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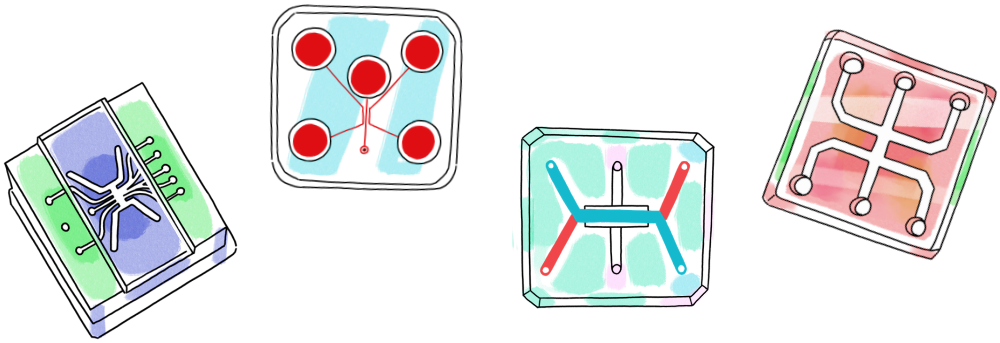
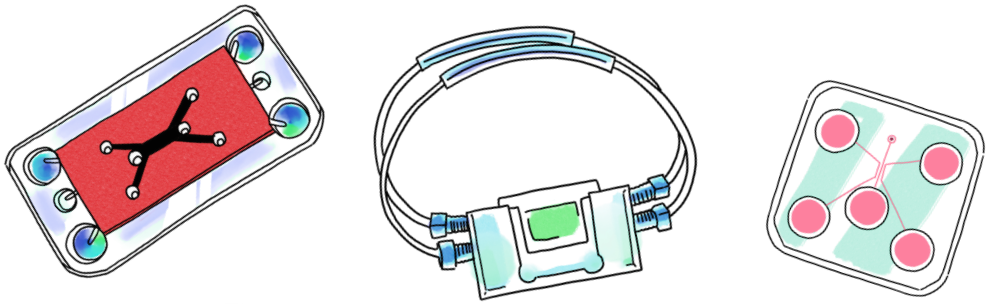
FRANCE 2030 RESEARCH PROGRAM
ORGANS AND ORGANOIDS ON CHIP

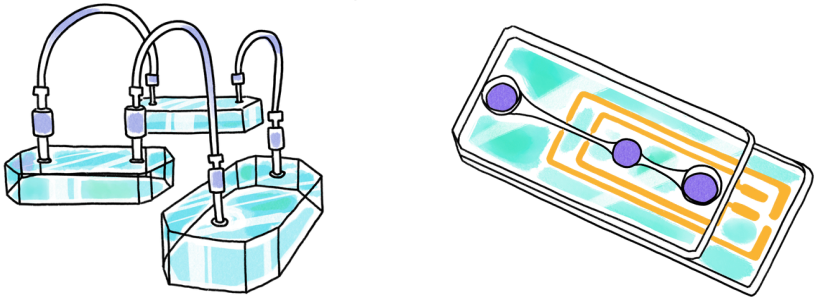
cea cnrs Inserm



# Organs and Organoids on Chip

## France 2030 Research Program





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## Organs and Organoids on Chip Research Program (PEPR MED-OOC)

The exploratory research program Organs and organoids on chips (PEPR MED-OOC) aims to deploy a new generation of biological models in France through the development of organs and organoids on chips (O&OoC). The French State has entrusted its management to the three major national research organisations **CEA**, the **CNRS** and **Inserm;** and its scientific direction to Arnaud Millet (CEA), Stéphanie Descroix (CNRS), and Maxime Mahé (Inserm). MED-OOC is funded by **France 2030** over **6 years** and has a budget of **€48.4 million** operated by the National Research Agency (**ANR**).


MED-OOC aims to achieve scientific and technological breakthroughs via three promising thematic axes:

- **Multi-sensing O&OoCs.** Challenge: instrument O&OoCs with sensors and actuators that monitor several key parameters involved in tissue metabolism but also more "sophisticated" functions.
- **Patient-derived O&OoCs**, **"clinical twins" of patients for personalized medicine.** Challenge: define and implement the minimum conditions necessary to faithfully imitate the patient's pathology on-chip.
- **Multifunctional and multi-organ O&OoCs** for new therapies. Challenge: develop these O&OoCs as preclinical models to screen and validate drugs, immuno- and biotherapies.

