



REPU MAGAZINE



REPU Seminar 2017
- Yale University -



REPU Seminar 2016
- New York University -



REPU Seminar 2015
- Yale University -

Training a new generation of Peruvian scientists

10 years transforming young Peruvian Scientists

Research Experience for Peruvian Undergraduates (REPU) is a program that seeks to empower young Peruvian students to generate a change in our scientific community and to strengthen a long-lasting network of scientists and professionals. Since the last REPU magazine edition, 3 years ago, REPU has experienced many changes. We opened 3 new branches: REPUPhysics in 2015, and EcoREPU and REPUatix in 2016. These have allowed us to expand REPU and to reach more Peruvian students from different areas of expertise and from different regions of Peru. Since their opening, these branches have received 7 amazing students, with more to come in the future. Also, during this period, two of our first REPU alumni have successfully defended their PhD thesis, and are the first PhDs that the program has generated. Congratulations, Kenyi Saito and Sofia Espinoza!

In this magazine, you will be able to have a quick glance at our evolution over the last 3 years through our REPU facts. We are also including the REPU Research section, in which you will find a summary of past research projects and current positions of our alumni. In addition to that, we are including articles about our two new home Universities and our new REPU branches. Moreover, we are launching a section of Interviews where we have captured the thoughts and opinions of one of our REPU directors, PhD Edson Bellido, as well as one of our Host Principal Investigators, PhD Nicholas Ingolia. Finally, our former co-director and first REPU fellow, PhD Kenyi Saito, will tell you, from an insider view, what it means to be part of this incredible community.

We are sure that you will enjoy this magazine as much as we enjoyed making it. We are looking forward to keep improving this year. Applications for REPU 2019 will be open soon. We invite you to follow us on our social networks pages and at www.repuprogram.org, to find out more information and updates.



Luz Saavedra
REPU alumna
Yang Lab
Harvard University
REPU 2017



Ricardo Gonzales
REPU alumnus
Reed Lab
Yale University
REPU 2017

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Paola Moreno-Román

From our last edition, we would like to thank REPU host laboratories so far:

Vanderbilt University:

Miller, Marnett, Graham, Macara

Yale University:

Crews, Brudvig, Emonet, Wright, Saltzman, Plata, Reed

Texas A&M University:

Young

University of Navarra:

Microbiology and Parasitology, Organic and Pharmaceutical Chemistry

McMaster University:

Ayers, Botton, Turak, Buijs

New York University:

Lehmann

UC Berkeley:

Ingolia

Harvard University:

Yang, Pfister

Ruhr-Universität

Bochum:

Biochemie I - Rezeptorbiochemie

General Atomics:

DIII-D Fusion Facility

University of Missouri -

Saint Louis:

Parker

Universidad Peruana

Cayetano Heredia:

Inmunología

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What does it mean to be part of REPU?

It was in 2008 when I was selected to participate in REPU. I didn't know what to expect. I wasn't sure what REPU was about, I only knew that I would work in a lab. Abroad. It was the opportunity of a lifetime. In a time where internships like this were scarce and not very well known. I knew that I had to invest all my energy and be the best I could be.

I met Abel -the founder- at the airport. With his guidance, I learned many, many things that helped me during my internship. I learned how to work with *Drosophila*, a model organism; do immunofluorescence; and even a little bit of cloning. I was thrilled with the new skills I learned.

However, by the time my internship at REPU was over, I realized I learned something far more valuable. I had a new and fresh perspective. I experienced a completely new scientific environment so very different from the one I was used to in Peru. I experienced a different way to do science. And it was exhilarating. To me, it was the way a country should aim to do science, not only in terms of techniques, and ways to tackle a hypothesis, but in terms of collaborations; multidisciplinary approaches; and more importantly, helping each other. I think this last part is key.

From my experience, I think science in Peru has been a selfish endeavor. Mostly because there is very little recognition or, as a professor once told me, "the cake is so small that everybody wants to get the biggest slice they can get." That compelled me to do something to help my country reverse this situation. Somehow.

Working with REPU gave me a great opportunity to help fellow students achieve their goals, build a community of Peruvian scientists who know and can collaborate with each other, and create/develop/form a safety net in case help is needed. That is, in a nutshell, the feeling that drove me to help REPU grow. I wanted to help others the same way REPU helped me, and be part of a project larger than myself which can have a profound impact on the way we do science in Peru.

As you can see, the idea behind REPU was far more complex and bigger than I thought at first. REPU is not only an internship in which you can learn new skills, live in a different country, or a way to boost your CV. That's just the icing of the most delicious, moist, and fluffy cake you will ever taste. Why is that? You might ask. Well, that's because REPU is a way to make a difference in our country. And, in my view, there is nothing sweeter than that.

Kenyi Saito-Diaz

REPU Former Co-Director
Postdoctoral Fellow - Ethan Lee Lab
Vanderbilt University
REPU 2008



Index

Page 3	What does it mean to be part of REPU?
Page 4	An interview with Edson Bellido (Co-Director of REPU)
Page 6	2017 REPU Research Projects
Page 12	2016 REPU Research Projects
Page 15	2015 REPU Research Projects
Page 19	Two new home-country universities
Page 20	New REPU Branches
Page 22	An interview with Nicholas Ingolia (Professor at UC Berkeley)
Page 23	REPU Timeline
Page 24	Last Remarks
Page 25	Acknowledgments

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An interview with Edson Bellido Co-Director of REPU

Edson Bellido, co-director of REPU and in charge of NanoREPU, shared his research experience, his involvement in REPU, and gave valuable advice to undergrads in Peru.



Could you tell us a bit about your journey from Peru to where you are now?

My journey began in the "Thin films" laboratory at Universidad Nacional de Ingeniería, where I started doing research in nanotechnology, working mostly in the synthesis and fabrication of nanostructured TiO₂ thin films that were used as photocatalyzers in prototype devices for solar water decontamination in the Peruvian Andes. Thanks to the experience I gained in that lab I was able to apply and be selected for a research internship to work under the supervision of Prof. Jorge Seminario, PhD, a distinguished Peruvian professor in the department of Chemical Engineering at Texas A&M University.

In the internship, I worked on measurements of the electrical properties of origami DNA. I was able to publish two papers from this work, and was thanks to these papers and the experience I acquired during the internship that I was accepted into the materials science and engineering PhD program at Texas A&M University. During my first years in graduate school I worked on simulations of graphene based nano-devices and explored applications of the vibrational modes of this material for molecular circuits and sensors. While I was working on these simulations, I found myself always thinking about the experimental procedures that will be required to reproduce my simulations. I realized that I had this strong desire to go to the lab and "do, try and experiment". After this realization, I decided to switch from the PhD program to a master program and look for a new lab where I could work on experimental research for my PhD.

