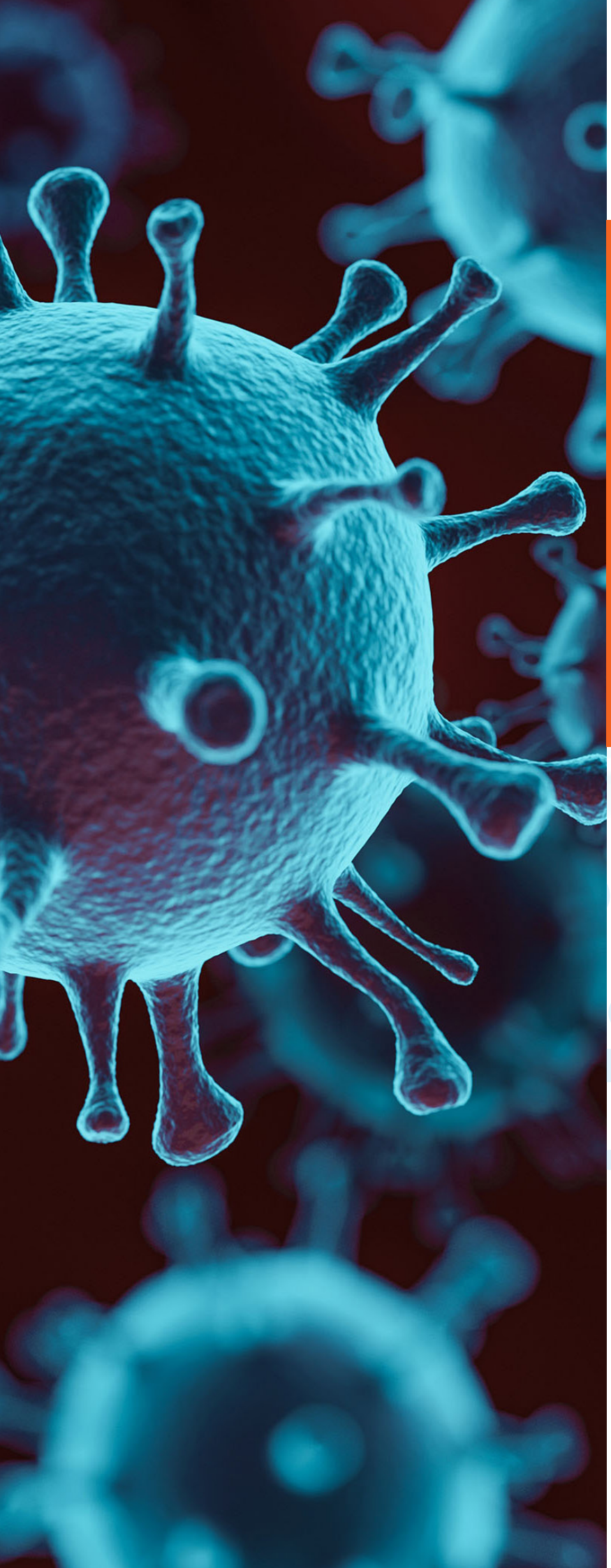

European Research Council

COVID-19 Frontier research in the spotlight

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The European Research Council (ERC) is the premier European funding organisation for excellent frontier research. It funds scientists and scholars of any nationality and in any discipline to undertake ground-breaking research following a bottom-up approach, with excellence as the sole evaluation criterion. This curiosity-driven approach, free of any thematic constraints, has resulted in a rich and diverse portfolio of projects generating fundamental advances in all fields of research across Life Sciences (LS), Physical Sciences and Engineering (PE), and Social Sciences and Humanities (SH).

Whilst the ERC follows a bottom-up approach to funding, the cutting-edge research that these scientists pursue generates results that address a wide range of issues with significant societal, economic and policy relevance. This is exemplified by the contribution of frontier research in addressing the COVID-19 crisis, proposing solutions, and supporting society.

