the universe. Exploring and discovering is in our DNA, so having never ending opportunities is just as exciting as it sounds: the fun and the amazement never ends.

MEXICO-TEC MONTERREY-LOGO

Facebook:
www.facebook.com/IgemTecMonterrey

Twitter:
@iGEMTecMty

Email:
igemtecmonterrey@gmail.com

20

[NETHERLANDS] EINDHOVEN

NETHERLANDS
EINDHOVEN

SYNTHETIC BIOLOGY IN THE NETHERLANDS: A EUROPEAN PERSPECTIVE

The Netherlands is a small country. With only 17 million inhabitants, it is dwarfed by the likes of France, Germany and the United Kingdom. Therefore, many of the initiatives in synthetic biology are undertaken on a larger scale: the European scale. Both the European Commission as well as the funding agencies of individual Member States have started initiatives to promote the development of synthetic biology. Two examples of these initiatives are EraSynBio and Synenergene. The former was a network of European funding agencies, supporting projects within synthetic biology, including iGEM. The latter is a project of which you all are presumably well aware.

THE RISE OF SYNTHETIC BIOLOGY IN THE NETHERLANDS: ACADEMIA

Research within synthetic biology has long been conducted in the Netherlands. The research conducted in the field was, however, not very visible. This changed in 2008, when three universities devised to invest an additional €60 million in centres specifically aimed at synthetic biology. Delft University for Technology opened the Bionanoscience department, the University of Groningen the Centre for Synthetic Biology, and our own Eindhoven U niversity of Technology the Institute for

Complex Molecular Systems. Fields in which these institutes are active are among others drug delivery systems, material sciences, biocatalysts and biofuels but also more fundamental developments such as self-assembling molecular structures and photosynthesis [1].

PROMOTING THE DEVELOPMENT OF SYNTHETIC BIOLOGY: ADVISORY ORGANS & FOUNDATIONS

The policy-makers in the Netherlands advised by many different organizations when it comes to synthetic biology. These organizations play a pivotal role in informing the public on synthetic biology. The most important of these organizations are the Rathenau Institute and the National Institute for Public Health and Environment (RIVM). In addition to these key advisory organs, a number of foundations is active to educate the public about biosciences, and in particular synthetic biology.

The Rathenau institute is a knowledge center, which explores the possibilities of synthetic biology and which assesses the risks associated with Synthetic Biology. The stance of the center is

FIGURE 1 – LEFT: CREATIVE WITH CELLS: SYNTHETIC BIOLOGY BY BIOWETENSCHAP EN MAATSCHAPPIJ. RIGHT: REPORT FROM RATHENAU IN WHICH IT APPEALS TO PUBLIC DEBATE.

that synthetic biology is too important to leave it to scientists and enterprise alone. To involve political and societal organizations in synthetic biological developments, it frequently publishes reports in which it addresses the chances, the risks and questions associated with synthetic biology. In addition to these reports, it organizes public debates in which the questions and dilemmas in the field of synthetic biology are addressed [2].

The National Institute for Public Health and the Environment, which acts on behalf of the central government. It is currently setting up a knowledge information point on synthetic biology. To this end, it both develops its own knowledge by means of scientific research and by assimilating existing knowledge. It also publishes a newsletter containing important developments in the field of synthetic biology, for scientists active in the field [3].A final organization promoting the progress of synthetic biology is Biowetenschap en Maatschappij, 'Biosciences and society'. This foundation aims to inform the public of actual and future developments within biosciences. An important recent publication from this organization was, Synthetic biology, in which it gives an overview of synthetic biological techniques, developments and ethical implications of synthetic biology.

THE FRUITS OF SYNTHETIC BIOLOGY: CURRENT AVAILABILITY

Two important synthetic biological developments which have become available commercially within Europe and thus the Netherlands are the products of biorefineries and genetically modified crops. The well-known Dutch multinational DSM focuses on the former branch of synthetic biology. The life sciences and material sciences company has promoted numerous technological developments and brought multiple synthetic biological products onto the market. It has, for example, collaborated with Delft University of Technology to develop biorefineries which efficiently produce ethanol from arabinose as well as xylose. Other products include biorefineries for the commercial production of Cephalexin, a synthetic antibiotic, and the chemical substance succinic acid [4].