In the search for a new lab I found the group of Prof. Gianluigi Botton and the Canadian Centre for Electron Microscopy at McMaster University. The great research and the state of the art facilities, with some of

the best electron microscopes on the world, were the perfect place for me to work on my PhD. I applied and I was fortunate to be accepted in the Materials Science PhD program at McMaster University. Since then I have been working on the fabrication and characterization of optical properties of silver and gold nanostructures. In particular, my research has two main objectives, one is to develop new methodologies for the characterization of plasmonic structures at the nanoscale using an electron probe, and the second is to understand the relationship between the geometry of metallic nano-structures and its plasmon resonances using high-resolution electron energy loss spectroscopy.

How did you find out about REPU?

It was through my friend and colleague Dr. Luis Jauregui that at the time was a PhD student at Purdue University. He was starting the "Nano" branch in REPU, and he contacted me and other PhD students working in nanotechnology to be part of the selection committee for nanoREPU. I gladly accepted his invitation and I started working in REPU since then. In 2014, I assumed the responsibility of the organization of nanoREPU that was moving from Purdue University to McMaster University, and I started my role as mentor.

What is your role at REPU?

I have three main roles at REPU: responsible for the organization of nanoREPU, mentor and the new role as co-director of REPU. As the person responsible for the organization of nanoREPU, I coordinate the student selection process and serve as chair of the selection committee. After the selection, I organize the internship of the REPU students that are coming to

McMaster University. I find the research groups where the students will do their internships and make sure their accommodation and paper work are arranged before their arrival.

In my role of mentor, I guide the students during their internship by providing advice on their research projects as well as and practical tips so they can get into the mindset of a researcher. In conjunction with the other mentors, I also organize activities such as journal clubs and research in progress sessions, where the students can practice and improve their communication skills and learn how to present their research and ideas in a coherent and clear way. The mentors work with the students during all their internship to make sure they can get the most out of this experience not only academically but also personally, so they can gain the skills that they will need in order to be accepted into graduate school and later be successfully researchers that contribute to the development of our country.

In my new role as co-director, together with the other directors, we lead the organization to achieve its goal, which is to build a strong Peruvian scientific community by complementing the undergraduate education with a research internship in laboratories in North America and Europe. We also supervise the committees that form the structure of REPU, and we are the responsible for establishing partnerships/agreements with organizations which values are aligned with our goals. Currently, we are working towards consolidating REPU as a legally recognized organization and establishing a strategic agreement to ensure that REPU students can receive funding for their internship. We want to build a strong organization that goes beyond the internship, we want a community of outstanding Peruvian scientist where all members work together and collaborate in the development of science and technology in Peru.

If you could go back to college, what do you wish your undergrad self knew that you didn't know back then but know now?

I wish I realized back then the importance of getting involved in activities beyond coursework. These extracurricular activities during my undergrad were fundamental for my applications to graduate school, internships and scholarships. In my case it was by pure chance that I got involved in these extra activities.

I took a class with a professor that had a very active research laboratory. One day he invited the class to go and see the lab and the work done there. I went to the lab and met a graduate students working on a thin film coating system. He asked if I was interested in helping with the project, I said yes, and little by little I got more involved in the research done there. People in that laboratory were very active and through them I got involved in other activities, but at the time I did not know the importance of those extracurricular activities and the connections you establish through them. If I knew back then, I would have started earlier.

Any advice for Peruvian undergrads who would like to go to grad school abroad?

Get involved in research activities as early as possible, you can even start in your first year. I know a very successful young professor. She has a very successful career, and she started doing research in high school. The more experience you get the better your chances of being accepted into graduate school abroad.

Study English early on, do not leave it for later. Perfecting your language skills is fundamental for graduate school, even if you go to a non-English speaking country you will still need English to communicate in the academic world.

Get help and advice from people with more experience. Ask alumni from your university that are in graduate school abroad for give you advice and guide through the application process, most people are willing to help, do not be afraid of asking for help.

Keep yourself updated in your field of interest. Constantly read papers about areas of research in which you would like to work on. This will be very help in your application because it will be easier for you to show that you are knowledgeable and have a true interest on research field. Take advantage of the new tools that CONCYTEC is providing to get access to scientific literature. When I was an undergrad student we did not have this option, I had to ask people abroad to send papers.

Be perseverant; keep working on getting research experience and in your language skills. Seek help and information on how you can achieve your goal. Even if you are not successful the first time, keep working to improve your chances of being accepted, follow your dreams!

2017 REPU Research Projects

By Luz Saavedra, Johnny Dávila and Ricardo Gonzales

REPU - Biology

Beatriz Garcia - New York University

Lehmann Laboratory, USA

Germ cells are the stem cells of the next generation; given the fact that they can generate a new organism. Despite their importance, we still know little about how their fate is determined. Research on the Lehmann lab focuses on *Drosophila* (fruit fly) germ cells. In the embryo, germ cells appear at the posterior pole and they are internalized during gastrulation. Once they are inside the embryo, they individualize and cross the posterior midgut epithelium that surrounds them. And after crossing, they associate with somatic gonadal precursors to form the embryonic gonad.

During her internship at New York University, Beatriz worked with Benjamin Lin in a project that aimed to decode the signaling network regulating the individualization of germ cells. Identifying the genes involved in this process is the first step towards understanding how it works and the implications it has in development.



Lidia Llacsahuanga - UC Berkeley

Ingolia Laboratory, USA



Translation is the last step of the fundamental biological process of gene expression, where the genetic information is decoded into a functional protein. It consumes roughly half the energy used by the cell during rapid growth and even minor defects on the translational apparatus can greatly affect human health. The difficulty of studying translation lies on the essentiality of many of the factors that drive it. Deleting those factors in order to observe the immediate effects of their absence is not easily accomplishable by traditional genetic techniques. However, a quick promising method can be developed using plant hormones.

Lidia's work consisted on developing a novel and rapid degradation system induced by the plant hormone jasmonate-isoleucine, and of implementing the already explored system based on auxin to rapidly degrade the desired factors in *Saccharomyces cerevisiae*.

Luz Saavedra - Harvard University

Yang Laboratory, USA



One of the most fascinating problems in biology is how the complexity of multicellular organisms arose. Every multicellular organism came from one cell, a single cell that proliferated and differentiated into a wide array of cells that constitute the different body organs and tissues. However, to form an organism, having a bunch of specialized cells is not enough. To lead to a functional organ, tissues need to acquire a particular shape and a precise organization of cells. Although it is not fully understood how this happens, there is evidence that many individual and group cells polarize, reorientate, migrate and move during embryonic development. For instance, when the limbs are developing, cartilage cells first proliferate and consequently need to rearrange and intercalate so that there is only one direction of growth. The Yang Laboratory studies how these cells communicate between them to sense how they must orientate, migrate, and follow the defined direction of growth. Their research is focused on

elucidating the role of the Wnt/PCP pathway as a key regulator of these processes. During her internship, Luz worked with murine genetic models to test the participation of new components inside of this signaling pathway.