## MED-OOC's mission

Promote a new generation of O&OoCs including those based on patient-derived cells and tissues for personalized medecine


## Outstanding scientific research

Based on **4 targeted priority projects** and **9 recently granted projects** forming the foundation of MED-OOC's research

## Coming up in France

- **Inserm Workshop 2026** | Organ on chip: technologies, applications and new challenges for personalized medicine - October 5-7 in Bordeaux and November 2-6 in Lille & Montpellier
- **Micro & Nanofluidic Research Group (MNF GDR) Summer School 2027 |** with special days dedicated to OoC (France - Location tbd)
- **Scientific conferences**
  - Microphysiological Systems: from organoids to organ on chip - April 2027 in Corsica
  - MED-OOC's Annual Scientific Meeting - 2027 (France - Location tbd)
  - Microfluidics Horizons - 2028 (France - Location tbd)

# European Mobility Assistance

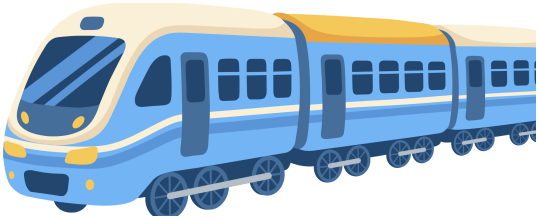
As part of its mission to support research and training, PEPR MED-OOC is setting up a mobility assistance program for researchers and doctoral students who wish to learn innovative techniques or participate in internships, stays, or training courses abroad (within Europe).
The aim is to promote skills development, international scientific collaboration, and the transfer of expertise within the community.

**Are you eligible?**

✔️ Researchers, teacher-researchers, engineers, postdoctoral fellows, and doctoral students affiliated with a French research unit.
✔️ For doctoral and postdoctoral students, mobility must be part of a research project approved by the scientific supervisor.
✔️ The research project must fall within at least one of the thematic areas of PEPR MED-OOC.
✔️ One grant may be awarded per person per calendar year.

**Nature and amount of financial assistance**

✔️Aid ranging from €1,500 to €6,000
✔️ 3 week to 3 month mobility



More information on how to apply on our website

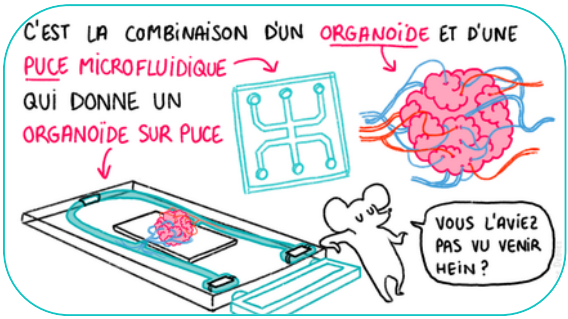
pepr-medooc.fr

# What we also do

## Community Animation & Structuring

### Scientific Events

- Annual MED-OOC internal Seminars to share our knowledge and expertise amongst the projects
- Annual Scientific Days open to the public
- Webinars starting in September 2026




### Outreach

Communicating to the general public on what are OoCs and what we do, thanks to Ana Garre Debiès

