
ORGANS-ON-CHIP
AND
MICROPHYSIOLOGICAL SYSTEMS
Activities & Thesis Projects

Research Activities: Organs on Chip

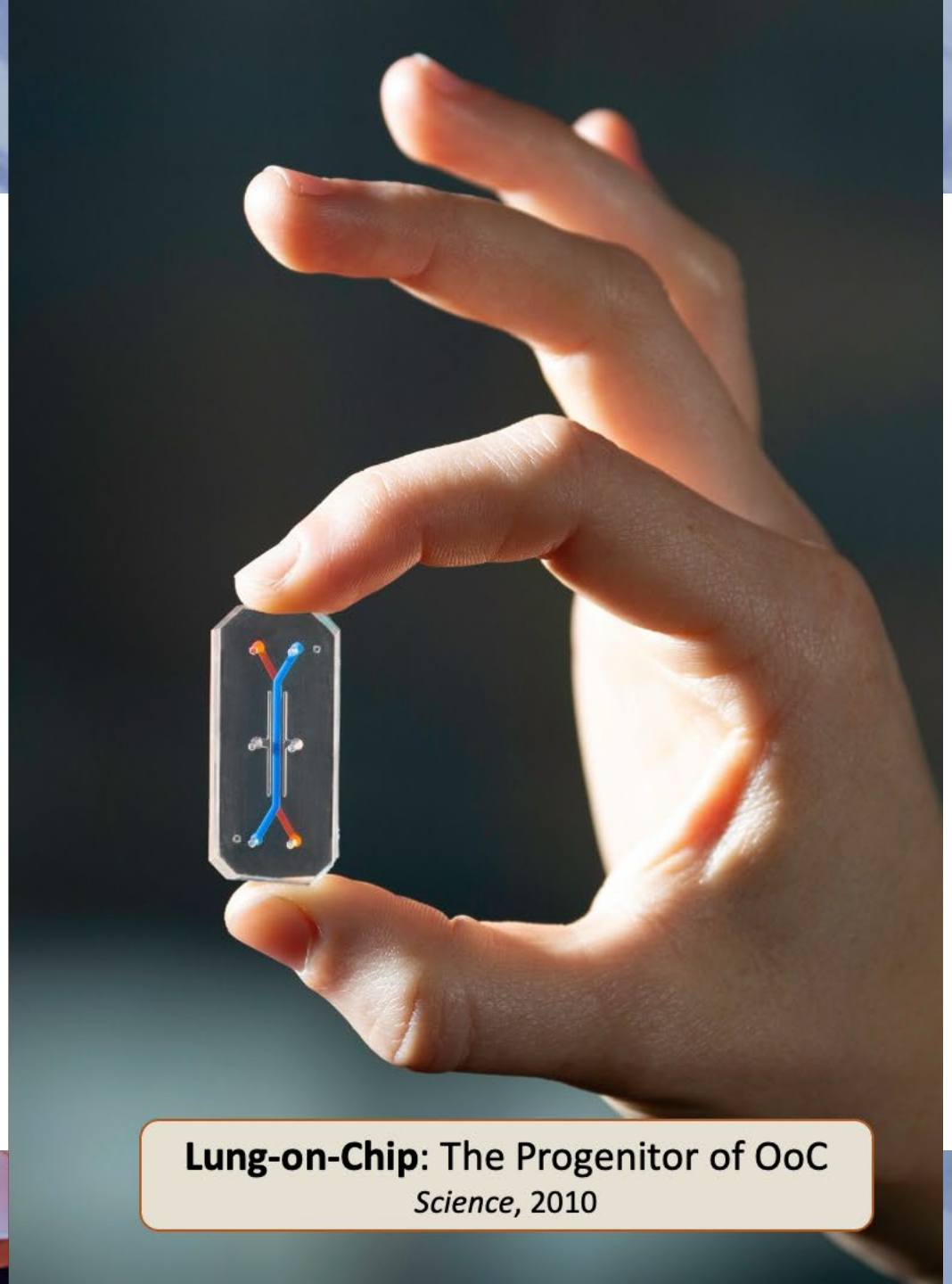
Pseudo-definition

An Organ-on-Chip (Ooc) refers to a population of **tissue cells** in a "smart" microenvironment (**chip**). The goal of an organ-on-chip *"is not to build a whole living organ but rather to synthesize minimal functional units that recapitulate tissue- and organ level functions"* (Don Ingber).

