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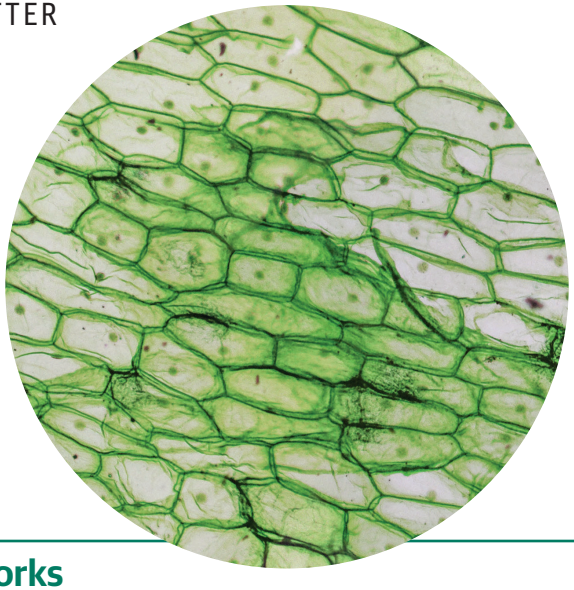

The Biohacking Landscape in Latin America

STRATEGIES FROM A REGION THAT WANTS TO PUT ITS OWN FLAVOR ON THE MOVEMENT

Edgar Andrés Ochoa Cruz, Oscar Joel de la Barrera Benavidez, Manuel Giménez, Maria Chavez, and Marie-Anne Van Sluys

> *When you feel that you should have been born in the future, the only option is to build the future, so you can finally get to where you belong.*
>
> **Andrés Ochoa**

The Beginning

DIYbio democratized genetic engineering, a technology known by many names, including molecular biology, biotechnology, and synthetic biology. An early promoter of DIYbio was Rob Carlson, who in a 2005 Wired article showed that $1,000 was all it cost to start using this technology and pointed to online resources. In 2008, *DIYbio.org* launched as a channel of communication for DIYers who wanted to build a community around it. In 2010, the first biohacker spaces opened in California (BioCurious) and New York (Genspace). Today DIYbio.org maintains a list of the biohacker spaces around the world: 35 in North America, 28 in Europe, 5 in Latin America, 3 in Asia, and 3 in Oceania. In six short years, the movement has become a global phenomena.

Here is where the Latin American story of DIYbio begins. Focusing on the cultural similarities of the region (from Mexico to the Patagonia), we will describe the landscape of the biohacking spaces and the open-science initiatives that are

expanding there. Also, we will describe the formation of the movement and the strategies that it has created to survive. In addition, we will explain the problems and questions faced by Latin America's biohackers when trying to develop this movement in their own cultural and technological context.

iGEM: The Spark That Began the Movement

The International Genetically Engineered Machine (iGEM) competition was created in 2004 at MIT and had five schools participating. By 2015, it had 280 teams with more than 2,700 participants from all over the world (iGEM, 2015). Reminiscent of robotics competitions held for engineers, iGEM uses biological platforms (bacteria, yeast, and plants, among others) to develop solutions and products and to create awareness about society's problems through synthetic biology (Ochoa & Van Sluys, 2015).

The first biohacker space in the Latin American was SyntechBio, which opened in São Paulo, Brazil, in 2012. It began as an experiment inside the University of São Paulo to accelerate the training of students in the synthetic biology area, enhance multidisciplinary studies, and create an open space to develop and share ideas that wouldn't be normally supported by the academic community in a research context. These ideas were embedded in an educational context, where creation is a free process and the goal is building skills and creativity using the infrastructure of the GaTE Lab research laboratory.

The founder of this biohacker space was in charge of the organization and scientific support of the Brazilian students that participated in the 2012 and 2013 iGEM. The iGEM is a catalyst to building a sense of community, knowledge, and interest in synthetic biology around the world. SyntechBio has developed projects open to any person in the community; these projects were created by students with the goal of hacking knowledge and solving problems that interest them and then was continued by the group. For example, the Plug&Play, which began as an iGEM project, is a molecular tool that allows for control or genetic modification inside microorganisms in fewer steps and with less cost, making the process easier and more accessible. Recently, SyntechBio partnered with Laboratório de Garagem in Brazil to create the first DIY thermocycler in Latin America. This device is open source, and you can build it yourself.

Biohacker spaces linked to universities are found in other regions, including North America. Denver Biolabs, associated with the University of Colorado Denver, was created as a makerspace that incorporated a biohacking space, and it

responds to the necessity of having a space of open collaboration and creation that integrates different disciplines inside the university.

There is a deep link between iGEM and biohackers in the Latin American region. The rise of the DIYbio Mexico movement in 2014 was also linked to the synthetic biology and biotechnology research groups that participated in iGEM. It began with a group of IPN (National Polytechnic Institute) biotechnology engineers that led to the creation of BioHackers México. Later, the collaboration of three communities—hackers, biohackers, and entrepreneurs—led to the opening of the Tepache Hacklab. The Synthetic Biology National Network in Mexico (Red Nacional de Biología Sintética de México), has an important role in this community by connecting the iGEM teams to scientists, students, and biohackers, allowing them to build a collaborative community. This group focuses on the development of machines and infrastructure for biohacker spaces.