Johnny Sandoval - Harvard University

Pfister Laboratory, USA

Morchella is a genus of mushrooms highly valuable in the market around the globe, with multi-millionaire industries developed around this resource. Although it is distributed worldwide, there is still a lack of information when it comes to the systematics of this taxa: around 90% of the recognized species are not formally described. Countries like China, USA and Canada have developed intensive research about phylogenetics of this genus; South America is still a mystery to unravel. Pildain et al. (2014) worked on this genus in Argentina, finding some new phylogenetic species. However, this fungus has been reported in some other countries in this continent. This summer, Johnny's project focused on the phylogenetic species of Morchella from the southern Chile using the nuclear region ITS (internal transcribed spacer) -known as DNA barcode for Fungi-. Furthermore, he made cultures of ascospores, proposing a non-invasive way to identify these mushrooms.



Oscar Sevillano - Ruhr-Universität Bochum

Biochemie I - Rezeptorbiochemie, Germany

In a chemical synapse, one neuron will release neurotransmitters, which will bind to receptors in another neuron, thus communicating. Glutamate is one important neurotransmitter, involved in muscle movement, thought process, and memory. AMPARs are the type of glutamate receptor that mediate fast synaptic transmission, and are helped by a family of proteins known as TARPs. For their similarities in sequence and structure to TARPs, the claudin protein family may have AMPAR modulatory activity. Proteins that regulate the activity of glutamate receptors are very important, since glutamate deregulation is associated with several neurological diseases and disabilities. Oscar Gabriel participated in a research project which aimed at the characterization of AMPAR heteromers activity when co-expressed with claudins. Here, he cloned and fused AMPAR subunits with different claudins expressed in mice brain, and used the *Xenopus laevis* oocyte expression system to measure their activity.

**REPU - Chemistry****Gustavo Cano - Yale University**

Plata Laboratory, USA



Carbon nanotubes (CNTs) are a novel nanomaterial that, are entirely made of carbon atoms. These atoms bond in such a special way that they form a cylindrical nanostructure which confers CNTs outstanding properties which include high tensile strength, low density, high thermal conductivity and stability, and large current capacity. However, in spite of nearly 25 years of focused investigation, none of the most promising CNT-enabled applications have been realized. This is due to a limited ability to manufacture CNTs at scale, economically, and with great precision, which is a consequence of a lack of knowledge in the formation mechanisms. In fact, their fabrication is a very inefficient industrial process as only 1 carbon atom in 100 - or sometimes 1 in 1,000,000 - forms useful product. As a result, the environmental impacts of the material fabrication can outweigh the lifetime benefits of the intended noble applications.

The Plata lab is currently assessing these limitations through an improved mechanistic understanding of CNT formation. This past summer, Gustavo's work focused on studying the synthesis of carbon nanotubes by using alkynes as gas precursors, which are thought to be growth enhancers and can possibly incorporate directly to the nanostructure. He also worked in the improvement of the synthetic efficiency of CNT by designing a recycling system to reuse a fraction of the gaseous effluent.

nanoREPU

Ricardo Gonzales - Yale University

Reed Laboratory, USA



Currently, one third of the world's population suffers from tuberculosis, being considered one of the deadliest diseases in the world. With current technology, detection of this infection requires at least 3 days with cell culture techniques. With dielectrophoretic (DEP) separation of bacterial cells in a lab-on-a-chip (LOC) application, a project being developed by the Reed Lab, it is possible to accomplish this detection task in only 30 minutes. This electronic phenomenon (DEP) depends strongly on the electrical and physical properties of the cells to be analyzed, the fluid to be injected in the microchannel, and the frequency of the electric field. Once the targeted cells are instantly separated from the red blood cells, an electrical quantification is made through a cell counter, which gives the detection result. During the internship, Ricardo worked on this project, led by Shari Yosinski, in which he was able to design new fabrication methods, to test its microfluidic properties and to operate the cell counter.

REPU - Physics

Álvaro Chupillón - McMaster University

Buijs Laboratory, Canada

Fission reaction is the process in which could generate a great deal of energy by splitting of heavy atoms into others particles. This reaction is the main process on nuclear reactors to obtain enough energy for electricity. In addition, there are not only nuclear reactors for the generation of electricity but also it is used for research.

On the field of research nuclear reactors, we can find many applications as neutron radiography for photographing the interior structure of solid objects, production of radioisotopes, neutron irradiation, etc.

During the internship, Alvaro participated in a research project in which the goal was to characterized the McMaster Nuclear Reactor (MNR) . In order to do that, he simulated the cycles during the rector was activated generating the results of the actual amount of uranium and plutonium in each cycle.



Claudia Parisuaña - General Atomics

DIII-D Fusion Facility, USA

Fusion is the process that powers the sun and the stars and years ago we managed to achieve fusion here on Earth inside reactors. If we managed to reach a steady-state operation in fusion reactors, we would have an energy source that is inexhaustible.

Moreover, fusion is environmentally friendly, producing no combustion products or greenhouse gases. Although fusion is a nuclear process, the products of the fusion reaction (helium and a neutron) are not radioactive, and with proper design would produce no long-lived radioactive waste.

During the internship, Claudia worked in DIII-D Fusion Facility. DIII-D Program is a large international program and its mission is to establish the scientific basis for the optimization of the tokamak approach to fusion energy production. She collaborated with the Electron Cyclotron Heating Group (ECH) inside DIII-D by analyzing the calorimetric measurements of the gyrotron heat collector.

**Víctor Valera - Yale University**

Wright Laboratory, USA



Neutrinos are fundamental particles that were postulated by Pauli to explain the energy conservation in a nuclear process known as beta decay, where a neutron decays into a proton and an electron, but an extra particle, carrying some extra energy is released, that extra chargeless particle is the neutrino. Since their experimental discovery as a product of isotopes decays inside a reactor core, neutrinos have shown the potential to lead physicists to new discoveries and theories beyond the standard model. Neutrinos come in three different types or "flavors". Although they initially were proposed as massless particles, later experiments found that neutrinos flavor oscillate while traveling through space, which means that they turn from one flavor to another. This phenomenon is allowed by quantum mechanics only if they had mass, changing the old paradigm. Current experiments have raised two new anomalies related to a deficit of neutrinos flux and discrepancies with the theoretical spectrum shape.

Victor was part of the PROSPECT, the Precision Oscillation and Spectrum Experiment. PROSPECT is a neutrino experiment designed to study the emission of antineutrinos from nuclear reactors and the oscillation of neutrinos over very short baselines. PROSPECT will make a precision measurement of the antineutrino spectrum and search for sterile neutrinos, a new form of matter. During his internship, Víctor assisted with the characterization of photomultiplier tubes for PROSPECT and analyzed data from the test detectors. He worked on the testing of the PROSPECT prototype detectors, assembly of detector components, and the analysis of test detector data.

ecoREPU

Jose Iturrizaga - University of Missouri - Saint Louis

Parker Laboratory, USA



Avian malaria is a parasitic disease that affects birds, it is caused by parasites of the genera *Plasmodium* and *Hemoproteus*, and it is transmitted by a dipteran vector. The life cycle includes two bird hosts and 2 dipteran hosts. Usually it does not kill birds, but in new areas it could, like the Galapagos or Hawaiian islands, it can be very deadly, bringing massive extinctions. In the 1800's Avian malaria was introduced to the Hawaiian Islands, leading to massive extinctions of local avifauna. The Galapagos archipelago is very similar to the Hawaiian Islands. In the year 2009, Dr. Parker found *Plasmodium* in a Galapagos penguin (*Spheniscus mendiculus*) via PCR, but not the infectious gametocyte stage, focusing her studies on this parasite. During the REPU internship, Jose Antonio used molecular techniques to screen mosquito samples to detect the presence of the *Plasmodium* parasites.