Applications

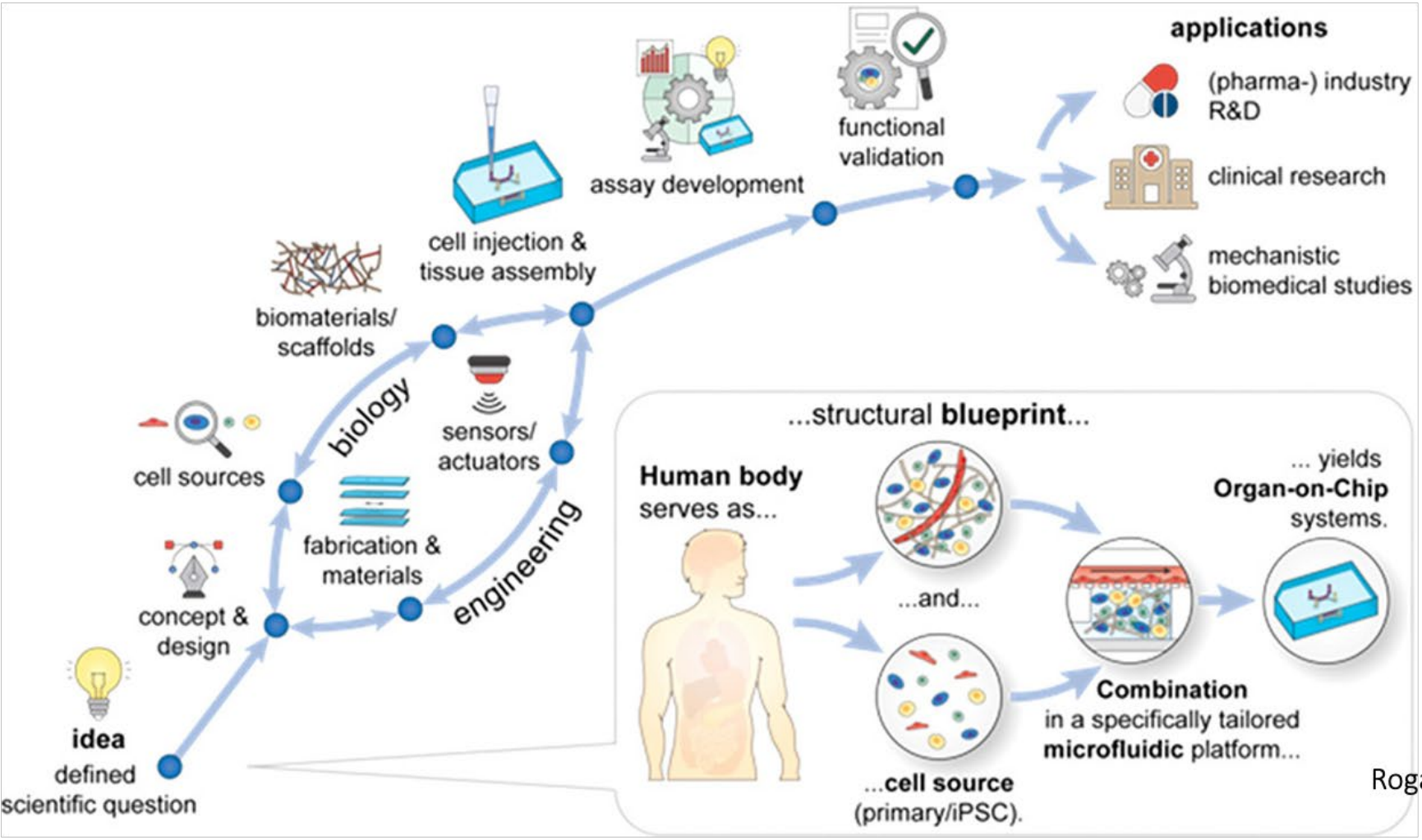
Understanding mechanisms of pathologies
Drug discovery
Development of advanced therapies
Precision medicine

