

"Engineering Multicellular Biocircuits:
Programming Cell-Cell Communication
Using PLASmids as WIRES"

A Synthetic Biology FP7 European research project

Plaswires Newsletter

September 2014



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SPECIAL POINTS OF INTEREST

- Multidisciplinary approach to synthetic biology
- Bacteria colonies as a processor
- Plaswires videos
- Meeting in Santander



**EUROPEAN
COMMISSION**

MULTIDISCIPLINARY

APPROACH TO

SYNTHETIC BIOLOGY

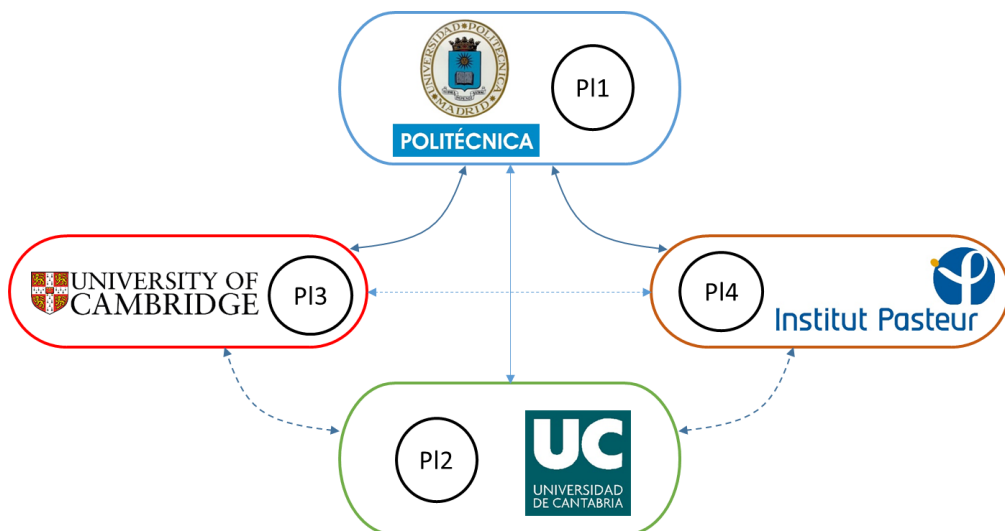
The Plaswires project, defined in the area of synthetic biology, has as one of its main objectives the formalization and systematization of conjugative plasmids as message and state handlers in bacteria colonies. Proper systematization will allow the use of plasmids as an engineering tool capable to cope with current challenges in society.

Dealing with synthetic biology is a complex process since there are several disciplines involved. Unlike other areas of knowledge where also needed cooperation among different disciplines, in synthetic biology all the disciplines are providing their latest findings so the knowledge handled is still not well established.

This means a big challenge for all the teams involved. Commonly the sharing of stable information among disciplines is complex so the sharing of cutting-edge knowledge really represents a challenge for itself. This can be a barrier for the development of synthetic biology. How can this barrier be overcome? Defining proper methods for systematization and formalization of communication and new findings in the synthetic biology area. However it is still needed a seamless sharing of knowledge among areas to build these methods. That is why a correct and precise consortium is needed.

The Plaswires consortium is a balanced group of teams with expertise, not only in specific fields of biology or engineering but also in the collaboration with teams of other disciplines. This trend to collaborate with other disciplines ease the initial sharing of knowledge needed to build a more robust and systematic communication methods.

THE TEAM

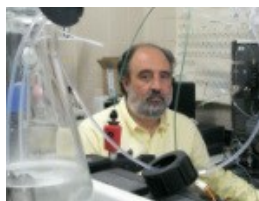


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PLASWIRES EXPLAINED TO... STUDENTS



So, can we use population of bacteria as cellular processors working in parallel?

Yes, because we can communicate them through different natural techniques (quorum sensing, conjugation, phages)

But those communication channels are very noisy...

Sure but we have a secret weapon for robustness in communications... Conjugative plasmids

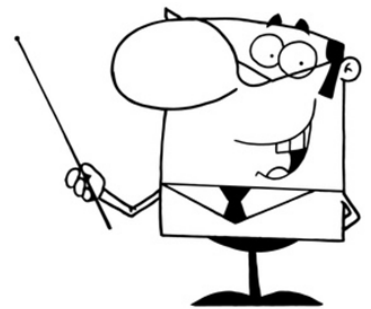
So you are pointing to we can perform parallel computation based on a population of bacteria and the use of conjugative plasmids as messaging platform between them. Don't we?

That is the idea!!!

