ERANet LAC

PROJECT
1st ERANet-LAC Joint Call

ERANet LAC

SUSTAINABLE DEVELOPMENT

Project acronym: **SCREAM**

Project title: Screening marine microalgae and ; in search of novel compounds of potential medicinal and other industrial values

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Project Duration: from (12/05/2016) to (13/05/2016)

1.1 Publishable summary

The project entitled "Screening marine microalgae and terrestrial bacteria; in search of novel compounds of potential medicinal and other industrial values- SCREAM" will generate a transnational long-term research co- operation platform within the EU-Latin America Programme between Norway (The Norwegian Institute for Agricultural and Environmental Research-, Bioforsk), Chile (Fraunhofer Chile Research-, FCR), Romania (SC PROPLANTA SR) and Peru (Universidad Peruana Cayetano Heredia, UPCH).

The project aims at identifying compounds produced by marine microalgae and terrestrial bacteria, with high value for industrial use. More specifically, the project will search for compounds that can be used for cancer treatments and food production through extensive interactions between the four partners and optimal use of each participant´s expertise and experience.

The expected results includes identification of novel cancer inhibiting metabolites from microalgae and bacteria, more specifically metabolites with ability to regulate cancer cell proliferation and/or invasion. Identification of compounds suitable for use in food products which are produced in large amounts by microalgae, such as carotenoids, PUFAs, vitamins and other antioxidants in addition to the potential of finding new metabolites with useful effects. Furthermore, SCREAM aims at pinpointing the mechanisms and metabolic pathways involved in production of the selected novel metabolites. The novelty of SCREAM derives from a number of original and innovative activities that will undoubtedly lead to a number of innovations within cancer research and functional food with the potential for further exploitation.

This highly innovative project has great economic potential, which will be demonstrated through economic analysis of the products and production process. The commercialisation potential will be carefully evaluated through market analysis taking into account technological, economic and legal aspects.

Project acronym: **CAVICE**

Project title: Cave ice microbiom: metabolic diversity and activity in response to climate dynamics and anthropogenic pollution

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Project Duration: from (06/01/2016) to (31/12/2018)

Project website address (if applicable):
www.ibiol.ro/proiecte/Cavice/index.htm

1.1 Publishable summary

The overall interest of the project is to characterize the diversity and metabolism of total and active microcosm from cave ice, and evaluate past, present and future consequences of climate driven ice retreat and human impact on biogeochemical and ecological processes by studying temporal and spatial changes in ecosystems present in ice and glacier caves from different geographical locations, and to establish a strategic framework for multidisciplinary research in ice ecosystems, including investigation of the applicative potential of ice microcosm in nanotechnology development.

The goals of the project are i) the first characterization of the functional diversity and activity of a cave ice microbiome using metagenomic and metatranscriptomic Next Generation Sequencing, ii) to assess the impact of climate dynamics and anthropogenic pollution on microbial communities preserved in this particular glacier environment, and iii) to identify novel cold adapted metal nanoparticle producing strains for bionantotechnologies.

The project started in 2016 and accomplished the main objectives and activities emphasized for this period. Ice samples were collected from the Europe and South American locations, including the glacier caves from Argentina (Viedma Glacier) and Chile (Grey Glacier), and the from the ice caves from Norway (Svarthammar), Romania (Scărişoara) and Slovakia (Dobšinská and Demänovska) with the participation of all the consortium teams. Physicochemical and geochemical analyses were carried out on Scărişoara ice of up to 2000 years old. Recent climate analysis of Scărişoara was initiated and carried out by long-term monitoring of water isotopic composition outside and inside the cave. Samples from the ice block of Svarthammar were collected for stable isotope analyses (432) and for 14C dating (14). Microbial DNA was extracted from the ice samples collected from all locations for determining the bacterial diversity; for Svarthammar ice samples, this step will be carried out in January 2017 with the participation of a Master student from the Romanian IBB partner in Norway UoB laboratory. Illumina sequencing of 16S rDNA was performed for samples collected from Grey Glacier dominated by Firmicutes and Bacteroidetes, while 454 pyrosequencing of five ice samples of Scarisoara showed the presence of Proteobacteria, Firmicutes and Actinobacteria in ice of up to 900 years old, a high representation of Bacteroidetes and Cyanobacteria in recent ice exposed to light, and the presence of Archaea in 400 and 900 years old ice. Shotgun metagenomics sequencing of 7 ice samples of up to 2000 years old from Scarisoara cave is in progress. Bacterial cultures and isolated colonies were obtained from Scarisoara ice cave and Grey Glacier ice samples and their identification based on 16S rDNA is currently underway.