Reduction of animal use in research



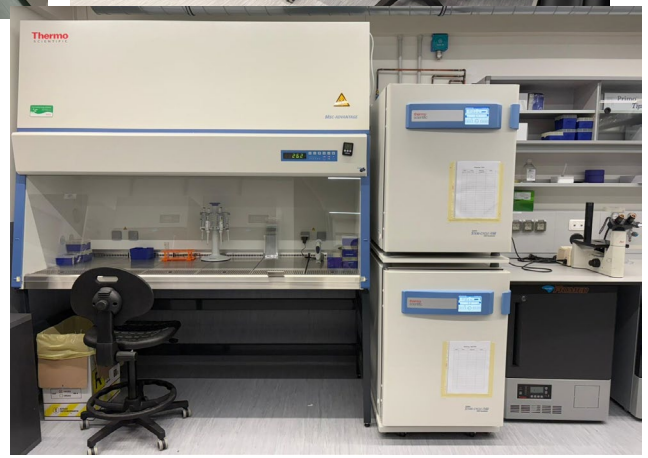
Lung-on-Chip: The Progenitor of OoC
Science, 2010

Organs on Chip Roadmap



Rogal et al., ACS Biomater. Sci. Eng. 2022, 8, 4643−4647

Labs and equipment



MiMic Lab

EvOoC Lab

Microfabrication facilities (powered by access to PoliFab)

Cell culture and analysis facilities:

- Cell culture h
- Molecular Biology (digital and real time PCR)
- Advanced Microscopy (epifluorescence and spinning disk micrioscope)
- Cell sorter and citofluorimeter
- Plate reader