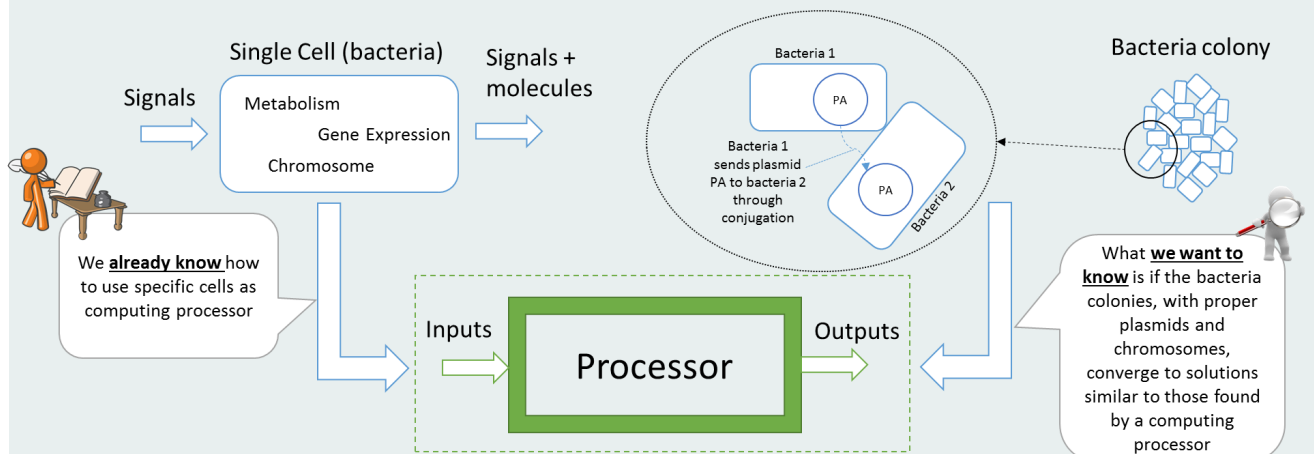
But... is it strong enough to be used as an engineering tool?. Can we use conjugative plasmids to develop functional distributed processors dealing with current challenges in synthetic biology and other fields as computer science?

Do you mean challenges such as complex genetic circuits, Programmable Logical Arrays or Programmable antibiotics?