Two CAVICE kick-off meetings were organized in Argentina and Slovenia, respectively, to ensure the participation of all the European and Latin American consortium partners for discussing a series of scientific and management collaborative aspects. CAVICE results were presented in three conferences (4 oral presentations and 4 posters), with the participation of members of 4 of the consortium partners.

This project is expected to provide pioneering knowledge on cave ice microcosm reflected in a better understanding of how the ice microbiomes mirrors the past and actual climate changes and the anthropogenic activities. We appreciate that this study will contribute to the knowledge for predicting the dynamics and evolution of the ice microbiomes in relation with the climatic patterns and anthropogenic pollution. Identification of pollution biomarkers would ease the monitoring activities, being of great help for the caves administrations in their effort to better preserve these unique sites. The novel cold adapted microorganisms able to synthesize metal nanoparticles that we attempt to identify are of broad applicative potential in nanotechnologies and medicine. This interdisciplinary project brings together specialists from various fields of Life Sciences, thus ensuring the improvement of the scientific level of the participating teams, and favoring further joint applications. Moreover, the project contributes to the formation of top-rank young scientists through an excellent training of the participant Master students and PhD students.

Project acronym: **METHANOBASE**

Project title: METHANOgenic Biodiversity and activity in Arctic, subarctic and Subantarctic Ecosystems affected by climate change

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Project Duration: from (01/11/2015) to (31/10/2018)

Project website address (if applicable): Website under construction, working version available at: http://maialenbarret.wixsite.com/methanobase

1.1 Publishable summary

Methane emissions from aquatic and terrestrial ecosystems play a crucial role in global warming, which is particularly affecting high-latitude ecosystems. As major contributors to methane emissions in natural environments, the microbial communities involved in methane production and oxidation deserve a special attention. Microbial diversity and activity are expected to be strongly affected by the, already observed (and further predicted), temperature increase in high-latitude ecosystems, eventually resulting in disrupted feedback methane emissions.

The METHANOBASE project has been designed to investigate the intricate relations between microbial diversity and methane emissions in Arctic, Subarctic and Subantarctic ecosystems, under natural (baseline) conditions and in response to simulated temperature increments. To achieve this highly challenging purpose, the METHANOBASE project relies on the use of state-of-the-art molecular tools and on a multidisciplinary team including experts from Europe (France, Belgium, Norway) and South America (Chile, Uruguay), as well as local partners in Siberia, Alaska and Patagonia for field expedition support. The project was designed to achieve the following specific objectives:

- To survey the baseline biodiversity and function potentialities of microbial communities involved in methane emissions in unexplored high-latitude ecosystems
- To establish the link between the methane-linked microbial community structure, the local environmental conditions and the in situ methane emission rates
- To compare the methane-linked microbial ecosystems from Arctic, Subarctic and Subantarctic ecosystems
- To assess the impact of projected global warming on microbial diversity and methane production/ oxidation activities
- To identify sentinel/indicator species, exhibiting critical response to global change

During the first year, the METHANOBASE consortium was mostly dedicated to field work. Three field campaigns were successfully conducted in Patagonia (Chile), Alaska (United States of America) and Siberia (Russia). A total number of 56 ecosystems were investigated, including lake, peatland and soil ecosystems. Methane emissions as well as several physico-chemical parameters (eg pH, temperature, dissolved gases) were monitored in situ, while methanotrophic rates (methane oxidation rates) were quantified on site (i.e., in laboratories located close to the ecosystems). Almost 500 samples were collected for further characterization, which is mostly in progress. The extended characterization of samples encompasses DNA extraction and high-throughput sequencing to assess the Bacteria and Archaea biodiversity, physico-chemical analyses, methanotrophic and methanogenic incubations at different temperatures to mimic climate change, and a meta-omic approach for a selected subset of samples.

METHANOBASE is expected to give insights into the scientific knowledge of the methane-linked biodiversity and into the understanding of the biodiversity-function link in the context of global change. The results will help to better understand the potential effect of global warming on microbial methane production, and its potential feedback on global changes. The experimental data generated both on the field and in the lab can subsequently be used as inputs of local to mesoscale models of emission simulation, in order to improve the accuracy of methane emission predictions in the context of global changes.

Project acronym: **AMAZONFISH**

Project title: Amazonian fishes and climate Change

Project Duration: from (09/11/2015) to (08/11/2018)

Project website address (if applicable): www.amazon-fish.com

1.1 Publishable summary

The Amazon basin concentrates the highest freshwater biodiversity on earth. This is especially true for fishes, which, with around 2,300 species recognized, represent around 15% of all freshwater fishes described worldwide. The processes having generated this highly diverse fish fauna are incompletely understood, while there is evidence that the structure and function of Amazonian freshwater ecosystems are being increasingly impacted by rapid expansions in infrastructure and economic activities. Climate change will probably amplify these disturbances. However, until now, there is no comprehensive database available that could help to develop regional conservation programs and contribute to large scales ecosystem management.

