OMIC ENGINE

Newsletter

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National Hellenic Research Infrastructure on Synthetic Biology.

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Editorial.

The role of Synthetic Biology in the Bioeconomy roadmap of Greece

by Kostas Mathiopoulos

Bioeconomy is a relatively new discipline that sprung from the realization of (1) the continuous environmental destruction mediated by the increased economic development, based on polluting fossil fuels, (2) the tendency of establishing sustainable development strategies based on environmentally friendly sources of energy, (3) the enormous contribution of biosciences, and especially biotechnology, in sustainable development. In general terms, Bioeconomy refers to the use of renewable biological resources from terrestrial and aquatic ecosystems for the production of products, processes and services covering all sections of industry and trade, in the context of a sustainable, circular economic system. Consequently, bioeconomy policies are strongly related to innovation, sustainability as well as economic development and employment.

Until today, more than 60 countries worldwide have developed formal strategies and roadmaps to promote their bioeconomy. Different countries specify their strategies according to three key points: (a) the corresponding resource availability (e.g., availability of agricultural land), (b) historically pioneering roles in specific fields of research and technology (e.g., biotechnology) (c) country-specific needs as well as priorities they choose to serve.

Technologically advanced countries, such as the United Kingdom, the United States, China and others, recognize synthetic biology as one of the "eight major technologies" of the future, making it a key driver of bioeconomy development. It is no coincidence, that the global market for synthetic biology is growing by nearly 25% a year. In the meantime, the market is dominated by companies selling genome editing and DNA synthesis technologies, but the part of basic products, such as synthetic microbes and integrated production bio-systems, is expected to grow rapidly over the next two to five years. Amyris and Gingko Bioworks in the US are pioneers in synthetic biology, developing new strains of microbes that produce fuels and chemicals, based on computer-aided design and automation.

To consolidate the role of synthetic biology in the bioeconomy, several roadmaps and reports have been published. These provide a detailed description of the opportunities offered by synthetic biology and the measures required to harness the potential of this technology as efficiently and responsibly as possible. The reports also highlight the need to develop educational systems to fit the multidisciplinary approach required by synthetic biology. Thus, European educational institutions have already begun to recognize the need of training young scientists in bioeconomy and synthetic biology, as there is an urgent need for a highly skilled workforce.

At the same time, research infrastructures are crucial, as is evident from the example of the United Kingdom. The dynamic research and training environment of infrastructures brings together a critical mass of researchers working across the UK, encouraging the higher education sector to make its own significant investments in synthetic biology and attracting significant additional funding from industry and international collaborations.

Editorial.

Regarding our country, there are no national strategies and roadmaps for bioeconomy, industrial biotechnology or synthetic biology. Nevertheless, government authorities put high priority on resource efficiency, energy-efficient and low carbon investments. However, despite the fact that molecular biology and biotechnology have a high acceptance in our society and the Greek molecular biologists have a large participation in prestigious research projects and publications, the development of a Greek biotechnology industry lags far behind. Among 54 countries analyzed, Greece is 42nd in terms of biotechnological innovation. Various university departments and research centres active in the life sciences offer not only highly specialized knowledge and techniques but also the bases for bio-based products of high added value. However, there are very few companies that are involved in the production of biotechnology products or that use biotechnology in their production line. One of the most well-known biotechnology companies in Greece is MINOTECH Biotechnology, currently EnzyQuest, which operates in Crete and supplies restriction enzymes to many international companies. Recently, ResQ Biotech was founded, a new company that genetically modifies microbial cells for the discovery of new drugs aiming to treat amyotrophic lateral sclerosis and other protein-missfolding diseases. In fact, ResQ Biotech is one of the 44 companies nominated for the Spinoff 2020 award of Nature journal, which is awarded to promising scientific companies that have emerged from academic laboratories in the last three years.

When it comes to education, in Greece, the Department of Biochemistry & Biotechnology of the University of Thessaly offers, at the undergraduate level, a course in Synthetic Biology. Students' interest in synthetic biology is also reflected in their participation in the international synthetic biology competition iGEM (international Genetically Engineered Machine). The first Greek participation was in 2017 and since then the number of teams is increasing every year. These teams have won both gold medals and special distinctions in this competition.