REPU - Atix

Richard Zapata - Universidad Peruana Cayetano Heredia

Laboratorio de Inmunología, Peru

Diabetes is a metabolic disease that can lead to severe and life-threatening conditions. The need of new therapies for the control and surveillance of this disease represents a great opportunity for research in regenerative medicine. This summer, Richard worked on developing a novel protocol for cell culture of mesenchymal stem cells (MSCs) that were treated with growth factors (GF) from human platelets lysate as part of a new approach for regenerative therapy to control diabetes. GF have been used as therapy based in the role of these molecules in cell growing and wound healing, while MSCs are the key players in regenerating tissues. Together, these elements represent a new alternative to control the progression of diabetic ulcers. However, overstimulation by GF can lead to cancer in some tissues. For this reason, Richard tested the effect of different concentrations of GF in MSCs cultures and evaluated, by a cytogenetics approach, the appearance of chromosomal alterations. In his words, he found this project "really challenging and brought out the best of his experience".



2016 REPU Research Projects

By Luz Saavedra, Johnny Dávila and Ricardo Gonzales

REPU - Biology

Cayetana Arnaiz - Vanderbilt University

Graham Laboratory, USA

Plasma membrane asymmetry is essential for cell function and survival, being required for cellular processes such as vesicular trafficking, apoptosis, or more specific events, like blood clotting. The maintenance of this asymmetry in lipid composition is done by a specific type of proteins called the P4-type ATPases or 'flippases', which serve as translocators of phospholipids within the membrane. The Graham Lab at Vanderbilt University focuses on understanding how flippases contribute to the establishment of membrane asymmetry and vesicle-mediated protein transport. One of the ongoing projects at The Graham Lab aims to define the mechanism of substrate recognition and translocation by flippases, using genetic and biochemical approaches. Cayetana Arnaiz performed several experiments with flippase knock-out yeast strains, to elucidate the ability of these mutants to grow under stressful conditions, such as alkaline environments. The aim of these experiments was to determine if the function of these phospholipid translocators was essential to activate a stress response in the cell.



*Update: Cayetana is currently a PhD student at Vanderbilt University.

Jorge Rua - Vanderbilt University

Macara Laboratory, USA



Exocytosis is a conservative transport mechanism in eukaryotic cells by which membrane proteins are transported and incorporated into or secreted from the plasma membrane. The Exocyst is one of the complexes involved in this process, being previously studied but whose assembly is still not clearly understood. Overexpression of the subunits could lead to wrong interpretations, that's why it is important to study these proteins under physiological conditions.

The Macara lab, at Vanderbilt University, aims to understand cell polarity of mammary gland epithelial cells and they have recently found that one of the Exocyst subunits, EXO70, interacts with the polarity protein PAR3. Jorge Rua used CRISPR/Cas9 technology to tag the endogenous locus of EXO70 with super-folding GFP (sfGFP) in order to create a stable cell line that enables the tracking of the Exocyst complex in live cells.

*Update: Jorge is currently a PhD student at Vanderbilt University.

REPU - Chemistry

Diego Nieto - University of Navarra

Organic and Pharmaceutical Chemistry Department, Spain



Malaria is a life-threatening disease that is typically transmitted through the bite of an Anopheles mosquito infected with a Plasmodium species organism. This tropical disease continues affecting large parts of the world and there are no long-term sustainable treatments available yet. Currently, artemisinin-based combination therapies are the mainstay of antimalarial treatment but in recent years parasite resistance against artemisinin and its derivatives has emerged and spread. In order to handle this challenge, new antimalarial entities are needed. Potent antimalarial drugs, such as quinine, mefloquine, lumefantrine and halofantrine owe their high antiplasmodial activity and ADMET values to the presence of an arylamino alcohol moiety into the structure. Based on this antiplasmodial pharmacophore, Diego Nieto worked in the Laboratory of Synthesis of the Department of Organic and Pharmaceutical Chemistry of the University of Navarra, mainly in the development of new molecules

that could meet the structure, activity and ADMET requirements of an active antimalarial drug, a crucial step in the drug discovery process.

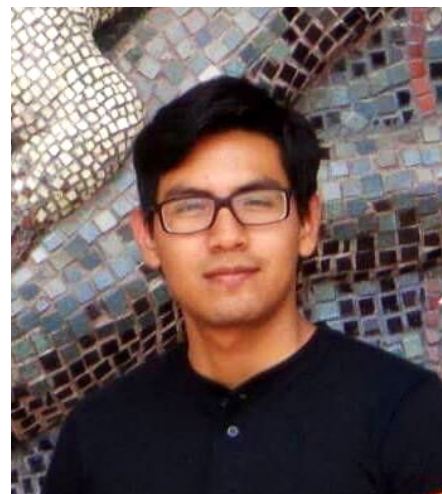
nanoREPU

Ricardo Vilchez - McMaster University

Turak Laboratory, Canada

In the past years, the price of fossil fuel has increased more than anytime in recent memory. Hence, the race for an alternate energy source to replace or lessen the use of fossil fuels has risen. The activity of creating electricity using organic solar cells is an example of a sustainable energy source. This technology also uses nanoparticles that exhibit unique properties, like Nanostructured titanium dioxide (TiO_2), which attracts significant attention in the field of photocatalysis, photonic crystals, optical emission and sensing, because of its optical and catalytic properties.

During his internship at the Organic Electronic Interface Laboratory at McMaster University, Ricardo focused on a solution of the charge transport problem on organic solar cells through the synthesis of titanium dioxide nanoparticles by reverse micelle technique and characterizing them with an atomic force microscope (AFM). Also, he studied the array order of the micelles and how can change it.



REPU - Physics

Pedro Cisneros - Yale University

Emonet Laboratory, USA

The research internship was done at the Emonet Laboratory, Yale University. The research involved the quantitative study of the sensory biological behavior of fruit flies (*Drosophila melanogaster*).

The most important result of the internship was the development of a computational tool which, through different techniques of computer vision and statistical analysis, could extract behavioral patterns of the fly in the presence of odor stimuli coming from attractive volatile chemicals. Likewise, the tool let us identify other important behaviors, like grooming or the interaction with other flies.

As a result, by the end of the internship, some preliminary analysis of a mathematical model which could describe the flies' odor sensory behavior was presented.