The presence of GMOs themselves in the form of genetically modified crops within Europe is still fairly limited. Just over sixty of these genetically modified crops have gained market authorization [5]. A major cause of this relatively low number is that GMOs have been very unpopular throughout Europe over the last decade. In British media, for example, the term Frankenstein Foods is quite popular. As a result of this skepticism, the European Union has adopted very strict regulations concerning the use of GMOs.

The stringency of these regulations can be seen in the market authorization procedure of GMOs within Europe, in which the precautionary principle is followed. This principle states that the burden of proof that the use of the GMOs is not harmful, falls on the firms seeking market approval for their GMOs. The applications are evaluated by the independent European Food Safety Authority (EFSA). It assimilates its findings in scientific opinions, which it reports to the European Commission. Finally, the European

Commission votes whether or not to give market authorization for the GMOs.The Netherlands tends to vote for market authorization if the risk associated with the GMO is negligibly small. To ensure that the risk is correctly assessed, Dutch researchers from the commission of genetic modification (COGEM) and RIKILT,the Dutch institute for food safety, evaluate the scientific opinion formulated by the EFSA [6].

FUTURE PROSPECTS

Synthetic biology in the Netherlands is blooming. Many academia have established and funded research institutes active in the field. The research institutes focus both on fundamental sciences and applied sciences. Moreover, these institutes work actively with the industry such that the developments can find their ways towards the market. In granting market authorization for these developments, the European Union is, however, very precautious – some argue too precautious. An important reason for this attitude is the public skepticism towards GMOs. Frankenstein Foods have a very bad image within the European Union. Educating the public regarding the carefully assessed risks and promise of GMOs is key to enable more of the fruits of synthetic biology to enter our daily lives. Luckily, we have a range of knowledge institutes, advisory organs and competent foundations which can help in educating the public about synthetic biology.

REFERENCE

[1] Health Council of the Netherlands, Advisory Council on Health Research, and Royal Netherlands Academy of Arts and Sciences, "Synthetic Biology: creating opportunities," The Hague, 2008.

[2] "Synthetische biologie vereist samenspraak — KNAW." [Online]. Available: https://www.knaw.nl/nl/actueel/nieuws/synthetische-biologie-vereist-samenspraak. [Accessed: 16-Jun-2015].

[3] National Institute for Public Health and the Environment, "Synthetic biology." [Online]. Available: http://www.rivm.nl/en/Topics/S/Synthetic_biology. [Accessed: 16-Jun-2015].

[4] "Current Uses of Synthetic Biology for Renewable Chemicals, Pharmaceuticals and Biofuels." [Online]. Available: https://www.bio.org/sites/default/files/2013-03-03-Synthetic-Biology-Products.pdf. [Accessed: 16-Jun-2015].

[5] W. J. Mansveld, "Summary EU-market authorization requests GMOs," 2015.

[6] Ministery of Public Health Well-Being and Sport, Beleidsnota Biotechnologie, no. 27 428 nr. 270. 2014, p. 9.

CONTACT INFORMATION

Email: igem2015@tue.nl

Twitter: via@Eindhoven_iGEM

Facebook: http://www.facebook.com/EindhoveniGEM

24

[SLOVENIA] SLOVENIA_HS

SYNTHETIC BIOLOGY IN **SLOVENIA**

BY NINA JERALA, MEMBER OF SLOVENIA_HS TEAM

Slovenia is a relatively small country of only about 2 million people, so you can imagine we often get overlooked on a map and just about everywhere else. But we do, luckily, have some very dedicated and hard working scientists who keep their work and consequently Slovenian science to the standards of ever modernizing world technology. For that reason it did not take too long for Slovenia to adopt findings and methods of synthetic biology to our own scientific endeavors.

The scientists who lead our efforts in synthetic biology often studied other natural sciences, most often biology or chemistry, as courses in biochemistry and synthetic biology were not available in the time of their studies. Current students, however, have the luxury of being able to study synthetic biology as an independent subject.

As such it has appeared in Slovenia around ten years after it has appeared in first universities in United States of America. Despite that, students often had to read foreign literature on the subject, as literature in our own language didn't exist yet. Last year first general textbooks on the subject were published in Slovenian language, but students might still encounter some difficulties, mostly with scientific expressions connected to their studies, as often we do not have Slovenian equivalents for them, with synthetic biology being such a quickly developing field.