OMIC-Engine was the first attempt of Greece to create and finance a Greek Research Infrastructure in synthetic biology. OMIC-Engine has actively contributed in recent years to the development of synthetic biology in research, education and industry. However, in order for synthetic biology to contribute to the transition of the Greek bioeconomy, it is necessary to develop mechanisms to support synthetic biology research in our country. It is necessary to support the Research Infrastructures of synthetic biology, to strengthen the education and the "consciousness" for SB, to give incentives for the creation of extroverted SB companies, so that our country faces current and upcoming challenges with a view of innovative approaches and professions of the future.

Kostas Mathiopoulos, is a Professor of Molecular Biology at the Department of Biochemistry & Biotechnology of the University of Thessaly and OMIC-Engine's Project Coordinator.

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Meet the Greek iGEMers V1.

| iGEM Athens 2021

This year, 2021, the iGEM Athens team consists of 7 people. We were all members of the iGEM Athens 2020 team and once again, we participate enthusiastically. Kleoniki Pylarinou, Vassilia Spyridaki, Ilias Toumbe, Eleftheria Kelefioti Stratidaki are undergraduate students at the School of Chemical Engineering, NTUA, Marianna Ioannidou is an undergraduate student at the Department of Biotechnology, AUA, Orsalia Veloudiou is an undergraduate student at Medicine School, NKUA and Spyros Kanelopoulos is a graduate from the Department of Biology, NKUA.

From left to right: Spyros, Klea, Orsalia, Elias, Eleftheria, Silia and Marianna after our workshop titled "Genetic circuit design for plastics degradation" at TedxNTUA

The problem we aim to address with this year's project is the accessibility and production limitations of PCR's raw materials, a method that is used daily in laboratories and diagnostic centres around the world. Each PCR reaction requires, among others, a polymerase and the four monomers (dNTPs) that structure the final product. However, the total cost of dNTPs production is high, and they are often produced by complicated, low-yield, unsustainable chemical processes. In addition, PCR techniques are feasible only in centralized laboratories by small groups of lab experts and expensive equipment. These problems can be generalized to all nucleic acid amplification (NAA) techniques. Using the principles of Synthetic Biology, we design a genetic circuit that will produce Pfu polymerase and RNR and TSase enzymes, which are necessary for the dNTPs production. Our goal is to make nucleic acid amplification techniques more accessible at non-centralized facilities!

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| iGEM Thessaloniki 2021

iGEM Thessaloniki is the interdisciplinary, undergraduate research team that has been representing Aristotle University of Thessaloniki in the iGEM International Synthetic Biology Competition, since 2017. Currently, our team consists of 11 members, from the Schools of Biology, Electrical and Computer Engineering, Informatics, Pharmacy, Physics and Chemistry of the Aristotle University of Thessaloniki, as well as from the Department of Molecular Biology and Genetics of Democritus University of Thrace. Our primary Principal Investigator is Dr. Vizirianakis Ioannis, Associate Professor of Pharmacology in the Department of Pharmacy of the Aristotle University of Thessaloniki.

From left to right: Emmanouil Chatzichristofis, Dimitris Trygoniaris, Maria Kosmidou, Dr. Vizirianakis Ioannis, Konstantina Tsouderou, Alexandros Tsigilis, Danai Eleni Vergini, Anastasia Theodosiadou, Charalampos Anagnostakis, Anna Anastasiou. The team also includes Anna Varvari and Panagiotis Valatsos, that are not showcased in the picture.

This year, we are designing a cost-effective and non-invasive tool for the diagnosis of pancreatic ductal adenocarcinoma (PDAC), which is the most common type of pancreatic cancer. In order to contribute to the earlier diagnosis of the disease, which in turn will allow a more effective therapy, we are developing an *in vitro* system for the detection of specific miRNAs that are upregulated in the urine of PDAC patients, during stages I and II. More specifically, this system is comprised of a type of synthetic RNA molecules, called Toehold Switches, that enable the production of fluorescence when abnormally high quantities of these miRNAs are present. The name of our project is METIS (MicroRNAs Expression Toehold Investigation System), a name inspired by the Greek goddess of innovation and crafts, Metis.