## Open Translational Centers

A network of platforms dedicated to OoC - current work in progress

## Launch of a socio-economical study

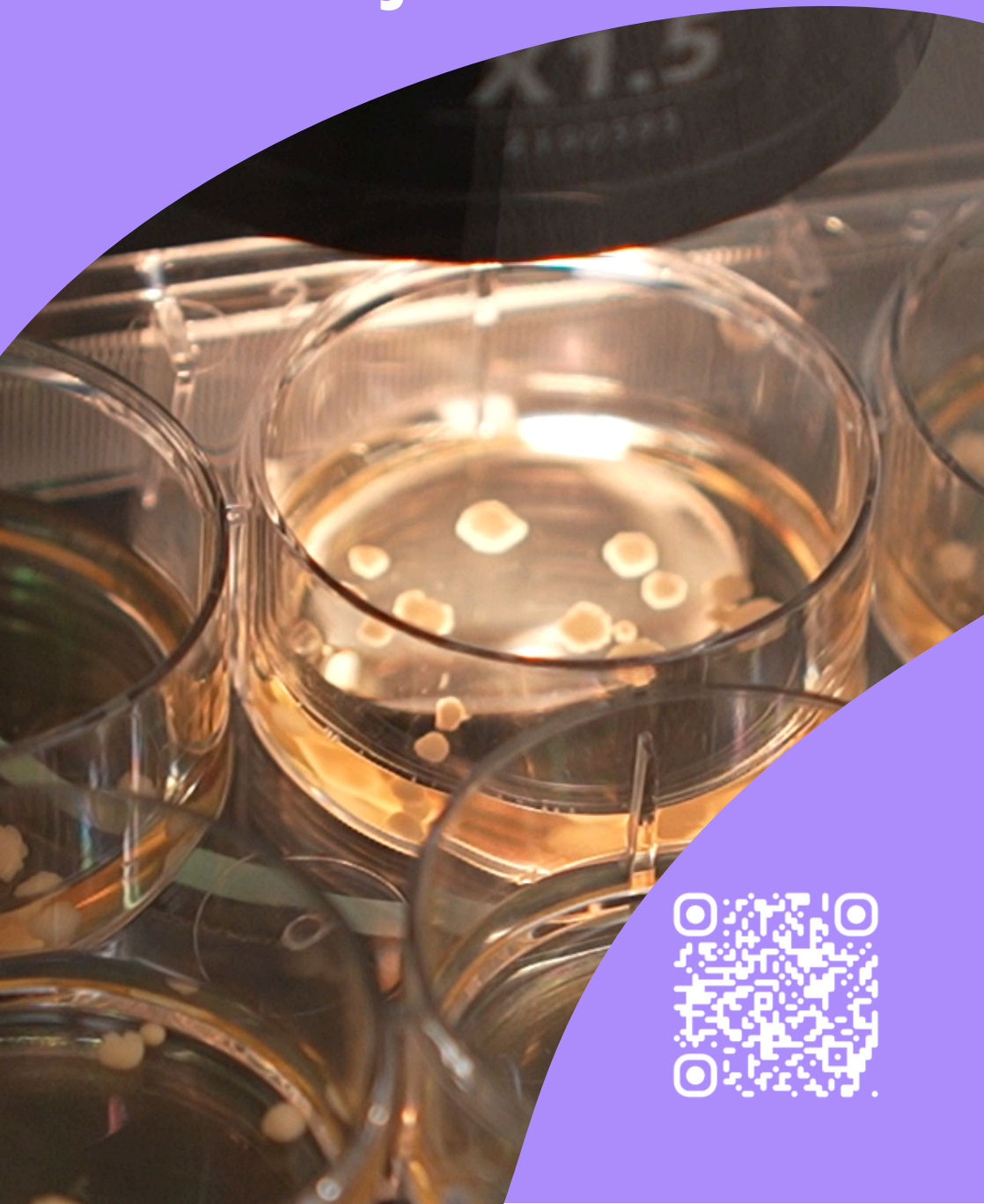
To evaluate the impact OoCs may have on French Health Economics – starting in September 2026

## Anticipation of industrial and clinical transfer

An advisory board of industrials and clinicians providing complementary expertise, focused on impact, use and deployment

and more!

# The Projects



# ENVIE

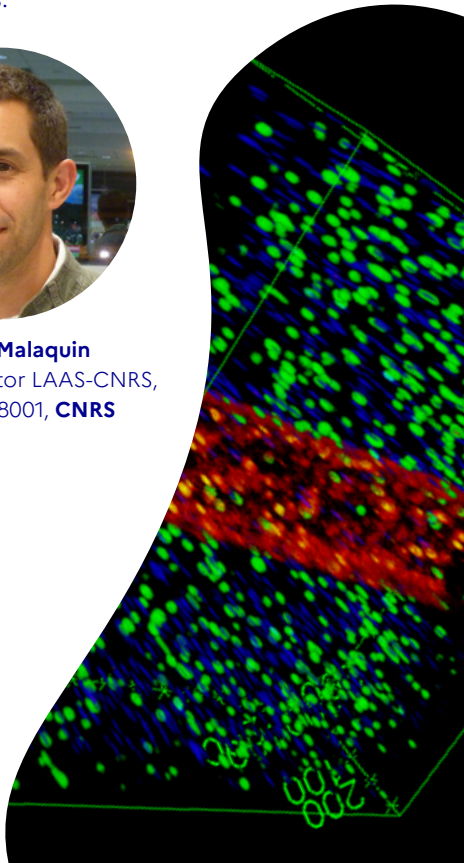
## Technology for microenvironment engineering and imaging for organs-on-a-chip

Current organ-on-chip (OoC) systems lack modular, scalable devices capable of mimicking complex tissue architectures while providing real-time access to cellular and molecular events. EnVie addresses this gap by developing a standardised, modular culture technology that combines microfluidic environmental control with innovative biofabrication methods. Two complementary approaches are pursued: tissue reconstruction (demonstrated on a colon-on-a-chip) and tissue integration (demonstrated by embedding pancreatic ductal adenocarcinoma explants on a chip). The platform integrates a library of ECM-type biomaterials with tuneable mechanical properties, microfluidic perfusion circuits, embedded biosensors, and high-resolution 3D live imaging. Interconnectable EnVie modules enable inter-organ communication studies.