Team


Marco Rasponi


Paola Occhetta


Mattia Ballerini

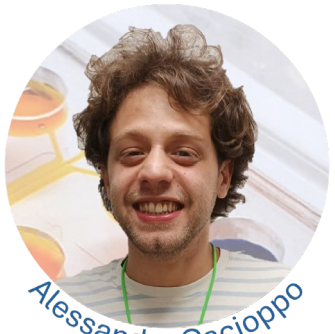

Cecilia Palma


Alberto Mantegazza


Alessandro Cordiale


Elisa Monti


Bianca Aterini


Alessandro Cacioppo


Giacomo Cretti

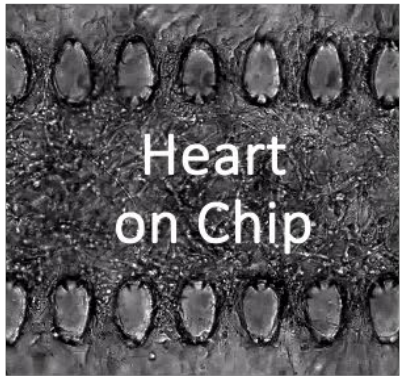

Elia Pennati

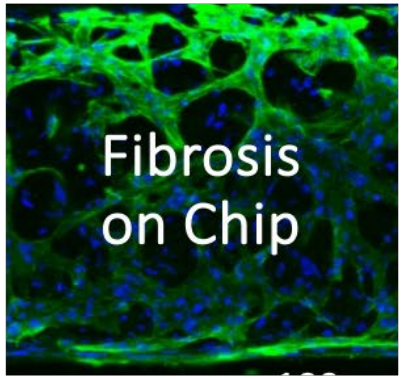

Teresa Lucifora

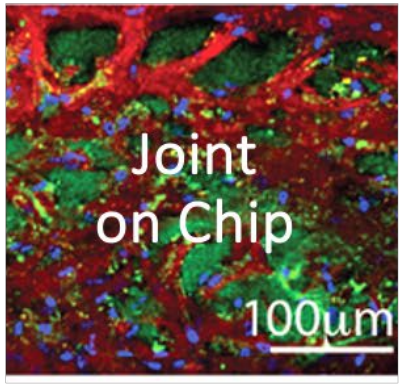

Sophie Materne

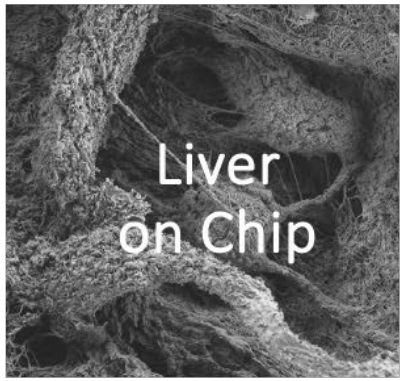

Marina Pata

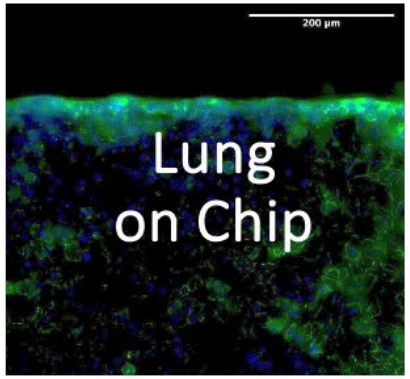
Organs-on-Chip @ MiMic Lab

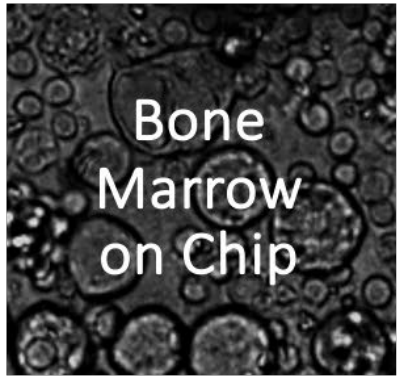


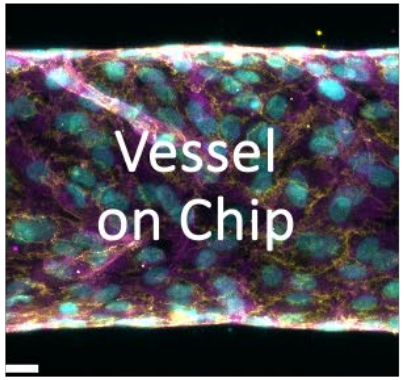


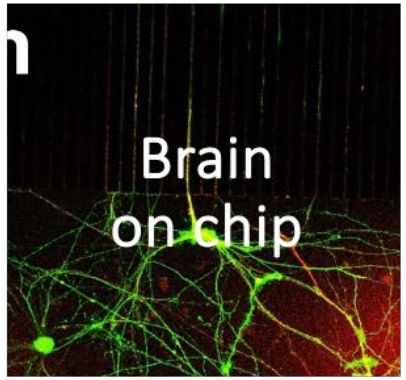


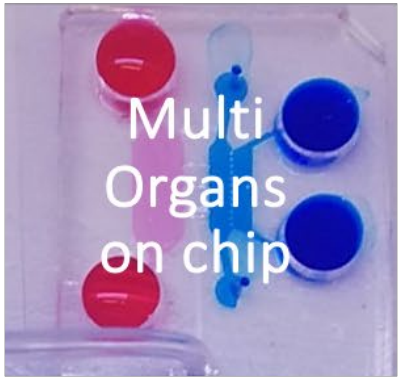