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| iGEM Thessaly 2021

iGEM Thessaly, University of Thessaly's interdisciplinary team, participates for the 3rd time in the iGEM Competition, with the research project "Amalthea". Our team consists of 12 undergraduate students from the departments of Biochemistry & Biotechnology, Information & Electronic Engineering, Electrical & Computer Engineering and Architecture. Our work is coordinated by Katerina Moutou, Associate Professor and Kalliope Papadopoulou, Professor at the Department Biochemistry & Biotechnology of the University of Thessaly.

From left to right: George Boukouvalas, George Mouchtaridis, Venetios Michelioudakis, Pericles Vasileiou, Spyros Felekidis, Efthimia Zissopoulou, Dimitris Biliouris, Babis Perinarelis, Ioanna Gkoni, Asteria Tsapadikou, Konstantinos Elenis, Anna Patri

Amalthea consists a continuation of our last year's entry in the competition, which targeted the creation of a micro-capsule for the direct and non-invasive diagnosis of Inflammatory Bowel Diseases (IBDs). This year, we carry on our research, aiming for the functional evaluation of the gut microbiome, rendering it more accessible for everyone. Through our design, we are able to detect gut dysbiosis, caused by the disrupted dietary pattern of the modern way of living, in its early stages. In such a way, Amalthea acts as a prevention tool for gastrointestinal disorders, such as colorectal cancer and obesity. The capsule detects the levels of Short Chain Fatty Acids (SCFAs), certain bacterial metabolites of the gut microbes that constitute an ideal biomarker for the overall health of the gut microbiome. The signal detection through the NOT-GATE, allows us to verify the absence of these metabolites. If dysbiosis detection occurs, we provide a probiotic supplement that has the capability to replenish the SCFA levels. Our work is a step towards ensuring food security and forming a sustainable food system in our society, through a practical tool for the prevention of gut dysbiosis and a supplement that reinforces the values of the present dietary patterns.

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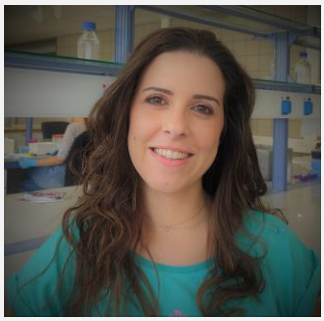
Interviewing OMIC-Engine Researchers

Interviews.



Dr Konstantina Tsoumani holds a Bachelor's degree and a PhD in Biochemistry and Biotechnology from the University of Thessaly (UTH). She then worked as a Post-doctoral Researcher under the "ARISTEIA" Action and was later awarded an IKY fellowship under the "Reinforcement of Postdoctoral Researchers" Action to implement research on olive fly biotechnology and genetic engineering. She has been also a contract lecturer at the Department of Biochemistry & Biotechnology (UTH). She was recruited by OMIC-Engine as Post-doctoral Researcher to study the organization of the Y chromosome in the olive fruit fly for the development of genetic sexing strains.

Contact Konstantina

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Konstantina, describe briefly your research work.

My research regards the engineering of an insect pest towards its population control. Specifically, I'm working on the olive fruit fly, an agricultural pest of great economic importance for all Mediterranean countries that causes significant crop losses if it is not treated effectively. Our research focuses on the development of alternative genetic control methods that will reduce its populations by circumventing the current chemical insecticide suppression. My aim is to engineer the olive fly so that we can produce and separate in the laboratory sterile male flies. When these flies will be released in the environment and mate with wild female flies, eggs will be infertile and the population will crash. Recently, we participated in an international effort published in the journal "*Science*" that identified the maleness factor, the key gene for sex determination in this species, located on the Y chromosome. Our challenge is to establish new synthetic tools that will use this gene as a genetic switch to produce male only progeny. Additionally, deciphering the structure of the Y chromosome will allow us to link specific genetic features, necessary for effective species-specific control.

Which opportunities did your secondment offer you in terms of training, networking and personal growth?

In all three terms, I could say that it was a positive experience. Scientifically, I improved my skills and applied them to develop the necessary genetic toolkit in the olive fruit fly that will render its effective pest biocontrol feasible, hopefully soon. Apart from the scientific point of view, I had the opportunity to be one of the instructors of the undergraduate team in the 2019 iGEM competition and a trainer at the training school held on March 2021. Both these actions gave me the chance to share my knowledge and expertise with young passionate students and researchers that came from diverse backgrounds and broaden my teaching knowledge. Additionally, the extended network of the OMIC-Engine participants and collaborators created the first Synthetic Biology community in Greece where all of us working in this infrastructure will be part of thereafter.