Another pioneer group in Mexico called Gene Garage wants to create a biotech community and an open lab focused on biotech entrepreneurship.

The iGEM competition can also be linked with the emergence of the biohacking community in Argentina, although not as strongly as it is in the cases already mentioned. The first biohacking community in Argentina, BiohackingBA, was founded in July 2015 by a former member and instructor of the Argentinean iGEM teams. At the moment, and mainly because it is a very young initiative, it has not established a formal relationship with universities or other institutions. It has received help and support from the Buenos Aires city government and local companies known to support the entrepreneur ecosystem there. Currently, it has projects focused on hardware (such as 3D-printed pipettes), arts (like installations with fluorescent bacteria and plants), neuroscience, and bioinformatics.

iGEM has had a tremendous impact in the biohacker movement and the synthetic biology field in the region. Nevertheless, South American participation in the competition the past 10 years (5.3% of teams per region) is small when compared to the North American (38.6%), the European (28.3%), and the Asian (27.8%) (Ochoa & Van Sluys, 2015). We aim to get more South American governments and education centers invested in sending new teams to the competition. The Latin American community's obstacles are shared by the biohacking community around the world, making the idea of biohacker spaces linked to universities appealing.

The model of biohacker space linked to a university is well suited to the necessities of the Latin American region, where economic resources are difficult to access, even for some of the well-established research centers. In Latin America, even the academic laboratories face funding problems and difficulty accessing technology. Machines and chemical reagents are expensive, and oftentimes these

items can take months to arrive at the local research centers, when they are imported. In this context, Latin American academic community has embraced low-cost solutions and the hacking of equipment to tackle these problems.

This model is expanding into Brazil, where the iGEM team from the Federal University of Minas Gerais is boosting the creation of a similar space. Likewise, Colombia is interested in developing a biohacker space, the first one in the country, at the BIOS research center, which focuses on bioinformatics as a tool to link industry and technology.

Universities and educational centers that support biohacker communities are frequently linked to iGEM teams. Nevertheless, those resources are not enough. For example, most of the iGEM teams in the region have to crowdfund or get corporate funding to be able to participate, which limits the number of teams that can be sponsored within the region. This problem has also opened the opportunity for new initiatives, like the TECNOx competition.

TECNOx is a competition inspired by iGEM with a strong regional imprint. It supports teams working on projects that seek to solve regional problems through robotics and synthetic biology; it is also important for the organizers to make a more affordable competition, which would allow more teams to participate. The idea was crafted during the Latin America Regional Jamboree of the iGEM competition. It supports teams working on projects that seek to solve regional problems through robotics and synthetic biology. The first competition will conclude at the end of April 2016, in Buenos Aires, and it will have teams from Argentina, Brazil, Colombia, and Mexico.

TECNOx is being strongly embraced by the Latin American region (the 2016 competition involved 12 teams with 198 participants total) and is helping to establish stronger relationships between the academic and biohacker communities. In Mexico, the Guanajuato team is being strongly supported by the DIYbio movement. The movement is challenging these students to build their own scientific equipment and to participate in short-term courses about synthetic biology, bioinformatics, and business skills.

The Maker and Biohacker Movement Are Coming Together

The DIYbio movements in the United States, Europe, and Latin America have common goals. They all believe in a democratization of science and the enabling of citizens to use biotechnology. The groups from the US can buy used equip-

ment online and get donations of old equipment from universities and research centers. Their Latin American counterparts don't have these possibilities, and must instead build low-cost versions of standard equipment. And who is better equipped to build things than the maker community?

A subset of the maker phenomena is the Fab Lab community. Their mission is to provide access to the tools and knowledge that allow everybody to use technology to build almost anything. In a list of the Fab Labs around the world, 44 of 541 are in Latin America.

The merging of the maker and biohacker communities makes sense when we consider how difficult it is for Latin American DIYers to access the technology and resources they need. The maker community gives its expertise on building equipment using online sources like Instructables, Waag Society, Hackteria, the Open Source Toolkit: Hardware and even YouTube. Meanwhile, the biohacker community teaches makers how to build using a different type of material: DNA.

Recently in Mexico, the maker community has seen in the DIYbio movement a new form of hacking. Several groups, including The Inventor's House (Aguascalientes), Fab Lab Puebla (Puebla), Hacedores Makerspace (D.F.), and LobbieLab (Oaxaca), began the process of creating spaces for biohackers. They also began to collaborate with the DIYbio movement. In Argentina, the local biohacking community is starting to work with the Fab Lab movement, which has four qualified labs in Buenos Aires.

In 2015, Brazil was the first to bring the BioHack Academy class created by Waag Society to Latin America. It was the first step to building what will become biohacker spaces inside the the Garagem Fab Lab and the Olabi Makerspace. The class built the equipment needed to develop basic microbiology experiments.