*Update: Pedro is currently a PhD student at UC Santa Barbara.



Gabriel Rabanal - Yale University

Wright Laboratory, USA



Neutrinos are the most abundant matter particles in the universe but despite their ubiquity, they elude most detection mechanisms. Current experiments exploit the quantum mechanical phenomenon of neutrino oscillation, in which a neutrino produced with a specific lepton flavor (electron, muon, or tau) can later be found with a different one as it travels through space. Oscillation implies that neutrinos have mass, which revealed physics beyond the Standard Model. This and other extensions to the Standard Model required theories whose predictions are to be tested. During his internship, Gabriel worked in PROSPECT, the Precision Reactor Oscillation and SPECTrum experiment. PROSPECT will analyze antineutrinos stemming from a nuclear reactor at short distances from it in order to address the so-called reactor anomaly, search for the hypothetical sterile neutrinos, and make the most precise measurement of the antineutrino spectrum from a highly-enriched reactor core. Gabriel

was involved in the assembly of a scintillator cell and developed simulations within the CERN Geant4 framework using ROOT to optimize the geometry of a Compton spectrometer built to characterize quenching effects.

*Update: Gabriel is currently a PhD student at Harvard University.

2015 REPU Research Projects

By Luz Saavedra, Johnny Dávila and Ricardo Gonzales

REPU - Biology

Renzo Gutiérrez - Vanderbilt University

Miller Laboratory, USA



Synaptic remodeling is a complex mechanism that governs the assembly of pre and postsynaptic domains to direct the flow of information among neurons. This process takes part during early development for the maintenance of cognitive processes. However, its genetic machinery is poorly understood. Currently, the GABAergic system of the nematode *C. elegans* exemplifies a model of study of this process. Dorsal D neurons undergo a switch polarity to synapse with dorsal muscles in early larval stages in a process regulated by the transcription factor UNC-55. The Miller lab exploits this system to uncover the transcriptional program that governs neuron-remodeling through the identification of candidate targets of UNC-55. During this internship, by using a CRISPR/Cas9 genetic approach, Renzo focused on the design and generation of *unc-8* mutant strains to disrupt the channel activity and further evaluated its impact on synaptic remodeling.

*Update: Renzo is currently a Msc(c) at Universidad Peruana Cayetano Heredia.

Julio Miranda - Yale University

Crews Laboratory, USA

Among tetrapods, only salamanders can fully regenerate their limbs as adults (arms, legs and tail). They are even able to regenerate their brain, heart or spinal cord. The axolotl is a salamander widely used in regeneration studies as it is easily maintained in the laboratory. When an axolotl limb is amputated, the wound heals and subsequently a mass of proliferating cells called "blastema" forms. During regeneration, blastema cells differentiate into all the tissues needed. Thus, the identification of genes expressed in blastema that are essential for regeneration is extremely important. A list of candidate genes was previously reported by the Crews group. Julio focused on using the CRISPR/Cas9 system to knock out some of the candidate genes in axolotl embryos. This was highly challenging because it has a very large genome that remains unsequenced. However, Julio was able to successfully mutate some of the genes and generated viable individuals for future amputation assays.



*Update: Julio is currently a PhD student at the University of Chicago.

Maria Fernanda Senosain - Texas A&M University

Young Laboratory, USA

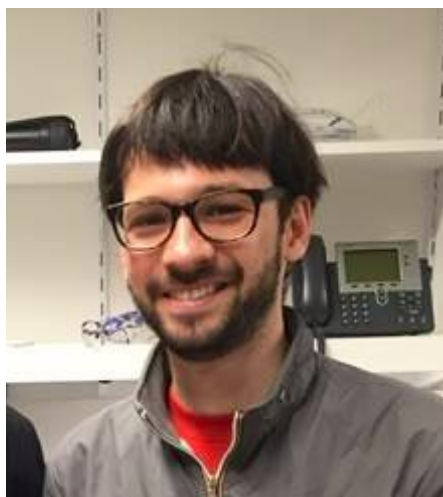
A bacteriophage is a virus that infects and replicates within a bacteria. The virus recognizes and attaches to specific receptors in the surface of the bacteria and injects its genome which is replicated and transcribed to form the viral particles. Once the maturation process is complete, lysis is induced and the viral progeny is released. In spite of being considered as potential antibacterial therapeutics, research about phages was left apart due to the discovery of antibiotics. Nowadays, the emergence of pathogenic bacteria resistant to most currently available antimicrobial agents has become a critical problem, which could be addressed with the use of phages. The Young lab is primarily focused on the molecular mechanisms by which bacteriophages, or bacterial viruses, accomplish host cell lysis. During the internship, Maria Fernanda worked on the isolation of bacteriophages against clinical strains of *Acinetobacter baumannii*, which is a gram-negative pathogenic bacteria resistant to most antibiotics. The isolation of several bacteriophages against this bacteria together with the annotation of the phages genomes is an important contribution toward the use of phage therapy in the future.



*Update: Maria Fernanda is currently a PhD student at Vanderbilt University.

REPU - Chemistry**Rodrigo Beltrán - Yale University**

Brudvig Laboratory, USA



During the last decade, efforts have been made towards research on alternative energy resources, such as solar energy. Solar fuel cells are capable of transforming solar energy into "useful" energy by the water oxidation reaction. This reaction is energetically and kinetically demanding and needs a catalyst to occur at normal conditions. The Brudvig Lab studies the chemistry of water oxidation in natural photosynthesis and to model this water-oxidizing chemistry with synthetic catalysts. Iridium organometallic complexes are the precursors which can be activated to form water-oxidation catalysts by the addition of a chemical oxidant or an electrode potential. Once oxidized, they become highly active catalysts capable of high rates of oxygen evolution with low overpotentials. Rodrigo worked on the characterization of the molecular species derived from the activation of two precursors, $\text{Cp}^*\text{Ir}(\text{pyalc})\text{OH}$ and $(\text{CO})_2\text{Ir}(\text{pyalc})$, through UV-Vis spectroscopy, cyclic voltammetry and NMR spectroscopy. The

results from Rodrigo's work have been published as part of a paper on Inorganic Chemistry.

*Update: Rodrigo is currently a PhD student at Technische Universität Berlin.

Brenda D'Acunha - Vanderbilt University

Marnett Laboratory, USA



Fever, pain and inflammation are immune responses that are induced by a series of cell-specific prostaglandins that come from prostaglandin H₂ (PGH₂) as part of the oxygenation process of arachidonate, catalyzed by the cyclooxygenase (COX) enzymes. There are two COX isoforms: COX-1 and COX-2, being the last one only induced at sites of tissue damage and infection and able to generate prostaglandins that mediate these processes. Because of its biological roles, its inhibition is the main objective of many pharmaceutical industries, especially for the treatment of chronic diseases like cancer, arthritis and Crohn's disease. A properly designed drug should be specific (block only COX-2 and not COX-1) and also potent. In order to achieve this, there is a need to study the structure of the COX-2 enzyme and its interactions with different substrates to completely understand the mechanism of action and to learn which are the desirable chemical characteristics in the drugs in order to block this

enzyme. As part of these efforts, Brenda investigated the substrate selective activation and inhibition of endocannabinoid oxygenation by COX-2. She worked, specifically, with two enzymes that had mutations at the interphase between the two subunits (COX-2 is a heterodimer).