**Audrey Ferrand**
Group Leader I2MC, Inserm u1297, Toulouse University, **Inserm**

**Laurent Malaquin**
Research Director LAAS-CNRS, CNRS UPR 8001, **CNRS**

The ultimate objective is to sustain primary patient-derived tissue cultures over several weeks and screen drugs or microbiota effects, providing a validated technological foundation for personalised medicine applications across the PEPR MED-OoC program.



# MAGIC

## Type 1 Diabetes on Chip

Type 1 diabetes (T1D) affects approximately 10% of the 537 million people living with diabetes worldwide. The current gold-standard treatment, developed by Grenoble University Hospital and reimbursed in France since 2021, is transplantation of pancreatic islets which restores insulin secretion. Yet 40% of patients experience rejection or autoimmune relapse within five years. Monitoring graft function is technically challenging because islets disperse diffusely in the recipient's liver. MAGIC develops Vascularized Islets of Langerhans on a Chip (VLoC): a microfluidic device seeded with a frozen islet sample from each transplanted patient and perfused with the patient's own T cells. Real-time sensors measure insulin secretion as a surrogate of graft viability.



**Fabrice Navarro**
Department manager « Microsystems for life interaction » CEA Leti, **CEA**

**Sandrine Lablanche**
Head of the Endocrinology, Diabetology and Nutrition Department,
**CHU Grenoble Alpes**

A low-risk clinical study with at least ten transplanted patients will validate this approach. In parallel, the VLoC will serve as a drug-testing tool for new immunosuppressants and explore overexpression of PD-L1 in iPSC-derived islets as a path toward autologous cell therapy requiring fewer immunosuppressive agents.

# MSY-OOC

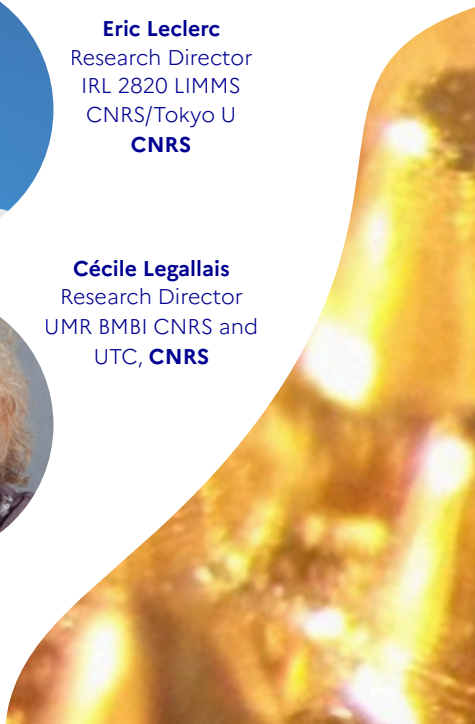
## Multi-organ coupling on a chip for metabolic syndrome monitoring

Metabolic-associated fatty liver disease (MAFLD) affects 25% of European adults and can progress to cirrhosis or hepatocellular carcinoma. It is tightly linked to metabolic syndrome (MSy), encompassing type 2 diabetes, obesity, and cardiovascular disease, which affects up to 36% of the European population. Animal models fail to reproduce human hepatic metabolism, and existing liver-on-chips do not fully recapitulate the perfused human liver. MSY-OOC builds on 20 years of consortium expertise in hepatic engineering and microphysiological systems to develop a next-generation liver-on-chip that reproduces cellular interactions, ECM properties, and lipotoxic conditions of MAFLD. A multi-organ demonstrator will couple the liver, adipose tissue, and vascular wall using the patented CCDIM Box platform. Biomarkers validated against patient cohort data will be identified, and innovative therapies evaluated, supporting risk stratification and personalised treatment development.

**Jean-Charles Duclos-Vallée**
PUPH in gastroenterology and hepatology at the Centre Hépato-Billaire of Hôpital Paul-Brousse APHP, Inserm, Paris Saclay U,
**Inserm**

**Eric Leclerc**
Research Director
IRL 2820 LIMMS CNRS/Tokyo U
**CNRS**

**Cécile Legallais**
Research Director
UMR BMBI CNRS and UTC, **CNRS**



# TME ON CHIP

## Tumor-on-a-Chip to Improve Patient Care

Cancer is the leading cause of premature death in France, with approximately 3.8 million people currently living with the disease. Response to treatment, including immunotherapy, is strongly shaped by the tumour microenvironment (TME), yet reliable patient-derived in vitro predictive models are lacking. TME On Chip develops patient-derived Tumour-on-Chip (ToC) devices that faithfully reproduce breast cancer TME complexity, integrating tumour cells, cancer-associated fibroblasts (CAFs), immune cells, and an endothelial vessel within a 3D matrix. The project focuses on triple-negative breast cancer (TNBC) and advanced cancers.