Interviews.

I consider my participation in this network positive in terms of both updating my skills and gaining the opportunity to know and interact with researchers across different fields that share the same need of implying Synthetic Biology towards problem-solving multidisciplinary approaches, thus adding value in either services or new products.

What do you think will be the impact in your future career?

Applications that rely on the principles of Synthetic Biology will pave the way to creative solutions in future approaches for sustainable agriculture. The latter is the main concern of the alternative pest control strategies, the field that I have focused on. So, I am convinced that my implication in the projects held under the OMIC-Engine infrastructure will have a positive impact on my future career in the aspects of the acquired skillset and the putative collaborations in future projects.

Has this secondment experience matched your expectations so far?

Although I was recruited by OMIC-Engine in later stages, I feel that I was benefitted in many ways. Unfortunately, I missed the in-person communication and ideas exchange, because of the pandemic since many scheduled meetings and actions were held virtually. However, reaching the end of this path working at the OMIC-Engine infrastructure, one can easily realize how valuable this effort was both scientifically and interpersonally. New tools and innovative approaches using cutting edge technologies have been developed by applying the principles of Synthetic Biology to finally solve diverse aspects of current problems in agro-biotechnology sector. Apparently generating new ideas by applying new thinking patterns and getting inspired by my colleagues in a friendly environment were also another asset that allowed me to be more creative and explore new thoughts and approaches on the project that I was working on. Overall, it was a great experience!

Three words that sum up your experience within the OMIC-Engine infrastructure.

The 3Cs: Creative, Challenging, Cooperative!

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Outreach.

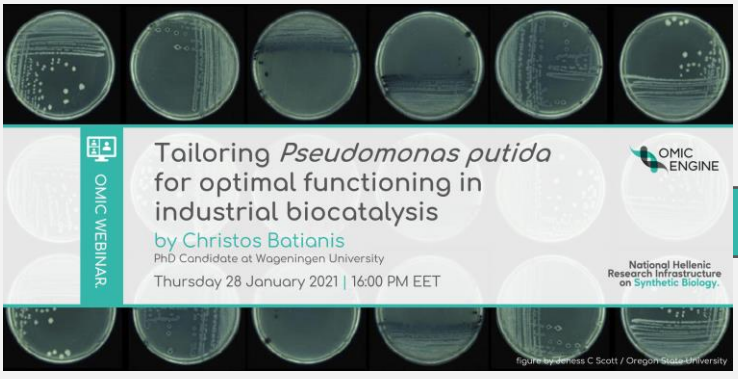
Subscribe to our YouTube channel.

RE-WATCH THE OMIC WEBINARS

OMIC Webinar #3

by Boas Pucker

Re-watch the Webinar



OMIC Webinar #2

by Christos Batianis

Re-watch the Webinar

OMIC Webinar #1

by 2020 Greek iGEM teams

Re-watch the Webinar

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Outreach.

Contributing to the BioRoboost project.

Last April, the European project BioRoboost, working on establishing standardization in biology in Europe in a co-creation scenario, highlighted our work in its newsletter. At the same time, the research carried out in our collaborating laboratories in Athens (National Technical University, University of Athens and National Hellenic Research Foundation) was presented, regarding the finding of new microbial chassis for Synthetic Biology.

Take some time to read our work

Engineering a Thermophilic Microbial Chassis for Synthetic Biology Applications

Engineered bacteria as an early-stage drug discovery platform against diseases caused by protein misfolding and aggregation

As the BioRoboost project comes to an end, the members of the Plant & Environmental Biotechnology Laboratory of the University of Thessaly, presented their work on Genome modification of plants and fungi through a BioRoboost video.

Watch the video here.

Publications.