ERC frontier research tackling COVID-19 crisis

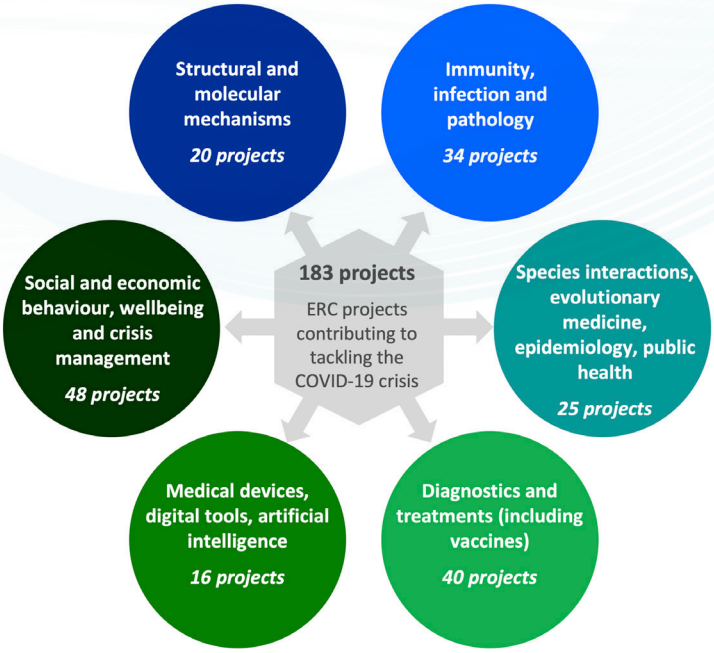
The COVID-19 pandemic resulted in an enormous health, economic and societal global impact. In this context, over 180 ongoing or completed ERC projects generate knowledge and technology that contribute to the response to the COVID-19 pandemic. These projects are funded through the European Framework Programmes for Research and Innovation FP7 and Horizon 2020 (30% and 70% of the projects, respectively) with a total value of more than EUR 340 million. They were initiated by researchers prior to the emergence of the COVID-19 crisis, showing the importance of well-founded long term research coming from 'bottom-up' frontier ideas. In addition, the ERC grants offer grantees the flexibility to adjust their research project. Several ERC grantees already benefitted from this possibility to address COVID-19 related research in their ongoing ERC project. In this context, it is remarkable that some projects contribute to address COVID-19 in an unexpected way. For example, the project 'NEUCOS' (Walter Winter), focusing on neutrinos and the origin of the cosmic rays, is exploring how the simulation of astrophysical environments could inform the modelling of the spread of the COVID-19 epidemic.

This ERC portfolio of projects forms part of the extensive EU response to the COVID-19 pandemic as regards to the research and innovation efforts.

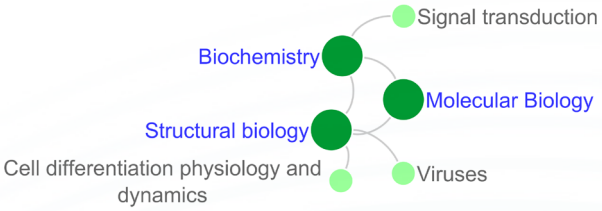
The scientific landscape behind the projects contributing to tackling the COVID-19 crisis

The portfolio of ERC projects is highly interdisciplinary, with projects funded in all three ERC scientific domains, LS, PE and SH. It provides insights across a range of six main scientific areas (see chart) going from the structural and molecular aspects, host-pathogen interactions, species interactions and evolutionary medicine, diagnostics and treatments, medical devices, to social behaviour and crisis management aspects.

The scientific landscape behind this diverse set of projects is represented in the network maps under each scientific area below. The maps portray the most prominent disciplines (dark green), research topics (light green), methodological developments (orange) and connections between them.