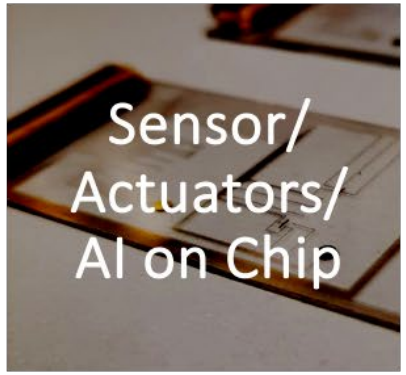




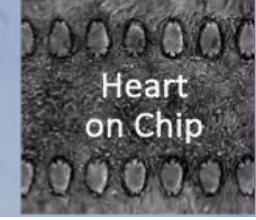






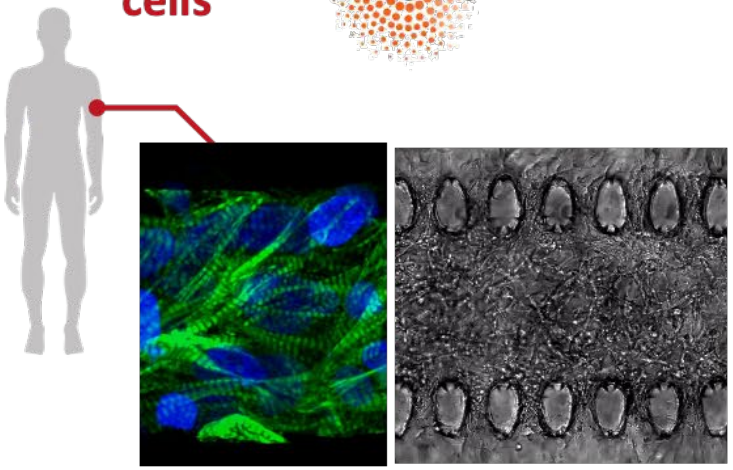


Example 1: Heart-on-Chip



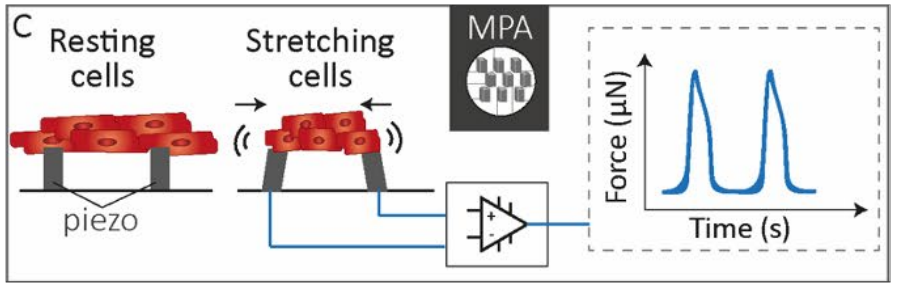
Human cells

European Research Council



- Commercially available healthy iPSC-derived cardiomyocytes
- iPSC-derived cardiomyocytes from patients with genetic mutations

Sensors' integration and AI algorithms for data analysis

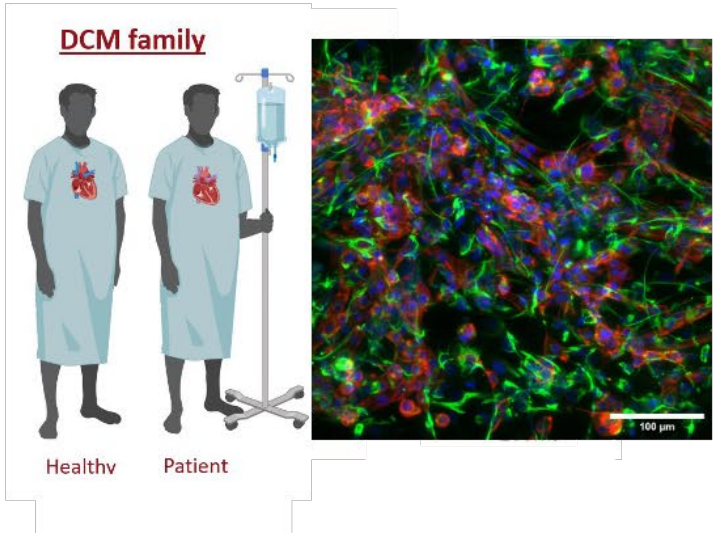


BiomimX
THE BEATING ORGANS-ON-CHIP

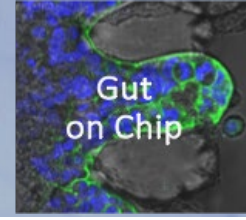
HUMANITAS
RESEARCH HOSPITAL

Output

- Physiological model for drug screening (cardiotoxicity)
- Disease models (laminopathies, dilated cardiomyopathy)