Check out our recent publications in peer-reviewed journals

Dimitrakopoulou M. E., Kotsalou C., Stavrou V., Vantarakis A., (2021) "Advancing quality control of food samples by Next Generation Sequencing compared to culture-dependent techniques", Journal of Food Science and Nutrition Research. https://doi.org/10.26502/jfsnr.2642-11000066

Garagounis C., Delkis N., Papadopoulou K., (2021) "Unraveling the roles of plant specialized metabolites: using synthetic biology to design molecular biosensors", New Phytologist. https://doi.org/10.1111/nph.17470

Bayega A., Oikonomopoulos S., Gregoriou M. E., Tsoumani K., Giakountis A., Wang C. Y., Mathiopoulos K. D., Ragoussis J., (2021) "Nanopore long-read RNA-seq and absolute quantification delineate transcription dynamics in early embryo development of an insect pest", Scientific Reports. 10.1038/s41598-021-86753-7

Education.

Offering training opportunities during a pandemic

by Leandros Tsiotos

As we reach the one-year mark of the COVID19 pandemic, we have been through unprecedented situations that call for bold responses. Stepping up to the challenge of expanding Synthetic Biology research and innovation, this year we managed to move our Training School, online. We considered this a unique opportunity to make education more accessible and pursue our strategic goal to nourish a dynamic research community of young scientists and academics in the field of Synthetic Biology.

As we all know, Synthetic Biology has evolved to a cutting-edge technology with a range of applications in fields that span from health to agriculture. Synthetic Biology triggers step-changing transformations in how we grow and produce food, what we eat, and where we source for materials and medicines. Our role, as OMIC-Engine, is to offer the equipment to harness the potential of this revolution.

For that reason, we have designed our Training School as a guided tour along basic methods used in Synthetic Biology research and their exciting applications. During the second week of March, we welcomed 20 young and ambitious PhD students and post-doctoral researchers from all over Greece and abroad and guided them through the world of Synthetic Biology. The course focused on covering the core principles of cloning strategies, the use of metagenomics in environmental samples, and the CRISPR/Cas9 technology. In addition, the participants were introduced in protein expression, purification and crystallization methods. On the final day of the course, we had the opportunity to discuss the potential of implementing such methods into their own research projects, through a fruitful discussion with the trainers and the organisers.

Our trainers, managed to deliver online lectures accompanied with practical sessions and exercises. In order to transform the laboratory experience into a virtual format able to support our educational course, we have created unique videos highlighting experiments and lab protocols. Before starting the course, we developed and shared with our trainees a detailed educational booklet covering all the theoretical background of the course and offering resources and tips for the practical sessions. We aspire that this booklet will serve as a guide for our trainees' current and future research. Finally, during the course we have used communication platforms to engage with our trainees and have fun.

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Education.

Our educational course was a success due to the continuous work of our trainers and research coordinators from the Department of Biochemistry & Biotechnology of the University of Thessaly as well as our trainees which gave life to the course through their comments, interesting discussions and inspirational presentations.

We are looking forward to welcoming them on our collaborating laboratories at the University of Thessaly and offering a hands-on experience. We have also promised for a city tour in Larissa and drinking nights with "tsipouro".

Thank you for making our quarantine better and we hope to see you soon, in person!

Leandros Tsiotos, is OMIC-Engine's Dissemination & Outreach Officer and iGEM Ambassador to Europe for 2021.

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Learn more about our Training School!

Read what our trainees shared with us...

This was an extremely well-structured course of high caliber, accompanied with lots of fun, communication, and wonderful playlists.

The training school was very well-organized, engaging and extremely helpful. Not only for my research interests, but also for the interconnection with others. Potential collaborations arise...

I am very satisfied with the overall training school! Keep up the good work!

Well organised, focused and with very interesting practical sessions!

It was a great experience comparing it with other study related online activities.

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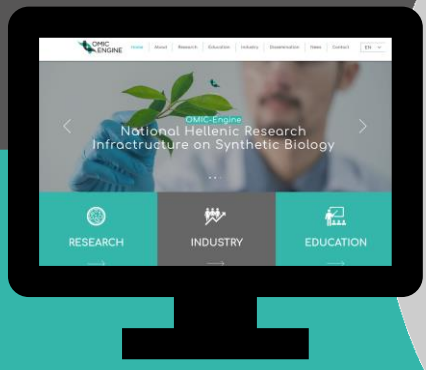
News.