**Stéphanie Descroix**
Researcher Director
Cell Physics and Cancer Unit (UMR 168) Institut Curie, CNRS, PSL U, Sorbonne U, **CNRS**

**Luc Cabel**
Medical Oncologist,
**Institut Curie**

Two clinical studies will be conducted at Institut Curie: an observational study (~80 patients per stage) assessing predictive concordance between ToC and patient response, followed by an interventional trial using ToC-based 'tumorograms' to guide treatment selection, with a target response rate of at least 25% versus 10–15% with conventional chemotherapy.

# AUGMENT

## Advanced Gut on a Chip to Decipher Gamma-delta T Cells Mediated Immune Response to a Viral or Fungal Infection

Conventional gut-on-chip models rely on oversimplified epithelial monolayers that ignore immune and stromal components, limiting their relevance for host-pathogen interaction studies. AUGMENT designs and validates a next-generation gut-on-chip (GoC) platform that incorporates the intestinal stromal microenvironment, including fibroblasts and γδ T cells, to investigate host responses to Candida albicans and Cytomegalovirus (CMV) infections. γδ T cells, abundant in the gut and occupying a unique interface between innate and adaptive immunity, are a particular focus. The chip architecture is optimised for live imaging and integrates photopatterned hydrogels mimicking ECM properties, full-field optical coherence tomography (FF-OCT), and an Incubascope for real-time label-free monitoring of cell dynamics.

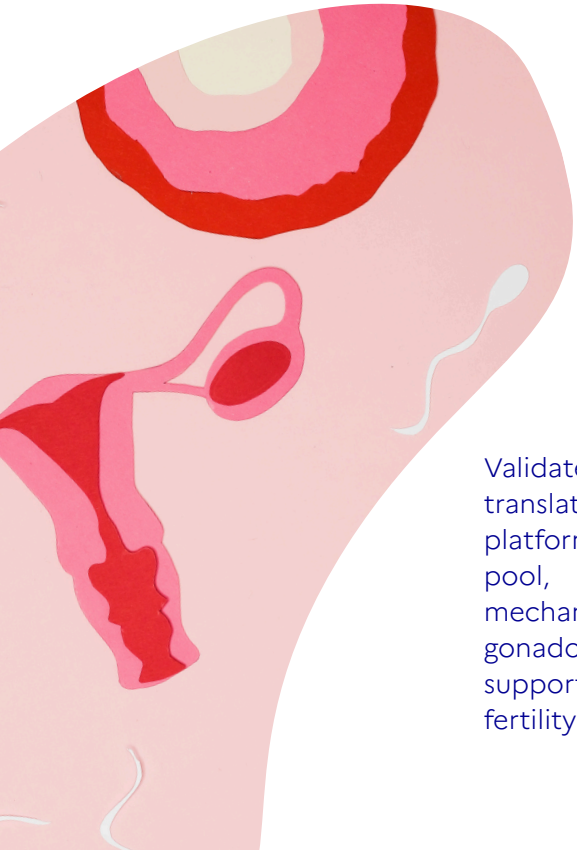
**Julie Déchanet-Merville**
Research Director
**CNRS**

Primary cells from a donor biobank established with Bordeaux University Hospital will be compared against cell lines via multiplex imaging and single-cell RNA sequencing, providing mechanistic insights into immune regulation and identifying new therapeutic targets.

# FERTILOOC

## Testis organ-on-chip: an asset to study spermatogonial stem cell fate and develop biotherapies of infertility

Infertility affects one in six couples worldwide, with male factors responsible for approximately half of cases. For patients undergoing gonadotoxic therapies, particularly prepubertal boys who cannot yet bank sperm, cryopreserved testicular biopsies represent the only fertility-preservation option, yet the molecular mechanisms governing spermatogonial stem cell (SSC) self-renewal and differentiation remain poorly understood. FERTILOOC develops testicular organ-on-chips designed to recapitulate in vitro the microenvironment required for SSC maintenance and induction of spermatogenesis in prepubertal tissue. A key innovation is a parallelised, live-imaging OoC system capable of analysing multiple chips simultaneously under oscillatory fluidic patterns that mimic systemic hormonal regulation.



**Pierre Fouchet**
Research Director
**CEA**

Validated first in murine models then translated to human biopsies, the platform will delineate the human SSC pool, reveal niche interaction mechanisms, enable screening of gonadotoxic agents, and ultimately support cell-therapy strategies for fertility preservation in cancer patients.