Welcome to **PLASWIRES!!!**



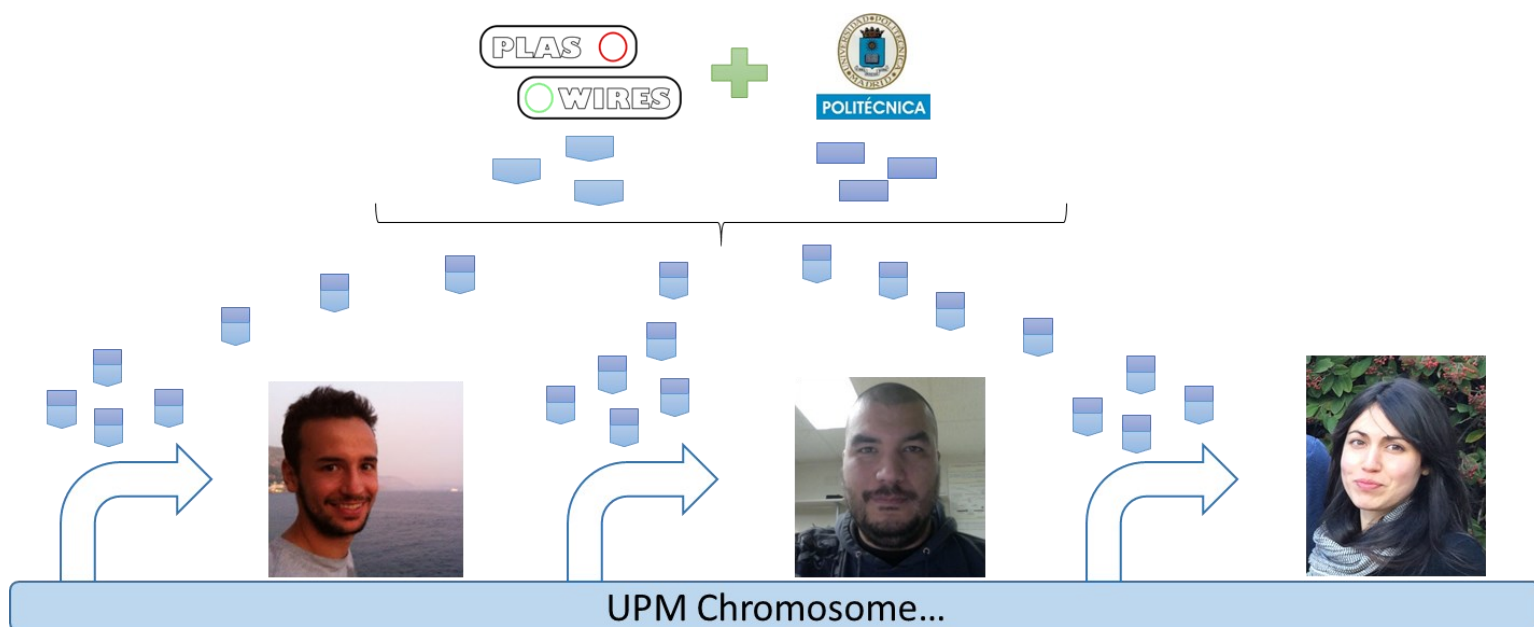
BACTERIA COLONIES AS A PROCESSOR





PHD STUDENTS IN PLASWIRES

Plaswires, as a cutting-edge project in synthetic biology, is oriented not only to achieve the proposed objectives but also to educate new researchers to continue and increase the knowledge of this multidisciplinary area as in apply this knowledge to current society challenges. In this sense all the teams come with Phd students that are a key part in the success of the project. In this issue the Phd students from UPM are presented.



GUILLERMO PÉREZ DEL PULGAR FROWEIN

Guillermo Pérez del Pulgar has been already pursuing his Phd for three years in LIA. He holds a Physics degree and a Biophysics Master in Universidad Autónoma de Madrid. Currently he is completely enrolled in PLASWIRES working on the modelling, analysis and redesigning tasks.

Since his arrival to the lab he has been interested and implicated in former projects people from the LIA were involved. Many of these projects ended in PLASWIRES and they now belong to a great team of researchers with the same aim of developing complex and distributed bacterial computations. He is especially proud of being part of that process.

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MARTÍN GUTIERREZ

Martín Gutiérrez is a PhD student at LIA-UPM and an Assistant Professor of Computer Science at UDP, Chile. He holds an Industrial Engineer degree from Pontificia Universidad Católica de Chile and a Masters degree in Engineering from the same university.

His research interests lie in Artificial Intelligence, Computer Science and Synthetic Biology. He is currently working in EU FP7 project PLASWIRES with the LIA team and is mainly involved in working with the GRO simulator, multicellular distributed genetic circuits and their implementation in GRO.

PAULA GREGORIO

Paula Gregorio is a PhD student at LIA-UPM. She has a degree on Physics from the Universidad Autónoma de Madrid (UAM) and a Masters degree in Biophysics from the same university.

She has experience in molecular biology and has worked with the Systems biology group at UAM. Her research interests are mainly Systems and Synthetic Biology and she is currently working in EU FP7 project PLASWIRES with the LIA team in the design of novel genetic circuits and the theoretical study of plasmid-plasmid interactions

DISSEMINATION (I)

PAPERS

Since Plaswires just completed the first year there is not specific published papers presenting the partial results. However all the team are working in their áreas getting a deeper understanding that will be useful for plaswires. In this sense some of the partners have published recently research works related with plaswires. In this issue we present two of the most significative in 2014.

A Computational Method for Automated Characterization of Genetic Components

Boyan Yordanov [†], Neil Dalchau [†], Paul K. Grant ^{†‡}, Michael Pedersen ^{†‡}, Stephen Emmott [†], Jim Haseloff [‡], and Andrew Phillips ^{*†}

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ABSTRACT

The ability to design and construct synthetic biological systems with predictable behavior could enable significant advances in medical treatment, agricultural sustainability, and bioenergy production. However, to reach a stage where such systems can be reliably designed from biological components, integrated experimental and computational techniques that enable robust component characterization are needed. In this paper we present a computational method for the automated characterization of genetic components. Our method exploits a recently developed multichannel experimental protocol and integrates bacterial growth modeling, Bayesian parameter estimation, and model selection, together with data processing steps that are amenable to automation. We implement the method within the Genetic Engineering of Cells modeling and design environment, which enables both characterization and design to be integrated within a common software framework. To demonstrate the application of the method, we quantitatively characterize a synthetic receiver device that responds to the 3-oxohexanoyl-homoserine lactone signal, across a range of experimental conditions.