In 2015, Peru and Chile participated with two Fab Labs groups in the class How to Grow (Almost) Everything, which is a biology version of the 1998 MIT class that birthed the Fab Lab movement. The Peruvian biohacking ecosystem is linked to hackerspaces, Fab Labs, and open hardware initiatives, including the Open BioMedical Initiative, which has strong links to the Peruvian community.

Meanwhile, there are biohacker groups that have grown independently. In Mexico, Interspecifics wants to explore new ways of biology interpretation, approaching the area from the arts and philosophy perspective.

There are also communities that discuss synthetic biology and biohacking. Most of them plan to build biohacker spaces, or they are groups of students or citizens who want to learn about the topic. These are the cases in Argentina, where DIYbioBA has weekly meetups; Brazil (Bios and SynbioBrasil) and Mexico (Biohackers DF and Biodescubre).

The opening of citizen-science spaces outside of universities raises an important question that must be discussed by the Latin American community, and it is: what about biosafety? The biohacker spaces in the region are already working on this topic. For example, the Mexican biohacker community considers it a major priority and wants to build a strong collaboration with the governmental institution that regulates it, CIBIOGEM (Interministerial Commission on Biosafety of Genetically Modified Organisms). In other regions, like Brazil, biohacking spaces must follow the biosafety rules of any level 1 laboratory, which means that the rules are pretty clear and safety can be easily granted.

Students, biotech engineers, biologists, artists, makers, hackers, and even physicists have pushed the DIYbio movement. But despite the diversity, a common language has emerged between iGEM teams, academia, biohackers, and society, which is the democratization of science and technology using community collaboration. The ideals shared by hackers and makers have become the flag of the movement: the biohackers want to create their own laboratory's equipment and interchange information and materials for free, with the goal of creating more spaces and resources for the community.

The Future Is Here

The future of DIYbio movement in the region relies on its ability to organize. The players are already talking and learning from one another's experiences. Most of the problems they have faced in their own country are difficulties common to the entire region. This is why they are coming together into a network of biohacker spaces.

The opening of the SyntechBio group supported other initiatives in the region, enhancing the communication and action of the community as a group. This led to the creation of the Latin American Network of Biohacker Spaces, launched at the end of 2016 (the biohacker space of this community was closed in 2015 so that the organization could focus on the creation of the network). It already includes groups from Argentina, Brazil, Colombia, Mexico, and Peru, and it is expanding through the region. The network has two international advisors with broad experience in building biohacker spaces, Maria Chavez from BioCurious and Ryan Bethencourt from IndieBio-SF.

The point of this network is to strengthen the relationship between the groups and incentivize the creation of projects involving the whole region, showing a cohesive group that may gain more attention from society. This will allow an

empowerment of the community before their governments; therefore, new proposals and initiatives can happen. We want to grow a team and impact the region in a positive way. If you have or want to open a biohacker space, do not hesitate to join our community and use our experiences to enhance and improve your space.

This is your biohacking community. Here you can ask questions, start projects and help others with theirs, post information, and discuss synthetic biology, genomics, and biohacking.

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Edgar Andrés Ochoa Cruz *(aka Don) has a PhD in biotechnology from the University of São Paulo, Brazil. He was an instructor of two Brazilian iGEM teams and founder of SyntechBio, the first biohacker space in South America that later became the Latin American Network of Biohacker Spaces. He manages and develops several projects in synthetic biology. He is also developing platforms for providing home and industry users access to biotechnology. He is the cofounder of Arcturus BioCloud in San Francisco, California, whose goal is to take synthetic biology to your home safely.*

Oscar Joel de la Barrera Benavidez *(aka Billy) is a biotech engineer from the National Polytechnic Institute (IPN). He is the founder of Biohackers Mexico, cofounder and CEO of the synthetic biology startup GATCorp, cofounder of the agro-biotech startup Huitl and advisor to the Guanajuato 2016 iGEM/TECNOx team. He considers himself an independent scientist and wants to democratize biotech and science.*

Manuel Giménez *is a synthetic biologist and computer scientist from Universidad de Buenos Aires. He was member and instructor of the first two Argentinean iGEM teams, founder of the first biohacking community in Buenos Aires (BiohackingBA), and is currently a graduate student at Boston University. He has recently been spreading the word about synthetic biology in his home country and the region. His dream is to see a mature and strong bioeconomy based on innovation developed throughout the whole Latin American region.*

Maria Chavez *is a biohacker from the San Francisco Bay Area. She is a board member at BioCurious, one of the first biohacking labs in North America, where she has organized events, classes, and community projects. She is also a board member of Real Vegan Cheese, an open-source project to create a synthetic cheese from genetically modified yeast. She recently became an advisor to the Latin American Network of Biohacker Spaces. She aspires to push open-source science and the creation of more biohacking spaces to democratize science globally.*

Marie-Anne Van Sluys *is an associate professor in the Botany Department of the University of São Paulo. She is the head of the Genomic and Transposable Elements (GaTE) Laboratory,*

which studies the impact of transposable elements in the structure, function, and diversification of bacterial genomes and plants. She has supported the iGEM teams of the University of São Paulo and the SyntechBio initiative since the beginning.