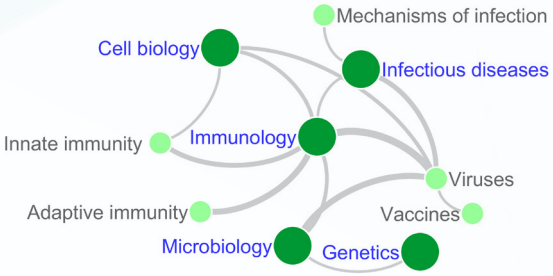
Structural and molecular mechanisms



ERC projects in this area study the structure and function of molecules inside and between cells. Many projects use molecular and structural biology and biochemical approaches to study viruses, cell differentiation and physiology, and signal transduction. These aspects are fundamental to understand for example the entry of SARS-CoV-2 virus in cells, gene expression and genetic variation in viruses, intracellular recognition of viral RNA, and molecular mechanisms of antiviral pathways. A few examples of important results tackling COVID-19 generated by these projects are:

- **PhosFunc (638884), Pedro Beltrao:** This research shows how SARS-CoV-2 hijacks human signalling pathways to favour its own replication and to infect neighbouring cells. The team identified existing drugs that disrupt this mechanism and have the potential to treat the infection. See publication and news.
- **MEMBRANEFUSION (648432), John A. G. Briggs:** This research shows (i) how SARS-CoV-2 enters cells and ways to modulate this process by blocking membrane fusion and (ii) the surface structure of SARS-CoV-2 virions, which is essential to understand the infection and vaccination strategies. See publication #1 and publication #2.
- **mitoUPR (803565), Christian Munch:** This research shows how SARS-CoV-2 infection modifies human cell responses, and identification of potential targets for COVID-19 therapy. See publication, news and video.

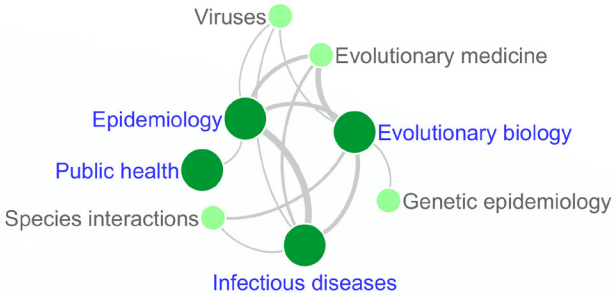
Immunity, infection and pathology



ERC projects in this area study viral infection and how our immune system reacts to it. Immunology is the common discipline behind most projects in this category, both at the level of innate and adaptive responses. Many projects study the cell biology and genetics aspects of host-pathogen interactions, generating knowledge relevant for the development of prevention strategies and treatment of COVID-19 (including vaccines). Those studies focus on the process of SARS-CoV-2 infection, the immune response at various stages of COVID-19 severity and COVID-19 pathology. A few examples of important results tackling COVID-19 generated by these projects are:

- **MInfla-Tilc (875102) & TILC (694502), Eric Vivier:** This research shows that targeting a specific pathway of the complement system, part of the innate immune response, could attenuate the inflammatory response characteristic of COVID-19. See publication, news and video.
- **XHaLe (771883), Danny David Jonigk:** This research shows the histology pattern (vascular angiogenesis) in the peripheral lung of patients who died from COVID-19–associated or influenza-associated respiratory failure. See publication and news.
- **OCLD (681870) & CircaCHIP (813109), Yaakov Nahmias:** This research shows that viral infection can modulate host metabolic pathways, which may be important for viral replication and COVID-19 pathogenesis. See publication, interview, news and video.

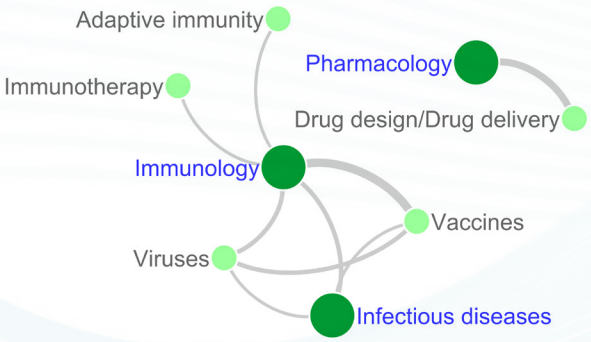
Species interactions, evolutionary medicine, epidemiology, public health