The exact contents of the subject are not strictly determined and might therefore vary in different universities, one of which is the Faculty for Chemistry and Chemical Engineering at the University of Ljubljana. The subject Synthetic Biology is one of the two core subject in the second year for students

reaching for Masters of Biochemistry. The subject is composed of nearly equal parts lectures, seminars and computer and laboratory exercises.

The faculty also often hosts seminars and lectures on the topic by domestic and foreign professionals for the students, professors and the general public.

Research in synthetic biology or research using synthetic biology approaches is also utilized in other research institutions across Slovenia, namely the Laboratory for Biotechnology at the National Institute of Chemistry, whose research has been published in world renewed journals, such as Nature Structural and Molecular Biology. Different institutes and universities also have outreach programs to connect with students in high schools, who are interested in learning more about synthetic biology. In 2013 there was even a summer camp in synthetic biology for chosen students who have demonstrated motivation and knowledge in the field.

The general public is most familiar with synthetic biology trough iGEM competitions, which are regularly attended by our student (and for the first time this year high school) teams, who reache for the top results, being the grand winners three times (2006, 2008, 2010), as well as reaching the second place in 2012 and the third in 2007. The first time a Slovenian team attended the competition in 2006 with a project

in sepsis prevention. They often choose project connected to health and medicine, having previously competed with project concerning AIDS, vaccines against bacteria H. pylori, and methods of in situ production of biological drugs, but also with projects concerning nanobricks and DNA as a program.

The success of Slovenian teams at iGEM not only teaches the general public about synthetic biology and inspires the students interested in natural sciences, but also proves that with motivation and inventiveness anything is possible.

As the first high school team of Slovenia we hope to be able to follow in the footsteps of our predecessors and to build on their great work.

CONTACT INFORMATION

Facebook:
https://www.facebook.com/hSiGEM

Twitter:
https://twitter.com/hSiGEM

Wiki:
http://2015.igem.org/Team:Slovenia_HS

Webpage:
hsigem.si

27

[SWITZERLAND] ETH-ZURICH

SYNTHETIC BIOLOGY IN **SWITZERLAND**

Synthetic biology is an emerging field in Switzerland and around the world. Since its development heavily relies on the further development of DNA technology, it is a relatively new science with lots of potential. Currently, most of the synthetic biology research in Switzerland is performed at the ETH Zürich and the University of Basel, primarily by the dedicated Department of Biosystems Science and Engineering. Over the last ten years, the department has been very active in the field, offering highly specialised lectures to students, participating in the iGEM competition, and hosting the Synthetic Biology 3.0 conference in 2007. Moreover, both the ETH Zürich and the University of Basel are participating in the METACODE project, which is aiming to orthogonalize an aspect of microbial metabolism to allow for the engineering of novel biological functions. If everything goes as planned, our iGEM team this year will be organizing a Science Café event as part of the METACODE project!

Last year, the Center for Technology Assessment of Switzerland (TA-SWISS) published a report where they addressed various social issues related to synthetic biology. They established that, being such a young and rapidly developing field, its representation in the mainstream media is of utmost importance due to the implications of public opinion on policy making towards this technology. This is because, unfortunately, many results and discoveries in the field are being ignored or misrepresented in the media due the highly technical nature of the subject matter. Ideally, workshops should be held with the participation of members of the scientific community, as well as journalists and other professionals

from other fields to shed light on and explain the issues that may arise now or in the near future.

A prime example of this is the inaccurate representation of genetically modified organisms (GMOs) in the media, which has led to their rejection by several organizations and a large body of consumers. Evolva, a Swiss company that has developed techniques to obtain products such as vanillin through synthetic biological methods has already faced criticism from the organization Friends of the Earth US, claiming that synthetic biology is a form of extreme genetic engineering that can damage the economy of developing countries, which depend on the culture of vanillin.

In light of this, it is our duty as upcoming synthetic biologists to properly inform the general public about the progress and possible dangers of this field in order to benefit maximally from this technology.