The project officially started on November 2015 for a three years period. The AMAZONFISH consortium comprises institutions with extensive experience and international recognition, complementary expertise and interests, and strategic aims in the field of Amazonian fish biodiversity (see website consortium page: *www.amazon---fish.com/consortium*).

AMAZONFISH aims to build a high quality freshwater fish biodiversity database for the entire Amazon drainage basin. This is done by mobilizing and integrating all information available in published articles, books, grey literature, online databases, foreign and national museums and universities and by checking for systematic reliability and consistency for each species recorded. At this time the database includes more than 10,000 sampled sites and 2250 valid species (Figure 1). A Geographic Information System (GIS) including all environmental factors meaningful in explaining fish species distribution has been linked to this biological database and basin---wide biogeographic analyses are currently performed using species range distribution, overall species richness, endemism and beta diversity descriptors. This will allow, amongst other things, describing the patterns of biodiversity and discussing the potential processes generating these patterns, defining degrees of irreplaceability and representativeness of the different communities (i.e. “hotspots”) and projecting potential changes in community structure due to future global changes.

By generating a high quality freshwater fish biodiversity database, describing the patterns of biodiversity and discussing the potential processes generating these patterns, defining biodiversity hotspots and projecting future trends in community structure the project AMAZONFISH will help developing regional conservation programs and contribute to large scales transnational ecosystem management.

ERANet LAC

INDUSTRIAL DEVELOPMENT

Project acronym: **GREENBIOREFINERY**

Project title: Processing of brewery wastes with microalgae for producing valuable compounds

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Project Duration: from (01/10/2015) to (30/09/2018)

1.1 Publishable summary

GREENBIOREFINERY is focused to develop new strategies to generate valuable bioproducts by integrating the treatment of brewery wastes with the production of microalgae biomass and derivate products. This integration allow transforming the wastes from breweries into valuable biomass, thus not only reducing the environmental impact of breweries activities but also recovering nutrients contained on these wastes, and producing valuable compounds.

To achieve this goal, the first task has been to characterize wastes (liquids and gases) generated from breweries located in countries of partners involved into the project (Spain, Portugal, Colombia and Argentina). Results confirm that in spite to be the same industry, the distinct operation schemes used by the different industries produce diverse effluents with large changes into its composition. Focusing in liquid wastes the Chemical Oxygen Demand (COD) values ranged from 241 to 40520 mg/L, whereas the nitrogen (N) and phosphorous (P) concentration values ranged from 23 to 1238 and from 15 to 95 mg/L, respectively. All of them are higher than limits defined by EU directive (COD/N/P below 100/10/2) thus additional treatments being necessary prior to release the water to the environment. Most of the companies perform this treatment out of the brewery in agreement with wastewater treatment plants, thus this treatment representing a relevant cost for the brewery because large volumes of liquid wastes have to be treated, from 100 to 2500 t/month. According to the performed analysis all the effluents analysed contains enough nutrients (C/N/P) to be used for the production of microalgae, thus from 0.5 up to 14 kg of biomass can be produced per cubic meter of liquid effluent. Considering a minimum value of the biomass of 1 €/kg (actual price of microalgae biomass worldwide exceeds 5 €/kg) to integrate microalgae biomass production schemes into breweries allow to minimize the release of valuable nutrients at the same time that increasing the profitability and sustainability of breweries.

Experiments have been performed at laboratory scale but simulating outdoor real conditions, with different microalgae strains, using identified wastes as culture medium. Robust strain as *Scenedesmus* and *Chlorella* habitually used in wastewater treatment schemes were used, in addition to high potential strains as *Botryococcus* and Euglena, but also new strains with large lipids contents as *Neochloris*, and the most largely produced strain in worldwide as Spirulina. Results demonstrate that all the tested strains can be produced in brewery wastes the major factor determining the operation and performance of the system being the composition of the waste instead the microalgae strain. COD was the major factor influencing the performance of the systems, the lower the COD content the better was the performance of microalgae cultures and the quality of final biomass

produced. When the COD is excessive (upper than 1000 mg/L) the growth of bacteria is enhanced whereas the growth of microalgae is reduced, by excess of turbidity into the culture medium. At these conditions large hydraulic retention times (larger than 5-7 days) are requested to remove the COD and produce valuable microalgae biomass containing low proportion of bacteria (lower than 25%). In front, when the COD is low (lower than 1000 mg/L) the growth of bacteria is limited the performance of microalgae being maximal if enough light is provided. At these conditions the hydraulic retention time can be largely reduced (up to 1-3 days) thus increasing the treatment capacity at the same time that removing all the contaminants (N/P) from the waste, and producing high quality microalgae biomass containing less than 5% of bacteria.