Plasmid Conjugation from Proteobacteria as Evidence for the Origin of Xenologous Genes in Cyanobacteria

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b) Departamento de Ingeniería Genética CINVESTAV-Irapuato, Irapuato, Guanajuato, Mexico

c) Institut Cavanilles de Biodiversitat i Biologia Evolutiva, Universitat de Valencia, Valencia, Spain

ABSTRACT

Comparative genomics have shown that 5% of *Synechococcus elongatus* PCC 7942 genes are of probable proteobacterial origin. To investigate the role of interphylum conjugation in cyanobacterial gene acquisition, we tested the ability of a set of prototype proteobacterial conjugative plasmids (RP4, pKM101, R388, R64, and F) to transfer DNA from *Escherichia coli* to *S. elongatus*. A series of Bio-Brick-compatible, mobilizable shuttle vectors was developed. These vectors were based on the putative origin of replication of the *Synechococcus* resident plasmid pANL. Not only broad-host-range plasmids, such as RP4 and R388, but also narrower-host-range plasmids, such as pKM101, all encoding MPFT-type IV secretion systems, were able to transfer plasmid DNA from *E. coli* to *S. elongatus* by conjugation. Neither MPFF nor MPFI could be used as interphylum DNA delivery agents. Reciprocally, pANL-derived cointegrates could be introduced in *E. coli* by electroporation, where they conferred a functional phenotype. These results suggest the existence of potentially ample channels of gene flow between proteobacteria and cyanobacteria and point to MPFT-based interphylum conjugation as a potential mechanism to explain the proteobacterial origin of a majority of *S. elongatus* xenologous genes.

DISSEMINATION (II)

VIDEOS

Plaswires vision from the leaders of the teams: <http://www.plaswires.eu/partners.html>



PRESENTATIONS AND OPEN TALKS

Teaching and general divulgation resources related with synthetic biology from computer engineering point of view:

<http://www.lia.upm.es/index.php/intro-to-syn-bio>

Programmable Biology
18 FAQs on Synthetic Biology of a computer scientist

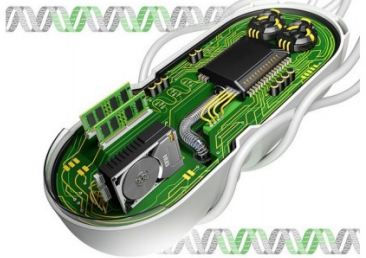


Image Courtesy of Liang Zong and Yan Liang

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Universidad Diego Portales
Santiago de Chile, 12/11/2013

DISSEMINATION (III)

PLASWIRES ON UPM (TECHNICAL UNIVERSITY OF MADRID) JOURNAL

URL: <http://www.upm.es/sfs/Rectorado/>

Gabinete%20del%20Rector/Revista%20UPM/NUMERO_28_ver.pdf

English translation available at: <http://www.plaswires.eu/publications.html>



From Revista UPM, June 2014, n. 28

<http://www.upm.es/institucional/UPM/CanalUPM/Revista>

Translation to English of the original report included in the UPM Journal n. 28, June 2014. Translation done by Esther Pozuelo de Prada.

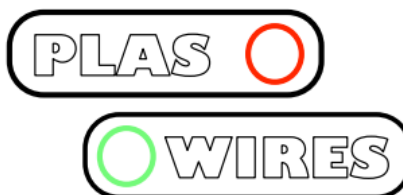
Biocircuits to program cell-cell communications

UPM researchers coordinate PLASWIRES, a European Synthetic Biology project whose objective is to program and build multicellular genetic circuits executed in live bacterial colonies.

How is a genetic circuit being programmed? Is it possible to transfer genetic programs between bacteria? Can bacteria do the work of an engineer? The PLASWIRES project tries to answer these and other issues; it is a European initiative aiming to design and carry out different genetic programs in bacteria and to establish an interbacterial communication protocol.