ERC projects in this area study viruses, or infectious diseases caused by viruses, from evolutionary and epidemiological perspectives. Some of these projects explore viral diversity and the origin and development of SARS-like viruses, contributing to the surveillance efforts to detect their emergence and spread. Several projects have developed statistical and computational methods to track in real time the evolution and transmission of viruses, some of which are already used by governments and regional authorities to track COVID-19 pandemic. Other projects focus on epidemiological aspects that can be used to inform COVID-19 mitigation measures. A few examples of important results tackling COVID-19 generated by these projects are:

- **PATHPHYLODYN (614725), Oliver Pybus:** This research focuses on the genetic epidemiology, evolution and transmission of SARS-CoV-2. See publication #1, publication #2 and publication #3.
- **TransMID (682540), Niel Hens:** This research collects and analyses social contact data from different studies worldwide, including making an openly available tool to extract matrices to study possible mitigation strategies for COVID-19 outbreaks. The PI also researches (i) antiviral treatments combined with contact tracing as control measure and (ii) generation interval for COVID-19 based on symptom onset data. See publication #1, publication #2 and publication #3, news.
- **Vis-a-Vis (724519), Rafael Sanjuán Verdeguer:** This research has resulted in a methodology to detect SARS-CoV-2 in wastewater that can be used for COVID-19 epidemiological surveillance. See publication and news.

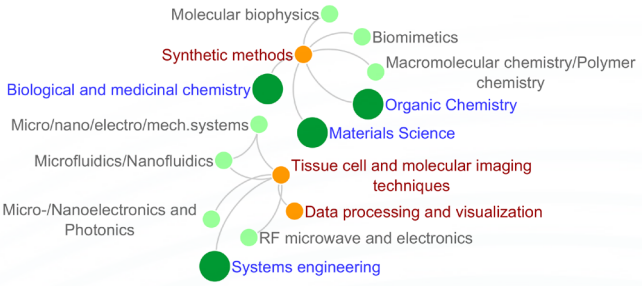
Diagnostics and treatments (including vaccines)



Projects in this area generate knowledge and technology directly relevant for the development of innovative prevention, diagnostic and treatment solutions for COVID-19 (including vaccines, antibodies and pharmaceuticals). In this context, several of these ERC projects are adapting the technologies they developed for the prevention and treatment of other diseases. Other projects are using in vitro systems to screen for drugs able to modify SARS-CoV-2 infection. A few examples of important results tackling COVID-19 generated by these projects are:

- **REGMAMKID (640525), Nuria Montserrat Pulido:** This research shows how the SARS-CoV-2 interacts with and infects tissues using engineered mini organs as model systems. The team was able to demonstrate that human recombinant soluble angiotensin converting enzyme 2 can inhibit early stages of SARS-CoV-2 infection. See publication, news #1 and news #2.
- **AbSens (632274) & SwitchProteinSwitch (280255), Maarten Merkx:** This research focuses on the development of a new type of rapid diagnostic test that allows detection of specific antibodies directly in the blood. The test uses sensor proteins that produce light by performing the same chemical reaction that is used by fireflies. See news #1 and news #2.
- **FluAttack (899835), Caroline Goujon:** The PI's team is currently studying the sensitivity of SARS-CoV-2 to interferon and to various restriction factors in order to identify active molecules against this virus. See lab webpage and news.

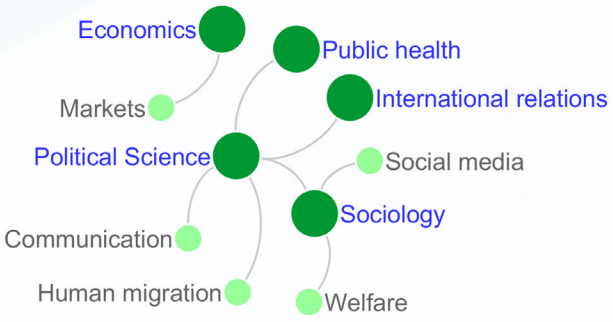
Medical devices, digital tools, artificial intelligence