Microalgae biomass produced from brewery wastes is being used to produce biofertilizers by enzymatic hydrolysis as main valorisation route, but also alternatives uses as to produce biofuels as BioHydrogen through dark fermentation with *Enterobacter aerogenes*, and of bio-oil through pyrolysis are being studied. All of them demonstrated to be feasible now the optimal schemes being evaluated to compare the best alternative to be validated at pilot scale.

Project acronym: **SUMO**

Project title: Sustainable Use of biomass from Oleaginous processing

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Project Duration: from (01/12/2015) to (30/11/2017)

Project website address (if applicable): http://www.sumo-project.eu/

1.1 Publishable summary

The SUMO project aim has been to develop sustainable solutions and valorization alternatives for lignocellulosic by-products generated during rapeseed and olive oil processing. The consortium is composed by six partners with special interest due to the relevance of these products for the economy of the agri-food sector in their respective countries. The valorisation routes developed comprise the use of the biomass and its components in food, feed, cosmetics, agronomy and energy. Thus, the partners have complementary knowledge on the sector and previous experience in oilseed processing, phytochemicals extraction, oil extraction, microalgae production, food and cosmetic applications, feed formulation and supplementation, composting and energetic valorization: anaerobic digestion for biogas production, fermentative processes for biofuel production, gasification and pyrolysis.

The general obtained result has been the design and proposal of several alternatives of bio-refinery processes adaptable to the current biomass processing and consumption sites in the different scenarios of the participating Countries. The alternatives intend to be flexible enough to process vegetable processing by-products and find synergies with other complementary wastes generated in the nearby.

With a duration of two years, the main expected results of SUMO project are: the reduction of the environmental impact generated by the oleaginous processing sector; an improvement of the competitiveness of the industrial sector; the development of new high added-value products for food, feed and cosmetics sectors (at least 10 different end products have been developed); a waste reduction and the fulfilment and implementation of environmental regulations in waste management and renewable energies in the participating Countries.

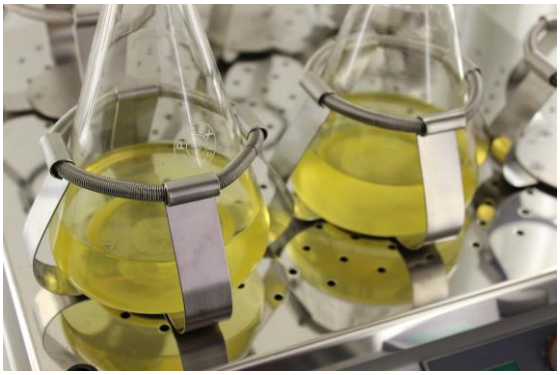
The project has been structured in Five Work Packages (WP) that encompass all key issues. The objective of WP1 was to make a detailed inventory and characterization of the by-products from rapeseed and olive oil production, a description of the current situation in the partner countries: process types, the by-products management types, existing valorization routes, regional initiatives, legislative aspects and the identification of stakeholders for innovative valorization opportunities. Meanwhile, the objective of the analytical and experimental work in WP2 “Development of valorization approaches” was the development of different complementary valorization routes, as well as the characterization of the processes and obtained products, to obtain valuable information about the technical feasibility of the proposed bio-refinery processes. As a result, 9 different protocols have been assayed and 10 assorted products obtained from olive pomace: olive polyphenols, microalgae biomass, feed formulations, biogas, biobutanol, biochar, briquettes for combustion and compost, as well as

lipophilic extracts from rapeseed cake and an aquafeed feed formulation with the exhausted rapeseed cake.

During the WP3, each partner has developed a Case Study, a practical example of the potential application of the technologies developed during the project in a scenario representative of their Country. Each of 6 case studies presents an analysis of the economic, legal, and environmental feasibility of the most promising of the proposed technologies; the definition of the conditions for the implementation of the valorization protocols and the possibilities of extrapolation to other production sites or scenarios.

The WP4 objective was the dissemination and communication of the project, its progress and results, where many actions have already been carried out (webpage, brochure, 4 project newsletters, …). 6 dissemination sectorial workshops were organized at national level, one per partner and country, with the participation of the other partners, to communicate the results and get the feedback of the local industrials and other stakeholders. Several congress conferences and posters, seminars, technical and scientific papers have resulted from this activity and other are now in preparation.

Finally, the WP5 was dedicated to “Project Management”: the administrative management, consortium coordination & technical meetings and technical reporting.