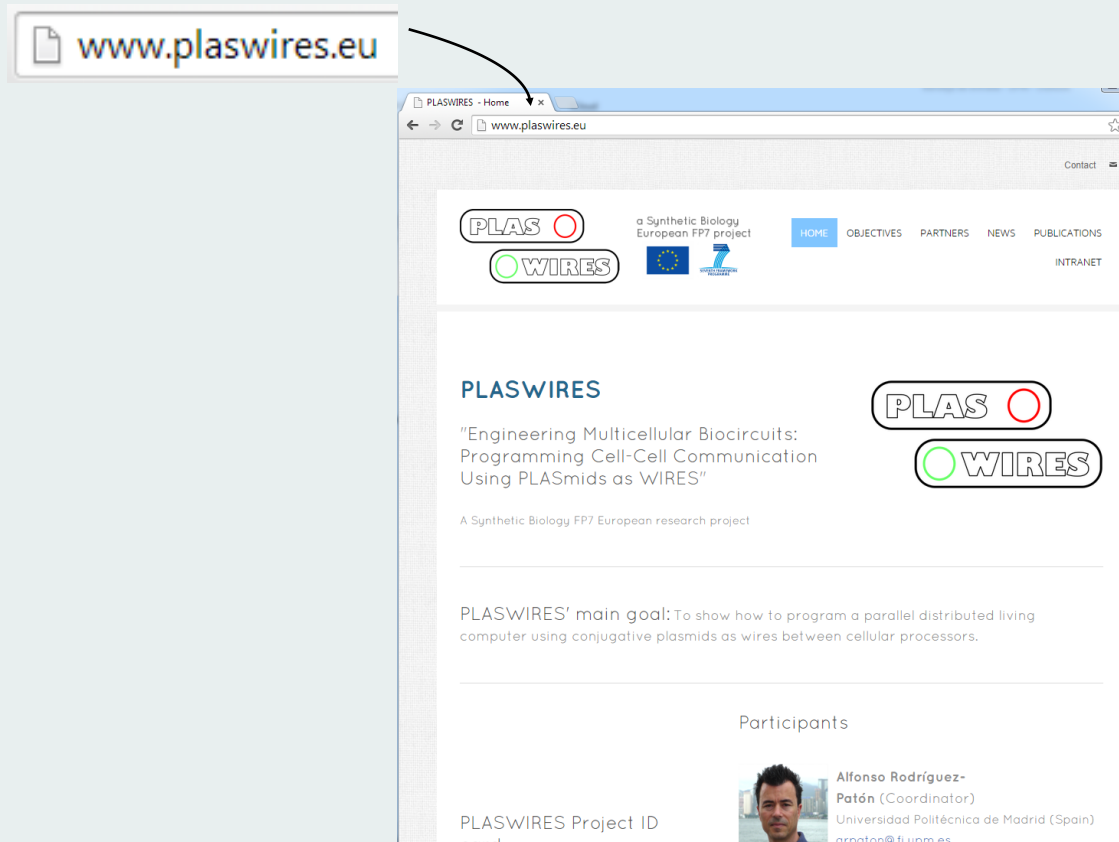
"This basic research project will have multiple potential applications in biomedicine, biotechnology or, for instance, in the development of antibiotics", Alfonso Rodríguez-Patón, professor at the Escuela Técnica Superior de Ingenieros Informáticos and project coordinator, explains.

The work fits into the European Union's seventh Framework Programme, in the FET Evolving Living Technologies Area. With interdisciplinary character, it is supported by funding of over two million and a half Euros and three-year duration. Along with the UPM, it involves researchers from the University of Cambridge, the Pasteur Institute and the Universidad de Cantabria.



DISSEMINATION (III)

VISIT PLASWIRES WEBSITE



OPENPLANT INITIATIVE

Haseloff Lab (University of Cambridge) is one of the partners of the openplant initiative. Openplant is called to be a reference entity for innovation and training in plant synthetic biology.



GETTING TOGETHER IN SANTANDER

Plaswires has finished the first year!. The project teams gathered in Santander (Spain) to share the conclusions of the first year and discuss about partial results and the strategy for the next years.

The meeting had a good atmosphere among researchers and supposed a proper environment to learn from each other, exchange ideas and improve the understanding of the methods and difficulties performed by the teams.

All teams presented their partial results and the difficulties they faced to reach those results.



*“A knotty puzzle may hold a scientist up for a century, when it may be that a colleague has the solution already and is not even aware of the puzzle that it might solve”.
Isaac Asimov (The robots of dawn)*



PLASWIRES CONTACT INFORMATION

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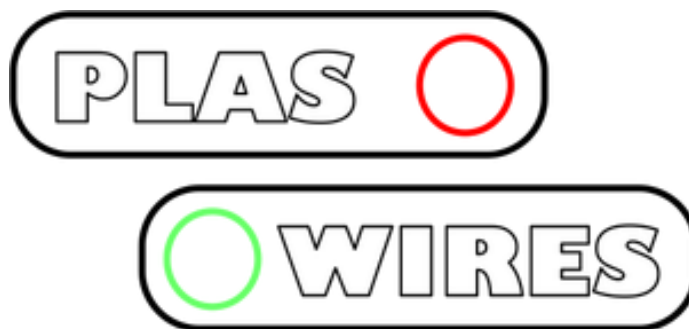
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