Projects in this area make use of applied sciences to develop devices and tools that can be exploited in the context of the COVID-19 crisis. Various approaches and technologies are explored in these projects including synthetic methods, organic and medicinal chemistry, biomedical and systems engineering, materials science, fluid dynamics, electronics and photonics. Many projects develop specific technologies for imaging tissues and cells. Other projects focus on the diagnostics of COVID-19 and detection of biomarkers using non-invasive ways or artificial intelligence tools. A few examples of important results tackling COVID-19 generated by these projects are:

- **EAR (833296), Cecilia Mascolo:** The PI launched a new mobile phone app, which will be used to collect data to develop machine-learning algorithms that could automatically detect whether a person is suffering from COVID-19 based on the sound of their voice, their breathing and coughing. See news #1, news #2 and Q&A.
- **SniffControl (297407), Noam Sobel:** Changes in the sense of smell have been confirmed as one of the symptoms of COVID-19. The PI has created a smell tracker for anybody to test the changes in their olfaction from home, using a dedicated web platform. See news and video.
- **CRYOMAT (638661), Matthew Ian Gibson:** The PI's team has developed the technology for a new diagnostic tool for rapid detection of SARS-COV-2 based on a glyconanoparticle platform. See publication, news #1, news #2.

Social and economic behaviour, wellbeing and crisis management



The COVID-19 crisis has a high impact on people, society and economy. Many ERC projects in the area of social sciences and humanities identify solutions that can lead to more resilient societies and to a better management of the crisis. The majority of those are in the areas of economics, political sciences, and sociology, with others coming from anthropology, psychology and history. Some of these projects study the effects of the COVID-19 pandemic on wellbeing, covering aspects such as work, mobility, access to public services, stress management and resilience. The impacts of misinformation on social media and of misperceptions are also topics of study. Other projects examine the socio-economic aspects of the pandemic, including perspectives from communities at the margins and from gender research, and pandemics and societal shocks are also studied from a historical perspective. A few examples of important results tackling COVID-19 generated by these projects are:

- **DATACTIVE (639379) & ALEX (825974), Stefania Milan:** The PI has launched a multilingual blog dedicated to explore 'COVID-19 from the margins' which seeks to explore the social, economic, infrastructure consequences of the COVID-19 pandemic and the ways people and communities at the margins respond to them. See publication and blog.
- **SOCIOGENOME (615603) & CHRONO (835079), Melinda Mills:** This research shows that different areas of England and Wales face disproportionate risks for COVID-19 hospitalization pressures due to their socioeconomic differences and the demographic composition of their populations. The PI's research also shows that a social network-based distancing strategy keeps risks low while it can mitigate the negative consequences of social isolation. See publication #1 and publication #2.
- **PACCASA (313421) & HEY BABY (771468), Lucie Dale Cluver:** Creation of the COVID-19 Parenting Emergency Response, which provides free proven parenting tips and activities for all ages in 90 languages. See news.

Meet the scientists whose work contributes to tackling the COVID-19 crisis

We have talked to a range of ERC grantees across various scientific fields to find out how frontier science is helping to fight the current COVID-19 outbreak. Visit our dedicated webpage to read their testimonials on how bottom-up frontier research is critical to deliver new – and sometimes unexpected – insights relevant for better understanding and fighting the COVID-19 pandemic, as well as for providing social behaviour and crisis management related solutions.

Four of these scientists have agreed to share their knowledge and insights during the European Research and Innovation Days, on the ERC session 'COVID-19: frontier research in the spotlight', 22 September 2020. In this session, the speakers explore a broad range of questions such as 'How do viruses evolve and adapt to a new environment and to different hosts? How (fast) does SARS-COV-2 spread?', 'How can technology development help in tackling the pandemic', 'What are the new and exciting solutions for treatments? How far are we from validation in clinical settings?' and 'What have we learned about our societies, institutions, governance, etc. from the current crisis? How can we use this knowledge to build more resilient societies?'. More details about the speakers and their research is available below.