Project acronym: **CELLULOSESYNTHECH**

Project title: Integrated valorization of lignocellulosic agroindustrial waste to furan based building blocks

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Project Duration: from (01/01/2015) to (01/01/2018)

Project website address (if applicable):

1.1 Publishable summary

This proposal aims to build an integrated platform for the valorization of lignocellulosic agroindustrial waste to furan based building blocks via the discovery of efficient transformation of pentoses (mainly xylose) and hexoses (mainly glucose) to furfural, HMF, and HMF analogs by more efficient and competitive catalyzed technologies. In addition, new advanced furanbased intermediates will be developed, to create more structurally complex target molecules.

Our planet's fossil raw materials are irreversibly diminishing, and the progressive switch of chemical industry to renewable feedstock appears as an unavoidable requirement. Although the chemical community starts being aware of the above problem, production of organic chemicals from renewable feedstock is at the moment far from being technically optimized. Biomass is significantly more multifaceted than fossil raw materials, and constitutes a complex blend of low and high molecular weight products. Furfural (F), readily obtained by cyclodehydration of naturallyoccuring pentosans, appears to be the only unsaturated largevolume organic chemical prepared from biomass. In this line, the furan analog 5 (hydroxymethyl)furfural (HMF) derived from hexoses is considered to be one promising biorenewable building block for the production of polymer monomers and other chemical commodities.

Project acronym: **BIO-FESS**

Project title: Biorefinery for the Production of Lowand HighGrade Activated Carbon from forestry wastes, maize residues and biogas digestate

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Project Duration: from (01/01/2015) to (01/01/2018)

Project website address (if applicable):

1.1 Publishable summary

Waste management of biomass has become a critical issue in terms of global warming and contamination of Earth resources. The slash and burn of maize wastes or the uncontrolled burning of forestry wastes cause wildfires, smog and greenhouse gases. Another problem is the proper digestate handling from biogas plants. This biomass has a very high water content, which reduces dramatically the energetic efficiency of incineration plants when burned. Also, the amount produced is too high to use it as organic fertilizer.

A biorefinery is proposed in this project that will take advantage of these lowcost materials to produce high quality activated carbon (AC). AC is used in a many applications that require high surface areas. Lowgrade activated carbon (LGAC) is used as adsorbent of impurities in liquid or gaseous media and as carbon molecular sieve to recover methane (CH4) from biogas. Highgrade activated carbons (HGAC) can replace expensive nanomaterials in energy storage systems like supercapacitors. This project will concentrate on these three applications. The AC production will occur in two stages: carbonization and activation. For the first one, maize and forest residues will be pyrolyzed and the biogas digestate will be pretreated with hydrothermal carbonization (HTC). The activation process will depend on the preferred type of AC: physical activation for LGAC and chemical activation for HGAC. The energy demand of the biorefinery will be partially covered from electricity produced from burning the pyrolysis gases and the methane from the biogas process. The production of LGACs and HGACs from biomass residues in a selfsustainable biorefinery is an ecological way to produce high-quality and technologically relevant material without impairing the food production or polluting the environment.

ERANet LAC

ENERGY

Project acronym: **INDuGRID**

Project title: Efficient energy management in industrial microgrids with high penetration of PV technology

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Project Duration: from (01/09/2015) to (31/08/2018)

Project website address (if applicable): www.industrialmicrogrid.org

1.1 Publishable summary

The main objective of this proposal is the introduction of innovative solutions to the improvement of energy efficiency in industrial environments. To this end, electronically coupled electrical microgrids with high penetration of PV technology and energy storage systems will be studied, designed and deployed.

Until today, different architectures of electrical microgrids for small and medium-sized industries have been analysed. Special attention has been given to the dimensioning of micro-grid components, including PV installations and energy storage devices. The communication system has also been analysed and, in particular, the impact of communication properties (such as delays, packet loss …) on the microgrid operation has been evaluated.

These studies have led to the development of control and management tools to operate industrial microgrids in both grid-connected and islanded modes, thus facilitating the exploitation of local PV production and storage capacity. The smooth transition between these operating modes has been achieved with the use of a communication-based phase-locked loop (comm-PLL).

From now on, the tasks of the project will focus on applying the concept of zero net energy in industries and, specifically, in the powering of heating and cooling industrial processes by means of solar technologies in factories buildings and offices. In addition, other tasks of the project will focus on improving the power quality in industrial microgrids with zero-carbon energy systems. The most significant impact is expected in the reduction of amplitude deviations, voltage unbalance and harmonics.

The benefits of the expected results will facilitate the resolution of problems related to energy efficiency in small and medium-sized industries. The improvements will have a positive impact on energy costs and reliability. The advanced solutions could be extended in future projects to solve social problems in commercial and residential urban areas. The application to rural areas is also a topic of great interest.