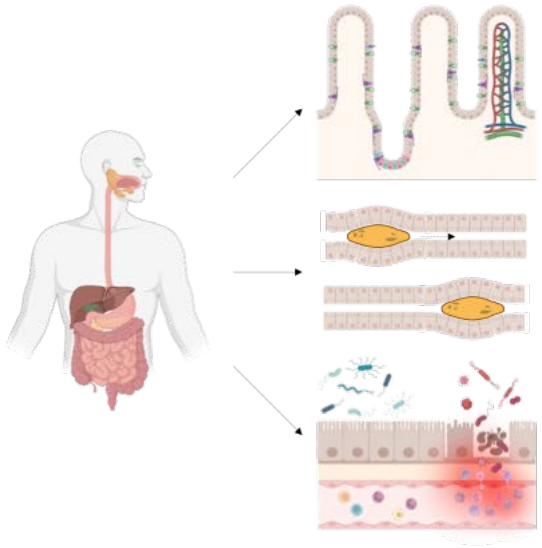


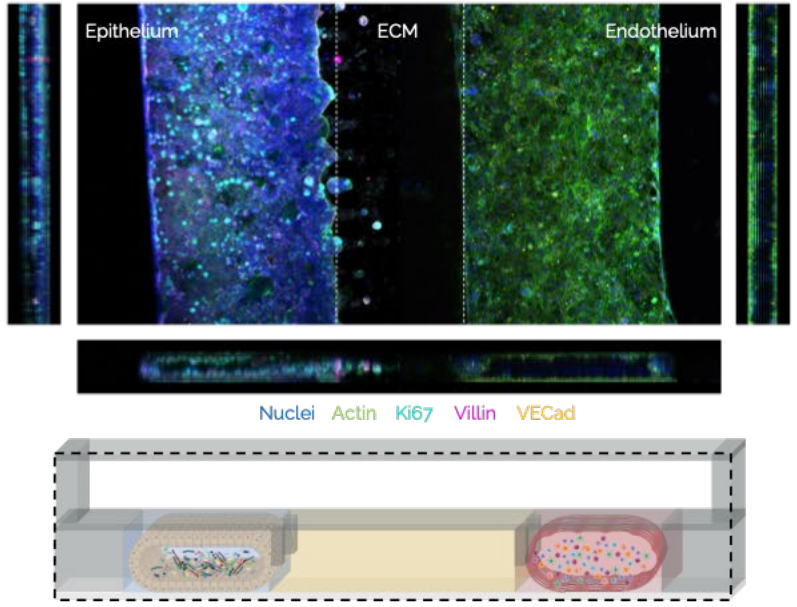
Example 2: Gut-on-Chip



IEO
Istituto Europeo
di Oncologia

Mechanically active 3D gut on chip model





PATH 1:
Testing of immunotherapies on- and off-target effects (through integration in multi-organs on chip)

PATH 2:
Modelling gut-related disorders (e.g. IBD)

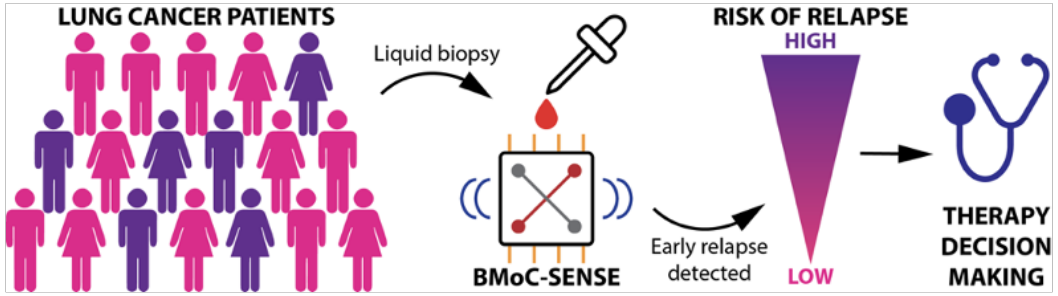
PATH 3:
Screening drug absorption and integration of online readouts (e.g. TEER)

Example 3: Bone Marrow-on-Chip

Bone Marrow on Chip

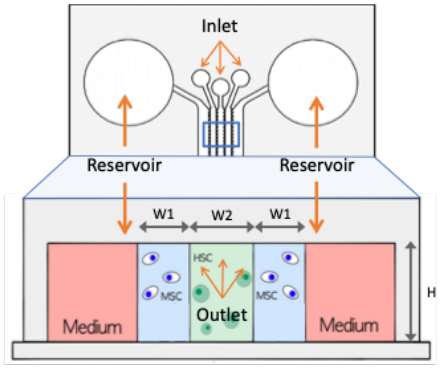
Clinical need: development of an organ on chip based-sensor for early detection of tumor relapse