*Update: Brenda is currently a PhD student at University of British Columbia

Daisy Unsihuay - University of Navarra

Microbiology and Parasitology Laboratory, Spain

Shigellosis is one of the leading causes of diarrhea worldwide. Each year, 160 million new cases of shigellosis are reported in the world, which causes approximately 1.5 million deaths. Thus, the need of an effective vaccine is still a priority. Previous studies showed the capacity of outer membrane vesicles (OMVs) to protect mice against an experimental infection with *Shigella flexneri*. Further studies, showed the capacity of the antigenic complex to confer a long-term protection by oral or nasal routes when encapsulated into nanoparticles. Daisy worked in the Microbiology and Parasitology lab of Universidad de Navarra in the synthesis of an Ipa-enriched antigenic extract. Ipa proteins are adhesin proteins known to be involved in bacterial invasion of intestinal epithelial cells. Secretion of these proteins in the extract was stimulated by the presence of bile salt deoxycholate (DOC) and Congo Red (RC) dye to simulate physiological conditions. The RC/DOC extract was characterized by SDS-PAGE, Western blot, KDO and Lowry tests. Data generated by Daisy suggest the presence of various adhesin proteins such as IpaB, iPaD, OspG, OspE in the RC/DOC extract that could enhance the interaction of the antigen complex with the mucosa and trigger a higher immune response.



*Update: Daisy is currently a PhD student at Purdue University.

nanoREPU

Diego Berrocal - McMaster University

Ayers Laboratory, Canada

The Ayers Group at McMaster University created their own Helpful Open-source Research Tool for N-fermion systems (HORTON). HORTON was created to address the need to revamp the existing quantum chemistry programs. It is a research tool that is computationally-efficient enough to be helpful, without compromising code-readability and user-friendliness. Thus, HORTON proves to be a helpful tool to develop and explore new methods, to interpret the results of electronic structure calculations, and to interact with other computational modeling software. Diego's work was based in implementing a new approach of the watershed algorithm for calculating boundaries between atoms given information about spatial density. The watershed algorithm is used in computer vision to mark boundaries in 2D images. Diego extended this algorithm to a 3D space and fed data from analysis given out by HORTON. During his internship, he acquired important skills needed to do research in computational science and many fundamentals of Density Functional Theory.



*Update: Diego is currently a software engineer at eBay.

Fabiola Bravo - McMaster University

Botton Laboratory, Canada



The limited commercialization of polymer electrolyte membrane fuel cells stems from the sluggish kinetics of the oxygen reduction reaction (ORR). The great catalytic ORR performance exhibited by platinum (Pt) alloys has been restrained by the affinity of transition metals to leach out in the fuel cell environment, leading to shorter operational lifetimes. Hence, it is desired to employ noble metals (Au, Ir) as alloying elements with Pt, that provide enhanced electrochemical stability. Pt-Au alloy nanoparticles, in particular, exhibit extended catalytic durability. However, the introduction of Au in the Pt lattice decreases its activity due to stronger chemisorption of oxygen than even pure-Pt. The catalytic activity of Pt-Au nanoparticles can be synergistically fine-tuned by adding cobalt as the third alloying element, known to weaken the chemisorption of oxygen by modifying electronic structure and lattice strain effects. Fabiola studied the synthesis of Pt/Co/Au alloy nanoparticles in an aqueous medium. She characterized

and synthesized them based on these Pt/Co nanoparticles, and changes in the order of introduction of the reactants showed an important effect on the morphology of the resulting nanoparticles.

*Update: Fabiola is currently a PhD student at UCSD.

Two new home-country universities

By Ricardo Gonzales and Richard Zapata

The REPU program is happy to announce that, so far, selected students have come from 9 different Peruvian universities. This year, 2 new universities joined the growing list of REPU's home-country universities. For the first time, we had one electrical engineering student from Universidad de Ingeniería y Tecnología and one biology student from Universidad Nacional Pedro Ruíz Gallo.

Universidad de Ingeniería y Tecnología (UTEC)

UTEC is a young private Peruvian university mainly focused on engineering, with a strong component of innovation and humanities. Currently, UTEC offers 10 undergraduate engineering careers, as well as professional and continuing education programs for executives. It also has UTEC Ventures and applied research services. In addition, UTEC is backed by the commitment of its founding members and Board, a group of entrepreneurs -like Eduardo Hochschild, Dionisio Romero, Roque Benavides, etc.- who have achieved great success in the most important industries in the country. The Board's commitment to education, innovation, research, and economic development supports the design of a first-rate educational model, aimed at meeting the needs of the labor market and addressing the various problems of the 21st century. Each component of UTEC's offer is designed in line with the trends and demands that globalization poses to modern engineering. The workshops and courses are designed to meet the needs of the labor market.



Figure 1. UTEC main building

Universidad Nacional Pedro Ruiz Gallo (UNPRG)

This public university was created in 1970, as a result of the fusion of two of the most representative universities of the region of Lambayeque: Universidad Agraria del Norte and Universidad Nacional Lambayeque. It received its name in recognition of one of the most important characters of Lambayeque, the great inventor and national hero, Lieutenant Colonel Pedro Ruiz Gallo.

Currently, this university has fourteen schools and more than twenty specialties, and is Lambayeque's main university



Figure 2. UNPRG main entrance

So far the list of Peruvian universities from which REPU students have been selected is:

- Universidad Peruana Cayetano Heredia
- Universidad Nacional Mayor de San Marcos
- Universidad Nacional Agraria La Molina
- Universidad Nacional de Ingeniería
- Universidad Ricardo Palma
- Universidad Nacional Federico Villareal
- Pontificia Universidad Católica del Perú
- Universidad de Ingeniería y Tecnología
- Universidad Nacional Pedro Ruiz Gallo

For more information on the 7 other universities on this list, please refer to our 2014 REPU Magazine.

New REPU Branches

One of the goals of REPU is to continue expanding its programs in order to include more academic disciplines and bring more opportunities to Peruvian undergraduates. Over the last three years, REPU has opened 3 new programs: REPUPhysics, ecoREPU and REPUatix .

Seeking for the fundamental laws of the Universe: REPUPhysics

By Víctor Valera and Luz Saavedra

REPUPhysics offers an internship for students with a strong interest in the fields of Astrophysics, Experimental Condensed Matter Physics, Experimental Nuclear Physics, Experimental Particle Physics, Gravitational Physics, High Energy Theory and Cosmology, Quantum Optics, Quantum Information Physics, etc. The program provides the opportunity to participate in projects run by big collaborations, hands-on experience and the chance of having an idea of what is a real day in the life of a physics researcher inside the lab.