Sunetra GUPTA

Professor of Theoretical Epidemiology - University of Oxford

Dr. Sunetra Gupta is Professor of Theoretical Epidemiology at the University of Oxford with an interest in infectious disease agents that are responsible for malaria, HIV, influenza and bacterial meningitis. She has been awarded the Scientific Medal by the Zoological Society of London and the Royal Society Rosalind Franklin Award for her scientific research.

She is recipient of 2 ERC Grants (ADG+1 PoC) looking at the co-evolution of hosts and pathogens under immune selection and the use of epitopes to produce influenza vaccines removing the need to vaccinate each year: this technology has been licensed by Blue Water vaccines in the USA. She is using the insights gained in her current work on SARS-CoV-2.

Links: Lab webpage

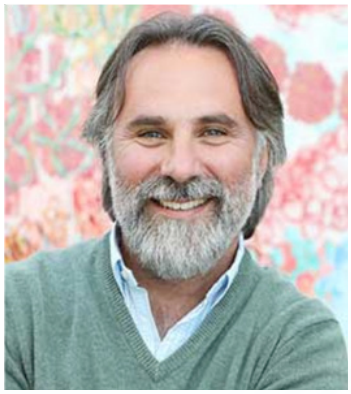
Balpreet Singh AHLUWALIA

Professor - University of Tromsø (UiT) – The Arctic University of Norway

Dr. Balpreet Singh Ahluwalia is a group leader at the Department of Physics, UiT Norway. He leads a cross-disciplinary bio-photonics and integrated optics research group that focusses towards the development of optical nanoscopy and its application towards clinically relevant biological application. He is recipient of 3 ERC Grants (STG+2 PoC). He is a co-founder of a spin-off Chip NanoImaging, outcome of his ERC project.

He has developed different variants of super-resolution optical microscopy (nanoscopy) using photonic-chip, which can significantly bring down the cost and complicity of the present nanoscopy. In collaboration with Leibniz-IPHT, Germany, they build chip-based nanoscopy platform with mobile phone cameras and demonstrated its capability to image SARS-CoV-2, with an estimated cost of the prototype below US$1000. This could enable widescale penetration of advanced microscope to clinics and hospitals.

Links: Lab webpage; Publication; Video



Vincenzo CERULLO

Professor - University of Helsinki

Dr. Vincenzo Cerullo is professor of Biological Drug, Head of Drug Research Program, PI at iCAN flagship, at HiLIFE and at the Translational Immunology Programme in Helsinki. He has received important financial support including the ERC Consolidator Grant and the ERC-PoC, two Business Finland PoCs. His group has produced significant discoveries and co-founded a multi-million spin-off company: VALO therapeutics.

Within his ERC-CoG grant, he has developed a rapid platform for cancer vaccine called PeptiCRAd. The peculiarity of this vaccine strategy is that it is rapidly adaptable, non-costly, and easy to translate to clinic. When the pandemic started, it was clear that this approach could be expanded from cancer to SARS-COV-2 vaccines. Consequently, together with VALO therapeutics, the company he founded based on his ERC PeptiCRAd project, he started working for developing PeptiVAX, a COVID-19 vaccine approach based on PeptiCRAd technology. Significant preliminary data has been generated since then.

Links: Lab webpage; Video

Meike BARTELS

Professor - Vrije Universiteit Amsterdam (VU Amsterdam)

Dr. Meike Bartels is Professor in Genetics and Well-being, VU Amsterdam. She leads a research group that aims to understand and identify the genetic and environmental influences on wellbeing. She is president of the Behavior Genetics Association and President-Elect of IPPA. Ms. Bartels is Director of the Research Master Genes in Behaviour and Health and was awarded an ERC grant to consolidate her line of research on Genetics and Well-being.

Prof Meike has expanded the original ERC based survey to investigate the effects of the pandemic on wellbeing (quality of life, optimism, meaning in life). Preliminary results show that is that the effects on wellbeing are not only negative and that it will be very important to sort out what the positive effects are, to use this in rebuilding and re-opening the world.

Links: Lab webpage

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