## HITOC

## Development of a neurocompetent multi segment intestinal OoC based on hiPSC for studying intestinal infectious diseases

Existing intestinal OoC models are restricted to single segments and lack the enteric nervous system (ENS), critically limiting their ability to capture spatially resolved host-pathogen interactions and gut-brain axis communication. HITOC builds a next-generation intestinal tract-on-chip from human induced pluripotent stem cells (hiPSCs) that recapitulates rostrocaudal gut segmentation (duodenum, jejunum, ileum, colon) and integrates a functional ENS derived from vagal neural crest cells. Spatially controlled morphogen gradients guide segment-specific differentiation on chip. Transparent 3D microelectrode arrays (MEAs) enable simultaneous electrophysiological recording of ENS activity, calcium imaging, and impedance-based epithelial barrier monitoring in real time.

**Alexandre Grassart**
Assistant Professor
**Inserm**

As a proof of concept, the platform will model infection by human-restricted pathogens (Shigella, Norovirus) known to target distinct gut regions, and will explore how microbiota-derived short-chain fatty acids modulate ENS neuronal circuits, providing new insights into gut-brain communication and neurogastrointestinal disorders.

# MICROCOSM

## A modular multi-organ-on-chip for personalized medicine in chronic obstructive pulmonary disease (COPD)

COPD is the third leading cause of death worldwide, yet treatment personalisation remains limited due to patient heterogeneity and a lack of predictive models. While the recent FDA approval of dupilumab for eosinophilic COPD represents progress, its benefit is restricted to a subset of patients, and identifying responders to biologics targeting epithelial alarmins (TSLP, IL-33) remains a major challenge. In addition, systemic effects of biologics remain to be determined, such as effects on skeletal muscles. Indeed, sarcopenia further increases mortality risk in COPD, highlighting the need for improved therapeutic strategies, but the lack of predictive models further hampers personalized treatment approaches.

**Isabelle Dupin**
Professor
**Université de Bordeaux**

MICROCOSM develops a modular multi-organ-on-chip integrating lung (airway and alveolar) and skeletal muscle cells derived from COPD patient progenitors. This model will allow to better mimic human physiology, and pave the way for personalized immunotherapy in COPD, improving patient outcomes and therapeutic success rates.

# MOHICAN

## Microassays Of Immune Cells Functional Analysis for Routine Personalized Clinical Oncology

Functional immunological assays are essential for guiding immunotherapy but are too complex, slow, and costly for routine clinical use. MOHICAN develops new microfluidic medical devices that integrate subcellular-scale molecular micropatterns to recreate structures mimicking secondary and tertiary lymphoid tissues. These devices enable real-time, single-cell, multiparametric kinetic analysis of T lymphocytes, CAR-T cells, and NK cells, including sorting, positioning, spatiotemporal activation, and detection of surface markers and cytokine secretion. Clinical applications focus on haematological cancers in collaboration with AP-HM and the Paoli-Calmettes Institute: patient stratification for monoclonal antibody therapies, predictive profiling of CAR-T cell products before administration, and post-treatment monitoring.

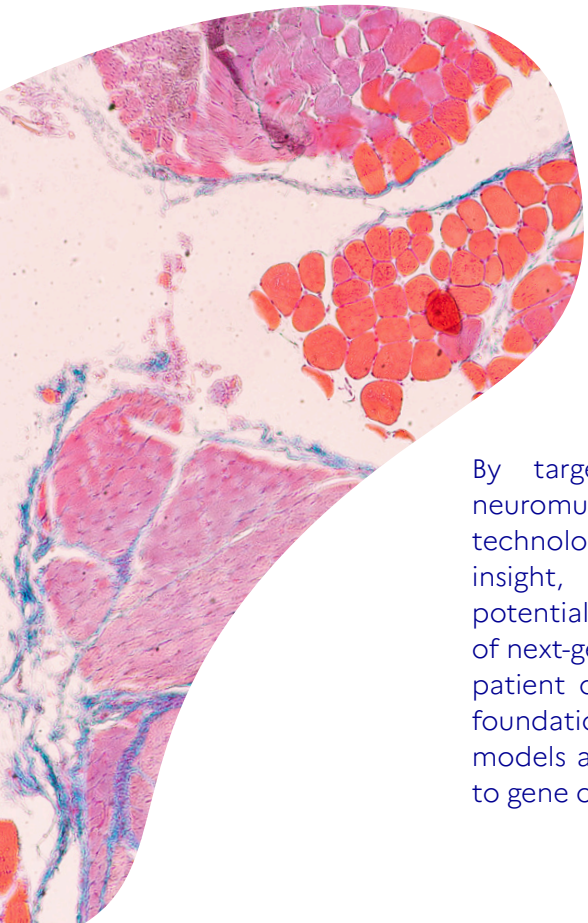
**Olivier Theodoly**
Research Director
**CNRS**

The chip fabrication process will be fully automated for high-throughput production.
A complete technological pipeline from blood sampling to multiparametric immune readout will be integrated into routine hospital workflows, constituting a central companion diagnostic device for personalised immunotherapy.