EIC Pathfinder



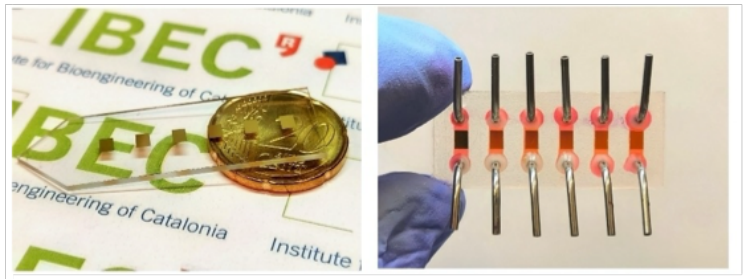
FONDAZIONE IRCCS ISTITUTO NAZIONALE DEI TUMORI

STEP1 - New chip design
recapitulating bone marrow niche

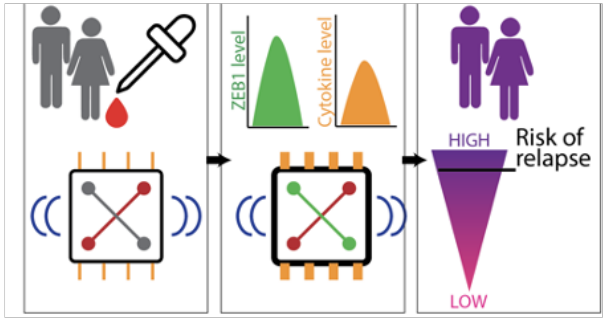


LUNDS UNIVERSITET

STEP2- Online sensors
to detect niche changes



STEP3- Clinical validation
chip data correlated with patient prognosis



Active collaborations

Italy:

- BioCell (gene delivery/report cell lines)
  Prof. Gabriele Candiani
- IRCCS Galeazzi (joint, tumor)
  Dr. Matteo Moretti, Dr. Silvia Lopa
- IRCCS Humanitas Hospital
  Dr. Elisa Di Pasquale (heart)
  Dr. Ana Lleo De Naldo (liver/tumor)
  Dr. Simona Lodato (Brain)
- Istituto Europeo Oncologia
  Dr. Luigi Nezi (Gut)
- San Raffaele Hospital (Brain circuits)
  Prof. Vania Broccoli
- IRCCS Istutito Nazionale dei Tumori (Bone Marrow)
  Dott. Sabina Stangaletti
- Politecnico di Torino (Cardiac fibrosis)
  Prof. Valeria Chiono
- Università di Genova (Cardiac fibrosis)
  Prof. Sveva Bollini
- Human Technopole (Brain)
  Dott. Elena Taverna
- Università di Parma (Heart)
  Dott. Michele Miragoli
- Università Roma Torvergata (heart/AI)
  Prof. Eugenio Martinelli
- Campus Biomedico Roma/CNR Nanotec Lecce (imaging/gut)
  Prof. Alberto Rainer
- BiomimX Srl
  Dr. Roberta Visone

Abroad:

- University Hospital Basel (joint)
  Prof. Ivan Martin
  Prof. Andrea Barbero
- Imperial College London (gut/vessel)
  Prof. Anna Randi
- Brunel University (vessel)
  Dr. Camilla Cerutti
- Houston Methodist Research Institute
  Dr. Francesca Taraballi (joint)
- NMI (U Tubingen) (cardiac)
  Dr. Udo Kraushaar
- Lund University (bone marrow)
  Prof. Paul Bourgine
- Institute for Bioengineering of Catalonia
  Prof. Javier Ramon (sensors)
- Micronit (The Netherlands) (microfabrication)
  Dr. Sandro Meucci

How does a thesis in MiMic Lab work?

- Duration: 12 months average; full time
- 1 supervisor (PhD student or Postdoc)
- Initial general training of device production (around 1 month)
- Specific thesis project assigned after the training
- Biological training if needed
- Participation to bi-weekly meetings (JC, presentation of project advancement)

We are collecting applications, contact: Marco Rasponi (marco.rasponi@polimi.it) or Paola Occhetta (paola.occhetta@polimi.it)