CONTACT INFORMATION

Facebook:
https://www.facebook.com/iGEM.ETH.Zurich

Twitter:
https://twitter.com/ETH_iGEM

Email:
igem2015@bsse.ethz.ch

29

[US] MISSOURI_ROLLA

SYNBIO AND IGEM IN **AMERICA**

Overall, synthetic biology in America is healthy and is not going away any time soon. The benefits from the use of synthetic biology have been realized in several fields, including food, energy, and medicine. The facts about these successes, however, has not reached the majority of the American public yet, which has led to a large gap between scientists' opinion of SynBio/Genetically Modified Organisms and the public's opinion. Additionally, the range of knowledge varies widely from state to state. In my team's state, Missouri, the knowledge of GMO/SynBio is generally limited to "Monsanto makes GMOs, right?" This makes my team's community outreach more important and sometimes challenging as well.

Much research has been done with GMOs in many fields, which has created a variety of innovative products and solutions. Some foods, vaccines, and industrial enzymes are now largely produced by GMOs. Each has benefited from the switch, either from reduced contamination, higher production rates, cheaper manufacturing, or any of several other advantages genetic modification allows. For example, take the recombinant(a.k.a. produced by a GMO) flu vaccine, before the switch, the vaccine was produced from live viruses grown in eggs. This poses two hazards, the risk of live virus being present in the vaccine or trace amounts of egg being present in the vaccine that may cause an allergic reaction in some individuals. The GMO approach solves both of these issues by producing inactive viruses from E. coli. As an additional benefit, fewer eggs need to be used in vaccine production, possibly increasing food supply.

Despite the advantages of GMOs, the technology has a very bad media presence and poor overall understanding of the details of GMOs. The Pew Research Center conducted a survey in 2014 to determine the gap in acceptance between

MISSOURI_ROLLA_LOGO

scientists and members of the public on several key issues.1 The largest difference in opinion of any question asked was on the safety of GMO foods, with 88% of AAAS scientists agreeing, while only 37% of US individuals surveyed agreed. GMO foods are the most discussed of all the GMO fields, which, seeing as 85% of corn and 93%2 of soybeans grown in the US are GMO, does make sense. Several varieties of GMO foods have been approved by the FDA and USDA for production and sale, including canola, sugar beets, papayas, and recently potatoes, and apples. However, many individuals do not trust these approvals, even though the FDA has been preventing unsafe foods from getting to market and issuing food recalls for foods found to be unsafe since 1906. The main fears are of potential allergic reactions or long-term toxic effects, neither of which the FDA has found evidence to support.

Another source of discontent stems from the lack of complete understanding of complex ecosystems and complex systems within an organism. A scientist can't predict every change that happens within a cell when they insert the new piece of DNA. In fact, the two main techniques for inserting genes (agrobacterium-mediated and gene gun) randomly inserts the new DNA. However, what scientists can and indeed routinely do is analyze the effects of the inserted DNA. Since there is always the chance that the insert will interrupt a gene critical to development, several different plant sprouts are treated with the insert, then grown separately. The plants that grow successfully are then tested for safety, quality, and yield to ensure that the insert is safe and effective. Effects on an ecosystem are harder still to predict; increased use of herbicides, the presence of natural pesticides, and plants that have new nutrient concentrations all affect the surrounding ecosystem. One popular ecosystem effect topic is the Bt toxin, produced by some varieties of GMO corn, on monarch butterflies. This topic aroseafter a study in 1999 found that monarch larvae grown on milkweed leaves dusted with Bt corn pollen had high mortality rates and growth inhibition.3 However, a later study in 2001 took into account concentrations of pollen found in fields, type of Bt corn, and the timing of pollination vs. monarch larvae development and found it unlikely that the corn pollen was affecting larvae significantly.4 Such ecological studies are very complex and require in-depth study of causes and

effects, making them inherently slow and prone to overlooking important factors in their results. This can lead to misinformation and long-standing beliefs based on poor data, both of which are bad for the public opinion on GMOs.

Where I live in the American Midwest, few people know much more about GMOs than what companies produce them and what the introduced traits mean (i.e. Roundup Ready). There is a general mistrust of the corporations and slight fear of GMOs overall. If you ask about SynBio, you will be answered with blank stares; very few people have even heard about the SynBio field or even the iGEM competition. This is why one of my team's main focuses each year is community outreach, before we can even talk about our project, people need to understand the basics about GMOs and SynBio. When the community hears about the many cool applications of other iGEM team's research, they are much more receptive to the idea, they see that we are trying to help and that we are not just scientists locked up in a lab with no understanding of real world problems.