More information on this project can be found on the website *www.industrialmicrogrid.org*. A public area is devoted in the website to dissemination purposes. In this area, the results and advances are described in a language accessible to non-expert readers.

Project acronym: **SMIBIO**

Project title: SMALL SCALE SELF-SUSTAINABLE BIOREFINERIES

Project Duration: from (01/11/2015) to (31/10/2018)

Project website address (if applicable): www.smibio.net.

1.1 Publishable summary

Development of modular small-scale integrated biorefineries to produce an optimal range of bioproducts from a variety of rural agricultural and groindustrial resudues / wastes with a minimum consumption of fossile energy

The aim of this project is to study technical economic and environmental viability of small scale integrated biorefinery units capable of processing different kinds of biomass produced in short radius catchments rural and small urban areas, both in Europe and in CELAC. Two different biorefinery platforms will be simulated under a wide range of dry and wet feedstocks: Lignocellulosic biorefinery for ethanol, sugars and lignin for further biological/chemical conversion and wet biomass for biogas through anaerobic digestion. The synergies of combining both platforms will be evaluated. The project shall develop appropriate general tools and methods to properly assess and optimize the technoeconomic viability (IRR, NPV and production costs) in a sustainable environmental assessment (LCA) including the social impacts (improvement in living conditions, job creation and new opportunities for rural development identification) for any smallscale integrated biorefinery. These economical and sustainability impacts will be validated for different real business case studies both in EU and LAC regions.

SMIBIO is a three-year research project funded by the first ERANet-LAC Joint call. The aim of the project is to study the techno-economic and environmental viability of small scale integrated biorefinery units capable of processing different kinds of biomass produced in short radius catchments of rural and small urban areas, both in Europe and in LAC countries.

The project focuses on modelling five case studies under proper and real conditions, considering optimal processing of local biomass in each selected region (two in Europe and two in LA). Biorefinery concepts to be developed are highly integrated energy efficient complexes, incorporating individual processes that synergistically convert different biomass feedstocks (dry and wet) into power, biofuels and value added chemicals and biomaterials by the integration of various technologies for the efficient production of a portfolio of bio-based products.

This deliverable describes the four biorefinery concepts, agreed upon by the whole consortium that will be analyzed under proper and real conditions. Furthermore, as it was decided at the kickoff meeting, an additional case study based on residues generated in the Colombian coffee industry will be analyzed. The selection of base case areas was made considering different biomass availability in Europe and Latin America and market needs for bioproducts selection. The Case Studies are based on real available biomass in the radius of maximum 50 km from the particular place in the given country. Each biorefinery concept involves both Lignocellulosic

Biomass (LC) and Anaerobic Digestion (AD) platforms. The techno-economic and environmental assessments of the five biorefinery concepts will be developed using available modelling tools such as ASPEN software and will be based on material and energy flow balances obtained by modelling the whole value chain from biomass supply to bioproducts production.

Project acronym: **WINNER**

Project title: SMART WINDOWS FOR ZERO CARBON ENERGY BUILDINGS

Project Duration: from (01/09/2015) to (31/08/2017)

1.1 Publishable summary

There is an urgent need for sustainable and efficient usage of energy in buildings, which currently accounts for 40% of the world's energy consumption. In Europe, directives have been established to improve energy efficiency and to ensure that all new buildings are nearly zero energy buildings (NZEB). In Latin American and Caribbean (LAC) countries, this is also a top priority and policies are being enforced to implement incentives for renewable energies and promote energy efficiency. WINNER aims to contribute to these ambitious and important goals by developing an innovative smart window system capable of generating energy for self-consumption at the same time as filtering out part of the IR radiation incident on the building, therefore reducing the energy demands for air conditioning, especially in hot climates.

In this context, the main objective of the project is to develop an innovative building-integrated photovoltaic system based on smart windows. By introducing suitable nanoparticles on façade surfaces receiving direct sunlight it is possible to build luminescent solar concentrators (LSC), which, on one hand, down-shift the solar spectrum towards the range where the solar cells have an optimal response, and, on the other hand, are able to redirect part of the incident light to the windowpane perimeter, therefore reducing the amount of radiation on the surface and contributing to the smart climatization of the building.

During the first half of the project, an extensive state-of-the-art review of materials to produce a luminescent solar concentrator (LSC) was performed. An initial selection of materials was done considering the requirements of: (i) matching the emission wavelength to the spectral peak of the external quantum efficiency (EQE) of the side-mounted PV cells; (ii) provide adequate colour and degree of transparency, which are determined by the type and density of luminophores and the properties of the supporting polymeric medium; (iii) have high efficiency and stability; (iv) enable adequate processability with up-scalable techniques. In parallel, materials deposition technologies were also analysed and several technologies were selected as the most appropriate and able to ensure both low-cost/high productivity and high performance of the LCS prototypes: (i) ultrasonic spray, doctor-blade (knife-coating) and (ii) polymer multilayer (PML). An initial optimisation of process parameters was conducted.