REPUPhysics was born in 2015 after the initiative of Sofía Espinoza (PhD from Yale University) and Maria Jose Maureira, and is currently supported by Humberto Torreblanca (General Atomics), Edson Bellido (Phd, McMaster University), Kevin Villegas (PhD student, Princeton University) and Andres Llacsahuanga (PhD student, Purdue University).

The program currently has five alumni. Gabriel Rabanal and Pedro Cisneros (REPUPhysics 2016) did their internship at Yale University and are both currently enrolled in PhD programs at Harvard University and UC Santa Bárbara, respectively. Claudia Parisuaña, Víctor Valera and Álvaro Chupillón (REPUPhysics 2017) did their internships at General Atomics, Yale University and McMaster University. These students had the chance to participate in projects related to Nuclear Reactors, High Energy Physics, Experimental Particle Physics and Neutrino Physics.

A new REPU Program: ecoREPU

By Rossana Maguiña

EcoREPU offers an internship in fields related to ecology, conservation and environmental sciences. EcoREPU was a long-awaited program considering the high interest of Peruvian undergraduates in an internship of this nature. What is more, we are aware that to study, manage and protect Peru's biodiversity, which includes more than 20 500 species of plants, more than 5 500 species of animals, etc., we need more Peruvian scientists trained for those purposes.

The opening of the ecoREPU Program was achieved with the collaboration of Peruvian students enrolled in ecology graduate programs in the United States. The ecoREPU team was formed by David Chang (PhD student, Cornell University), Nereyda Falconi (PhD student, University of Massachusetts), Cindy Hurtado (MSc student, Twonson University), Patricia Mendoza (PhD student, University of Missouri-St. Louis), and Rossana Maguiña (PhD student, UC Santa Cruz, mentor).

Our very first ecoREPU student was Jose Iturrizaga from Universidad Peruana Cayetano Heredia, who joined the Parker Lab at the University of Missouri at Saint Louis. The Parker Lab is focused on the study of animal behavior and disease ecology in tropical areas like the Galapagos Islands. Jose also had the opportunity to participate in research studies at the Saint Louis Zoo as part of the Animal Behavior Lab.



Figure 1. Jose Iturrizaga and Rossana Maguiña from ecoREPU

'Atix': Building scientific capacity in the inside of Peru

By Renzo Gutiérrez

In previous years, the lack of local contacts and networks was a great obstacle to establish a communication channel between STEM students from regions outside Lima. Fortunately, during the 2016 call, we received many messages of support from different regions of Peru asking how to host short talks about the program.

Thanks to the effort of students that served as key intermediaries between us and their universities, we could share for the first time the experiences of REPU in the cities of Lambayeque, Piura, Arequipa, Ica, and Ancash. On each trip, we met faculty professors and authorities who were committed to building scientific capacity. Moreover, we found in STEM students an unforeseen source of inspiration and enthusiasm.

Although science education in some regions faces several difficulties, essentially on the lack of facilities and labs, we could recognize in students the genuine commitment to excellence that drove them to take any opportunity to improve their knowledge and skills. Based on these experiences, we launched REPUatix as a new branch of REPU dedicated to empowering the talent of STEM students all over Peru throughout an intense training in top Peruvian institutions. 'Atix' is a Quechuan word that, although it has no precise English translation, contains a deep and motivating meaning: 'the one who tries, the one who can, the one who achieves'. This feature is a hallmark of Peruvian students who do their best every day to pursue their academic goals.

This initiative motivated a chain of kindness among previous members of REPU, colleagues, student associations, and professors at Universidad Peruana Cayetano Heredia (UPCH) who did not hesitate on providing valuable documents and funding that made this project possible.

Finally, after a process of selection, we announced Richard Zapata, a biology student at Universidad Nacional Pedro Ruiz Gallo (UPRG) in the city of

Lambayeque, as the very first participant of REPU atix. Richard has a strong background in cancer genetics that made a good fit with the ongoing work in the Laboratory of Immunology at UPCH. Besides the lab work, we introduced several complementary activities that sharpened his critical thinking and communication skills. With the lessons learned on this year we hope to keep working on create more opportunities to encourage STEM students from different disciplines to pursue their goals.



Figure 2. Richard Zapata from REPU atix

REPU
Research Experience
for Peruvian Undergraduates

Why REPU?

- You will conduct a research project during a 12-week-long internship in North America or Europe.
- You will network with Ph.D. students and faculty of world-wide recognized universities.
- You will discuss current scientific articles and present your research at the REPU Seminar 2017.
- You will be paired up with an outstanding Peruvian scientist who will be your mentor during the program.

Program details:

- Our current program has 4 branches: nanoREPU, REPU-Chemistry, REPU-Biology, and REPU-Physics.
- REPU starts on January 1st and goes through March 15/30th, 2017.
- Applications from Peruvian undergraduate students interested in the Biomedical Sciences, Nanotechnology, Engineering, Physics and Chemistry are encouraged.

Application closes: May 31st 2016

Apply here*:
https://yalesurvey.qualtrics.com/SE/?SID=SV_0ITPfoavoSQsNiR
*Available only after May 5th 2016

REPU 2017
Research Experience for Peruvian Undergraduates Program

www.repuprogram.org

Figure 3. REPU 2017 recruitment flyer

An interview with Nicholas Ingolia Professor at UC Berkeley

Lidia Llacsahuanga, REPU Biology 2017, sat down with her Principal Investigator, Nicholas Ingolia, to share her research and some thoughts about the REPU program.

What kind of research do you do in your laboratory?

We are broadly interested in understanding the translational control of gene expression. So, why is it that some RNAs are translated better than others, and why some RNAs are translated much better in some conditions and not well at all in others.

We use a variety of techniques to measure and perturb translation. One particular challenge we run into is that many of the core proteins that are involved in translation initiation are essential; so we are not able to knock them out. And even if we deplete them, it is very quickly toxic to cells. So one of the things we really wanted to do is a better genetic approach to very rapidly deplete some of these core proteins, so we can look at the immediate effects of their depletion. That will give us a better understanding of what they are normally doing in the cell during translation.

And that's something we've been working on this spring: a way to very rapidly deplete these proteins. This is sort of co-opting a system that plants use to rapidly degrade certain proteins in response to plant hormones. So we can transplant that whole system into budding yeast, which is one of our favorite model organisms to work with.

Then, in yeast, we can rapidly target some of these proteins, like the cap-binding protein, and target that for rapid degradation, which lets us see what happens to cells when that protein goes away quickly.

What do you think of the REPU program?

I think it's a wonderful program! Certainly, from my perspective, it was great to have Lidia here visiting in the lab. I know that she got to work very closely with an experienced postdoc. I know that he really enjoyed that opportunity. And I think that she really got a lot out



of that: an opportunity to really see how we do science. So yeah, I think it's really great.

What is your overall opinion on Lidia's performance and would you be willing to recommend the program?