The current state of GMOs and SynBio in America is fairly good, and with coming advancements and proper regulatory oversight the field should continue to grow and prosper. iGEM teams across the country are educating their communities about the field and answering the questions people have. The advances already in practice can be explained and future areas of research can be explored during the educational and outreach events hosted by these teams. Hopefully the points of under- or misinformation will be cleared up and the general understanding will improve. Maybe some will become

US-MISSOURI_ROLLA-BOSTON-MIT-01

more interested in the field and pursue more information on their own, becoming educators to their peers and further spreading the field.

– Levi Palmer of the Missouri_Rolla iGEM Team

REFERENCES

1. Gap in perceptions:
http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/pi_2015-01-29_science-and-society-00-01/
2. USDA Report on GMOs:
http://www.ers.usda.gov/media/1282246/err162.pdf
3. 1999 Bt corn study:
http://www.news.cornell.edu/stories/1999/04/toxic-pollen-bt-corn-can-kill-monarch-butterflies
4. 2001 Bt corn study:
http://www.pnas.org/content/98/21/11937.full

CONTACT INFORMATION

Facebook: River Li
Email: River070405@gmail.com

33

[US] WLC

US-WLC

Facebook: http://www.facebook.com/WLCiGEM

Email: sierra.tackett@mail.wlc.edu

Synthetic biology is a rapidly growing field of interdisciplinary biology. It revolves around the concept of altering organisms at the genetic level. These genetic changes give the organisms components that they otherwise would not have. These features may be aesthetic (think GloFish) or functional (think bacteria that clean oil spills). If you haven't heard of synthetic biology, maybe you have heard of GMOs. Specifically GMOs in food, usually plants. GMOs have been stigmatized and while not all may be safe, many are. Scientists and those in iGEM should aim to educate the public about synthetic biology. When the understanding of synthetic biology is more widespread, advancement may become more easily received. When the public is aware, it can encourage informed policy-making. Government, academia, and industry have becoming increasingly interested in policy-making for synthetic biology. Synthetic biology has many discoveries and innovations in its future, and we must also make an effort to keep the public informed so it can share in the excitement and benefits!

PROJECT DESCRIPTION:

For this year's project the WLC-Milwaukee team is looking into phage therapy. Specifically we are looking for phages specific to the outer-membrane efflux pore protein tolC. tolC analogs are found in most gram-negative bacteria, and they have been implicated as an essential protein in an efflux-based resistance mechanism to certain types of antibiotics. Our project involves expressing tolC homologs from infectious strains of bacteria in a tolC knockout strain of E coli. We are using these transgenic E coli to search for bacteriophages specific to our selected gastrointestinal tract pathogen's versions of tolC. Our hope is that the phages specific for a pathogen's tolC can be used in combination with an antibiotic generally resisted via an efflux mechanism to put the pathogenic bacteria in a lose-lose dilemma: bacteria which try to efflux the antibiotics will expose themselves to the pathogen-specific phage, while those which do not express TolC will be weakened to the antibiotic therapy.

FEEDBACK

1. Is this issue useful for your team?

A. Yes. It may help.
B. No. I cannot see any important reference value to my own team, because each situation differs.
C. Maybe a little.

2. How many passages are suitable for each issue?

A. Not more than 5.
B. 6-8
C. 9-12
D.13-15
E.15-20

3. How often should we publish Newsletter?

A. Weekly.
B. Biweekly. (The same as last year)
C. Triweekly.
D. Monthly.

4. Is is necessary to add new content besides project & update?

A. Yes. (Run to 5)
B. No (Run to 6)

5. What contents can be added in Newsletter (multiple-choice) ?

A. Discussion on bioethics.
B. Experts' interviews.
C. Summary information for Biobricks.
D. Wiki technology.
E. Art & Design.
F. Others _____(Please let us know your idea)

6. Are there any problems you have encountered? Would you like to write them down on Newsletter so that other readers can help you?

7. Any suggestions after reading this issue? Help us to make the Newsletter better!

Thank you for your support!
Please complete the feedback form and send it to us: igemxmu@gmail.com