In parallel with the development of the LSC, the design of the smart window was completed. Taking into account market trends and smart functionality of the window, a conceptual design was developed and agreed among all project partners. The design considered thermal, acoustic, ergonomic and luminosity aspects. The smart window was decided to integrate not only the PV cells on the window frame, but also all the basic electronic components for an autonomous mode of operation, including batteries and

miniaturised balance-of-system elements. A maximum power point tracker (MPPT) was included for each branch of the PV system, which has a very different output due to the different positioning on the window frame. The design was conducted and initial electronic components were acquired and tested. Also, a new laboratory for the final validation of the smart-window in hot climates (Dominican Republic) was defined and its construction was started.

First prototypes will be built during the next period and extensively validated, demonstrating the potential of the smart window to generate electricity in buildings in a sustainable way. In addition, through the diffusion of the results, the project will contribute to the promotion of renewable energies globally and more specifically in the LAC region. The exploitation of alternative energies in these countries can increase technology transfer opportunities and have an important impact in improving the national economies.

ERANet LAC

HEALTH

Project acronym: **CONGENITAL CHAGAS DISEASE RESEARCH CONSORTIUM**

Project title: RESEARCH IN PREVENTION OF CONGENITAL CHAGAS DISEASE: PARASITOLOGICAL, PLACENTAL AND IMMUNOLOGICAL MARKERS

Project Duration: from (01/11/2015) to (30/11/2018)

1.1 Publishable summary

Chagas disease, caused by the protozoan Trypanosoma cruzi, is a neglected health problem in Latin America and, due to global migration of asymptomatic people has emerged in nonendemic countries. According to WHO, new diagnostics are among the top priorities for Chagas disease research. The congenital transmission of T. cruzi (CI) is one of the major routes of spreading Chagas disease worldwhile. Since 65% of CI cases are asymptomatics, prevention and control would require screening of children and women of childbearing age and their treatment. However, early detection of CI is not adequate; current methods lack sensitivity and a high proportion of newborns abandon maternity services without a diagnosis and must be followedup for final diagnosis by serological assays only after nine months of age. In most endemic regions, economical and social constrains provoke that a high proportion of infants remain undiagnosed and thus untreated. In this context, studies to improve early diagnosis are a priority in public health.

Furthermore, it is necessary to deepen insight on the mechanisms of CI to enable define risk factors. Accordingly, this project proposed to characterise parasitic, placental and immunological factors in clinical samples from binomials of seropositive women and their newborns to find out atrisk factors of transmission and validate novel laboratory tools for early diagnosis. Novel approaches have been explored. During this first period, we carried out analytical validation of duplex quantitative Real Time PCR for detecting infection and estimating parasitic load in blood of newborns. Limit of detection was very satisfactory starting from 1 ml of blood treated with stabilizing agents (0.2 parasite.equivalents/ml). A RT-qPCR method based on amplification of 18s ribosomal RNA was also developed to characterise the persistence of active parasites in placental tissues. This technique was applied to a murine model of congenital infection and revealed different placental tropism of T.cruzi strains.

Extracelullar vesicules carrying T.cruzi mucine associated surface proteins (MASPs) were detected in parasitized cells and in sera from Chagas disease patients. Our findings suggest a role of EVs in distracting the immune-response, facilitating parasite evasion. Furthermore, serological detection of immune complexes formed by EVs carrying immature MASP proteins and antibodies may serve as a novel tool for detecting infectionPolymorphic SNPs detected in genomic sequences of placentary expressed human MMP2 and ADAM 12 genes were found associated to susceptibility of CI. This battery of novel tools will be used to detect and characterize infection in peripheral blood and placental tissues of binomials of Chagas disease women and their newborns admitted at Maternity services of Argentina and Spain. Transcriptomics has been carried out by microarray analysis in human placental chorionic villi explants infected with a parasite strain

originally isolated from a CI patient and differentially expressed genes related to citokines and chemokines and remodelling of extracellular matrix were identified. Moreover, transcriptomic studies by means of RNAseq were initiated in pools of placental samples from infected pregnant women.

Finally, preparation of parasite lysates was carried out to start experiments of cell stimulation to study cellular immunity associated markers.

It is expected that the integration of the parasitological, molecular, placental and immunological data obtained will contribute to understanding the mechanisms causing CI and improve early diagnosis for prompt treatment.