# MUSCLOR-OC

## The Skeletal Muscle Complexity Recapitulated on a Chip to Model Neuromuscular Diseases and Predict Treatment Efficacy

Skeletal muscle is the most abundant tissue in the human body and is critically compromised in neuromuscular disorders (NMDs) such as Duchenne Muscular Dystrophy (DMD) and Spinal Muscular Atrophy (SMA), as well as in sarcopenia and chronic disease. Current in vitro models fail to reproduce native muscle's spatial organisation, cellular complexity, and domain-specific functionality. MUSCLOR-oC engineers a next-generation human skeletal muscle-on-chip that, uniquely, integrates both neuromuscular junctions (NMJs) and myotendinous junctions (MTJs) within a single construct.



**Frédéric Relaix**
University Professor and
Hospital Partitioner
**Inserm**

By targeting key unmet needs in neuromuscular research and integrating technological innovation with logical insight, MUSCLOR-oC holds strong potential to accelerate the development of next-generation therapies and improve patient outcomes. It will also provide a foundation for building clinical twin models and stratifying patient responses to gene or drug therapies.

# NEMOCHIP

## Integrated Human Neuromuscular-on-Chip and Virtual Replica Platform for Diagnosis, Disease Modelling, and Drug Evaluation

Neuromuscular diseases (NMDs) are primarily genetic, often progressive and incurable, affecting millions worldwide. Diagnostic delays are common due to restricted access to patient-derived tissue and the limited human relevance of animal models - particularly at the neuromuscular junction (NMJ), the critical site of nerve-muscle communication. NeMOCHIP creates standardised, patient-derived hPSC-based neuromuscular platforms that incorporate spinal motor neurons, skeletal muscle, and self-organising NMJs in OoC systems enabling real-time non-invasive functional assessment.
A comprehensive NMJ atlas combining RNA-seq, spatial transcriptomics, imaging, and biosensor data is integrated into a virtual replica (digital twin) for personalised diagnostics and treatment planning.

**Cécile Martinat**
Directrice de recherche
**Inserm**

Translational applications include standardised functional assays for myasthenic syndromes, disease-specific models for myotonic dystrophy type 1 (DM1) and facioscapulohumeral dystrophy (FSHD), and tools for therapeutic screening and patient stratification. All resources - cell lines, atlases, and analytical tools - will be made openly accessible, supporting the French National Plan for Rare Diseases (PNMR4).

## ON-CHIP

## Optic Nerve-on-Chip: A 3D iPSC-Based Platform for Vision Repair and Drug Discovery

Glaucoma - particularly primary open-angle glaucoma (POAG) - causes progressive and irreversible degeneration of retinal ganglion cells (RGCs), whose axons form the optic nerve. No existing OoC model integrates the multiple interacting components of this disease. ON-CHIP develops a human Optic Nerve-on-a-Chip by unidirectionally connecting iPSC-derived retinal organoids to cerebral assembloids through a 3D microfluidic channel that enables RGC axon growth and fasciculation - reconstituting a three-dimensional optic nerve for the first time in vitro. The platform incorporates glial cells, microglia, and inflammatory monocytes to reproduce neuroinflammation, and allows controlled channel deformation to mimic elevated intraocular pressure.

**Xavier Guillonneau**
Chargé de recherche
**Inserm**

Retinal organoids may be genetically modified to introduce patient-specific POAG risk variants. Genetically encoded sensors provide dynamic real-time monitoring of RGC homeostasis. The system will be used for pharmacological screening, gene therapy validation, and evaluation of iPSC-derived cell transplantation strategies to overcome the limited survival and integration of grafted cells in the altered glaucomatous environment.

## SOFTER

## SOFT Tumour On Chip Mimicking Endometrial Tumour Microenvironment to Predict Therapeutic Efficacy

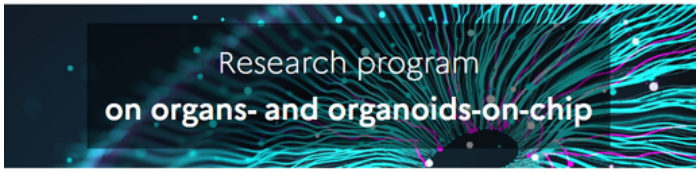
Endometrial cancer (EC) is projected to become the third most common cancer and fourth leading cause of cancer deaths in women by 2030. While immunotherapy benefits patients with microsatellite instability (MSI), the majority (75%) of EC cases are microsatellite stable (MSS) and respond poorly. Advanced preclinical models that predict individual treatment responses are urgently needed. SOFTER develops a Soft-Tumour-on-Chip (Soft-ToC) that recapitulates key EC tumour microenvironment (TME) features: hypoxia, tuneable ECM stiffness, endothelialized vascular channels, and resident immune cells. By combining multiplexing, automation readiness, and physiological relevance, the platform aims to meet the reproducibility and scalability standards required for translational research and preclinical drug testing.