Check out our new website!

www.omicengine.com



- More news
- Training opportunities
- Job positions
- Upcoming events
- New publications
- New services

National Hellenic Research Infrastructure on Synthetic Biology.

New Projects.

MINAGRIS | MIcro- and NAno-Plastics in AGRIcultural Soils: sources, environmental fate and impacts on ecosystem services and overall sustainability.

Coordinator: Dimitrios G. Karpouzas | dkarpouzas@bio.uth.gr

Plastic use in agriculture has tremendously increased in the past decades resulting in soil pollution with plastic residues forming besides macroplastics micro (MP) and nanoplastics (NP). MINAGRIS aims to contribute to healthy soils in Europe by providing a deeper understanding and tools to assess the impact of MP and NP in agricultural soil health. MINAGRIS will assess the use of different plastic polymers in agricultural systems in 11 case study across Europe and identify the resulting types and concentrations of MPs/NPs. MINAGRIS will provide validated analytical tools that allow the quantification and identification of MPs and NPs in soils and plants. Based on the results of the case study sites, controlled experiments will be conducted to analyse the impact of MPs and NPs on physico-chemical soil properties, soil biodiversity, plant productivity, and Ecosystem Services, as well as their potential transfer to other parts of the environment and plants. Furthermore, synergistic effects with other stressors like pesticides and veterinary drugs will be also assessed. In addition, the microbiota on soil plastisphere and its role in pathogens and antibiotic resistance gene dispersal as well as their role as hotspot for the evolution of novel catabolic traits against interacting organic pollutants will be determined via metataxonomic, metagenomic and plasmidomic approaches. Quantification of the impacts of MNP on soil biodiversity and agricultural productivity, their transport and degradation in the environment, their impacts on socio-economic components, and synergies between all of them will make it possible to identify, in a multifactorial vision, the benefits and risks associated with the use of plastics in agriculture. MINAGRIS is a 5-year project, starting in September 2021 and involves 20 partners from around Europe with a budget of 7 million euros. The Laboratory of Plant and Environmental Biotechnology of the Department of Biochemistry and Biotechnology, University of Thessaly will have a leading role with Dr Karpouzas acting as the scientific coordinator of the project.

Visit the project's website at www.minagris.eu.

New Projects.

DRAMA-TERROIR: Valorization of Drama wine identity through a holistic characterization of the natural and microbial environment

Coordinator: Dimitrios G. Karpouzas | dkarpouzas@bio.uth.gr

The aim of DRAMA-TERROIR is to fully characterize the role of the abiotic and microbial terroir of the Drama wine-growing zone. DRAMA-TERROIR will take on a multidisciplinary approach which will be implemented at two stages: a) the design and implementation of a geographic database of environmental parameters with a decisive influence on the quality characteristics of the wine leading to the definition of the terroir units (MT), and (b) the selection of a pilot vineyard by variety which will be used for the characterization of the natural (abiotic) and microbial terroir. The abiotic environment in the MT will be assessed through calculation of bioclimatic indicators and by detailed soil and isotopic analysis. The vine microbiome (prokaryotic and eukaryotic) in the MT will be determined in leaves and berries using amplicon sequencing approaches to identify microbes with a potential role in vine growth characteristics and grape maturation. Pilot vinification will be performed and the produced wines will be characterized for their organoleptic profile, antioxidant and anticancer properties. At the same time, the vinification microbial succession will be recorded using amplicon sequencing while shotgun metagenomics will provide insights in their metabolic capacity. Based on the analysis of the vine and vinification microbiome, indigenous yeasts and malolactic bacteria will be isolated, identified and oenologically evaluated with a potential to enhance the quality and local identity of local wines. The Department of Biochemistry and Biotechnology, University of Thessaly, Laboratory of Plant and Environmental Biotechnology and Laboratory of Animal Physiology and also the Department of Molecular Biology and Genetics, Democritus University of Thrace will participate in the project with main task the determination of the role and composition of the vine and vinification microbiome, microbiome-directed isolation of indigenous microbes with high oenological potential and characterization of the antioxidant and anti-cancer activity of produced wines. DRAMA-TERROIR is a three-year project which was just selected for funding in the frame of the 2nd Call RESEARCH-CREATE-INNOVATE.

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OMIC-Engine is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure" funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (EU Regional Development Fund)

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