Project acronym: **MYCO-NET²**

Project title: Detecting drug resistant Mycobacterium tuberculosis with low-cost next generation technology

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Project Duration: from (1/4/2016) to (1/3/2019)

Project website address (if applicable): http://myconet.infectognostics.de

1.1 Publishable summary

Tuberculosis (TB) is a devastating disease affecting millions of people around the globe. The increasing appearance of multi-drug-resistant (MDR) strains worsens the threat to human kind with unprecedented risks. Rapid and cost-effective methods for early diagnostics and detection of MDR are required.

Pyrazinamide (PZA) is the only drug that effectively kills dormant tuberculosis. In average two-thirds of the world population is infected with latent TB. Resistance to PZA is increasing globally and no other drug has yet been identified to replace PZA for resistant strains. Therefore, it is necessary to better understand the mechanisms of action and resistance of PZA to put the basis towards the design of alternative drugs. It is also important to early and accurately detect PZA-resistance in order to improve TB care and control.

Here, we form a consortium with expertise in biochemistry, biophysics, bioinformatics, genetics and clinical research, aiming to develop novel methods for early diagnosis and real-time monitoring of TB infections and PZA resistance markers. Two main streams of collaborative research will flow along the EU- LAC axis: 1) Detection of Mycobacterium tuberculosis by single-cell Raman spectroscopy on Lab-on-a-Chipdevices with enhanced materials for cell isolation from complex biological samples, in particular from direct sputum. 2) Detection of PZA-resistant M. tuberculosis markers by exploiting the potential and versatility of molecular sensing combined with novel nanomaterials on inexpensive sensors.

The MYCO-NET2 consortium will deploy state of art technologies to allow Lab-on-a-Chip and nanotechnology for TB detection and PZA resistance determination to be used in developing countries as a point-of-care diagnostics in a sustainable manner.

So far, in tihis first year we obtained approximately 500 sputum samples from TB patients and controls, and cultured them in presence of PZA. Antibodies and aptamers against POA and specific proteins of MTB have been produced. Micro-Raman spectra for MTB and POA have been obtained and confirmed its validity for detecting these specimens. Advances in the nanostructured filters are being done with promising results.

Project acronym: **CAPRI-PC**

Project title: Recognition of the primary infection by *Pneumocystis* in infants: A silent threat to public health

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Project Duration: from (30/11/2015) to (30/11/2018)

1.1 Publishable summary

Increasing evidence suggests that the most common respiratory infection affecting infants is the mild and stealth, primary infection by the micro-fungal organism *Pneumocystis*. This infection goes currently unrecognized and has been neglected as a subclinical irrelevant infection by contrast with the severe *Pneumocystis* pneumonia affecting the immunocompromised host. However, compelling new evidence suggests that this infection may be pathogenic to certain infant age groups and that microbiome-host interactions in early life may condition the development of altered immune responses in older infants or adults. They underscore the importance of understanding this highly prevalent subclinical *Pneumocystis* primary infection.

This infection is acquired close to birth, develops over a period of few weeks, and peaks between the ages of 2 to 5 months. Furthermore, this age interval period coincides with the peak of infant respiratory morbidity and post-neonatal mortality, raising the hypothesis that a pathogenic role of *Pneumocystis* in infants is possible provided the near-universal prevalence of this infection at that particular age window.

This hypothesis is strengthened by the recent demonstration of pathology consisting of increased mucus associated to *Pneumocystis* in infant lungs in line with observations in animal models from us and other research groups that show Pneumocystis-associated transient respiratory impairment and airway remodeling.

Importantly, *Pneumocystis* has been detected in lung of aborted fetuses, which may suggest vertical transmission and an eventual co-factor role in abortion and in newborn respiratory distress due to the demonstrated ability of *Pneumocystis* to decrease pulmonary surfactant. Therefore this proposal aims to recognize the epidemiology of this silent infection in preterm and term otherwise healthy newborns and small infants in different countries, to recommend a preferred method for diagnosis by comparing sensitivity of available methods of known specificity, to characterize the pulmonary myco-microbiome using metagenomic analyses, and additionally, to understand the *Pneumocystis*-airway epithelium interaction using transcriptomic studies to identify the host-activated gene responses associated to this unique fungal pathogen in infant lung specimens.

The proposal will importantly explore *Pneumocystis*-associated breathprints using non-invasive detection of volatile organic compounds (VOC) in exhaled air that may prove as an ideal method to recognize stealth infections especially in prematures and small infants. Recognition of the wide distribution of *Pneumocystis* epidemiology will be in itself a measure of success of this proposal and, furthermore, understanding this early life infant-microbial interaction may lead to prevent infant and, additionally, older age respiratory morbidity. Therefore, results

of this proposal will contribute to prevent infectious-related morbidity and promote well being, by increasing our recognition and understanding of this early-life and highly frequent *Pneumocystis* primary infection.