**Charlotte Rivière**
Professeure des Universités
**Université Claude Bernard Lyon 1**

Predictive performance for standard chemotherapies and immunotherapeutics will be benchmarked against tumoroids and validated through correlation with patient outcome data. Deep Learning approaches will be used to correlate multi-parametric readouts with clinical outcomes and identify robust biomarker signatures, supporting personalised therapeutic decision-making.

## For more news about PEPR MED-OOC

Visit our website





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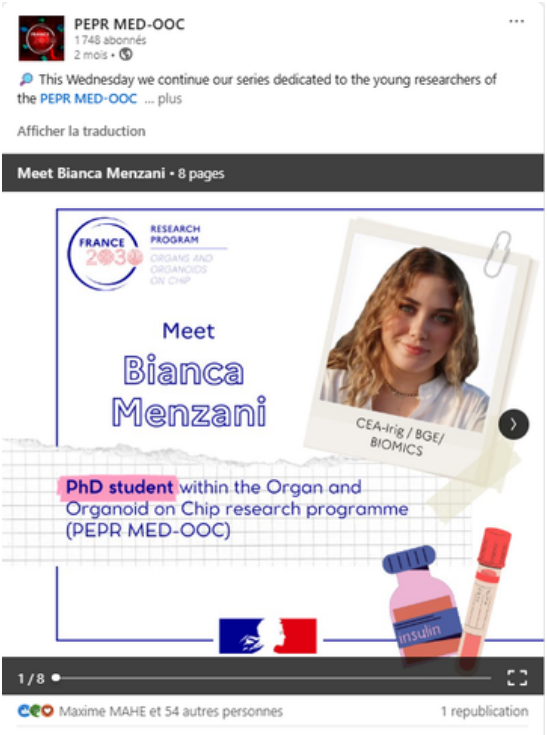


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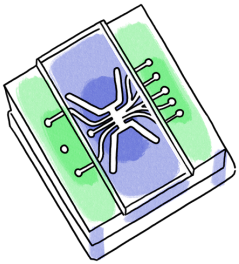

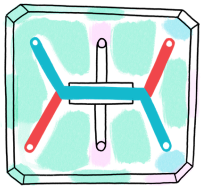
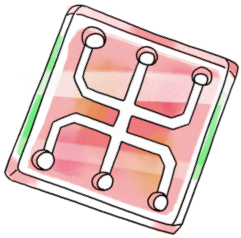

FRANCE 2030

**RESEARCH PROGRAM**

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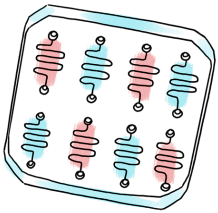
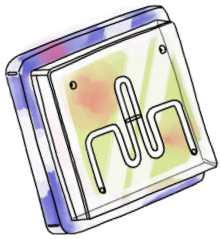

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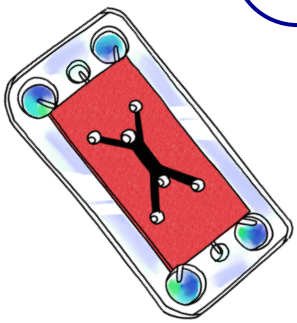
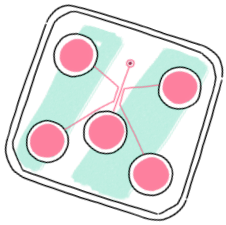
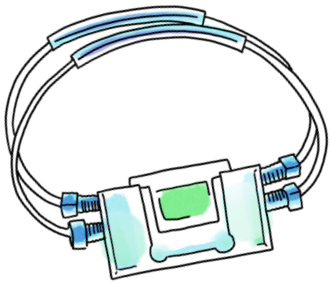
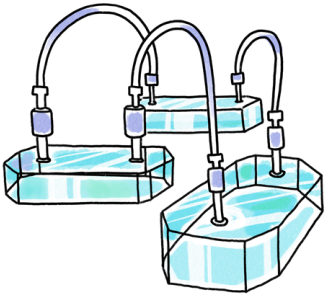
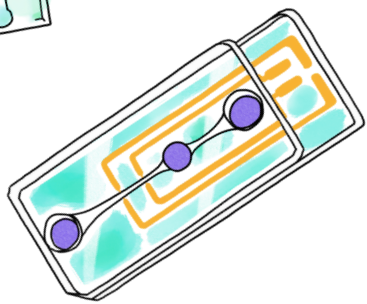
contact@pepr-medooc.fr

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