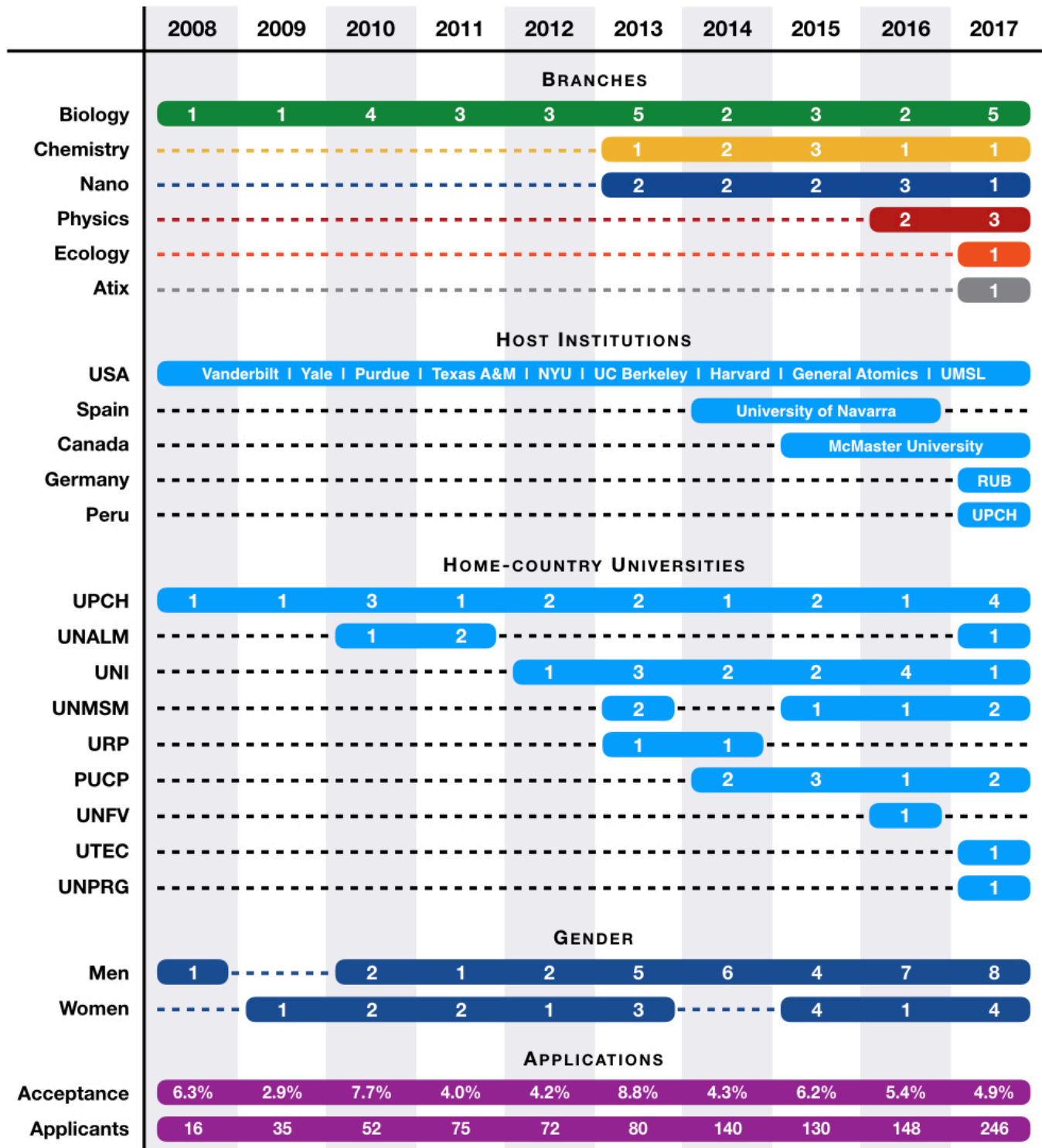
Yeah! It's really been a pleasure to have Lidia here. I think that she has made some real progress in a project that has been going on in the lab, something that is really a pretty central interest of ours and that we've been working on for a while. She's really moved that forward and it's been great to have her around to interact with students and postdocs in the lab. She's really brought a lot to the lab too. It's been great to have her.



Figure 1. Ingolia's Group with Lidia Llacsahuanga

REPU Timeline

REPU has grown exponentially in these 10 years. Explore our evolution through this timeline. The numbers in each row represent the amount of REPU students in each category.



Closing remarks

Since its inception, back in 2007, the REPU program has been growing thanks to the help of many volunteers that devoted their time and effort to make the program what it is today. The last three years featured in this magazine are an example of this growth process that began with Abel Alcazar-Roman's vision of helping develop the scientific community in Peru. The program started with one branch, one REPU student, and one mentor. Now that REPU has turned 10, the program has 6 branches, 13 students (2017 cohort), 11 mentors, a community of more than 100 professionals all over the world, and a vision to continue growing and aid in the formation of the critical mass of scientist and professionals that Peru needs.

In these closing remarks, I would like to acknowledge two people that together with Abel were key to the success of the program in these 10 years, Sofia Espinoza, and Kenyi Saito. They were the first REPU students, and they are an example of the "REPU cycle". With the research experience gained in their internships, they applied and were admitted to prestigious graduate school programs, and soon after they took leadership positions within REPU and became mentors and co-directors of the program. They both successfully finish their Ph.D. studies and received their doctorate degrees, and transitioned to the REPU advisory board, the most senior position within REPU, with this transition they are completing the REPU cycle, and in this way, they helped and changed the lives of many Peruvian undergraduates, many of those who are now following their footsteps taking leadership positions not only in REPU but in other organizations that work in the development of Peru.

Succeeding Sofia and Kenyi in the position of co-directors, Margarete Diaz and Paola Moreno-Roman have joined the co-director team and have been successfully working in the program demonstrating their leadership, responsibility, and commitment to the REPU mission and vision. Margarete is a Ph.D. student at Harvard University in Developmental and Regenerative Biology, and Paola is a Ph.D. student at Stanford University in the Department of Cell Biology.

Working with the co-director team there is a group of passionate individuals working in different roles, people like Rossana Maguiña that designed, organized, and led the launch of EcoREPU; Omar Julca and Andres Guillen that re-structured, organized, and lead the admission process; Renzo Gutiérrez Loli that leads the communications team and spends countless hours replying messages, designing posters, posting information on social media, and much more; and many other people that work tirelessly behind the scenes to make the program work. All the growth in these 10 years was achieved thanks to the support of all the volunteers and collaborators. To all of you who gave your time and effort, THANKS you made the program successful.

Edson Bellido
REPU Co-Director
Postdoctoral Fellow - Botton Lab
McMaster University



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Patronato de la Universidad Nacional de Ingeniería

Vicerrectorado de Investigación y Facultad de Ciencias e Ingeniería - Pontificia Universidad Católica del Perú

Departamento de Ingeniería Electrónica - Universidad de Ingeniería y Tecnología





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