



Development of an instrumented
physiological microdevice to study the
impact of the vascular microarchitecture
and tumoral context on the brain
angiogenesis and blood-brain barrier.



Forum Cancéropôle Est - November 28, 2025

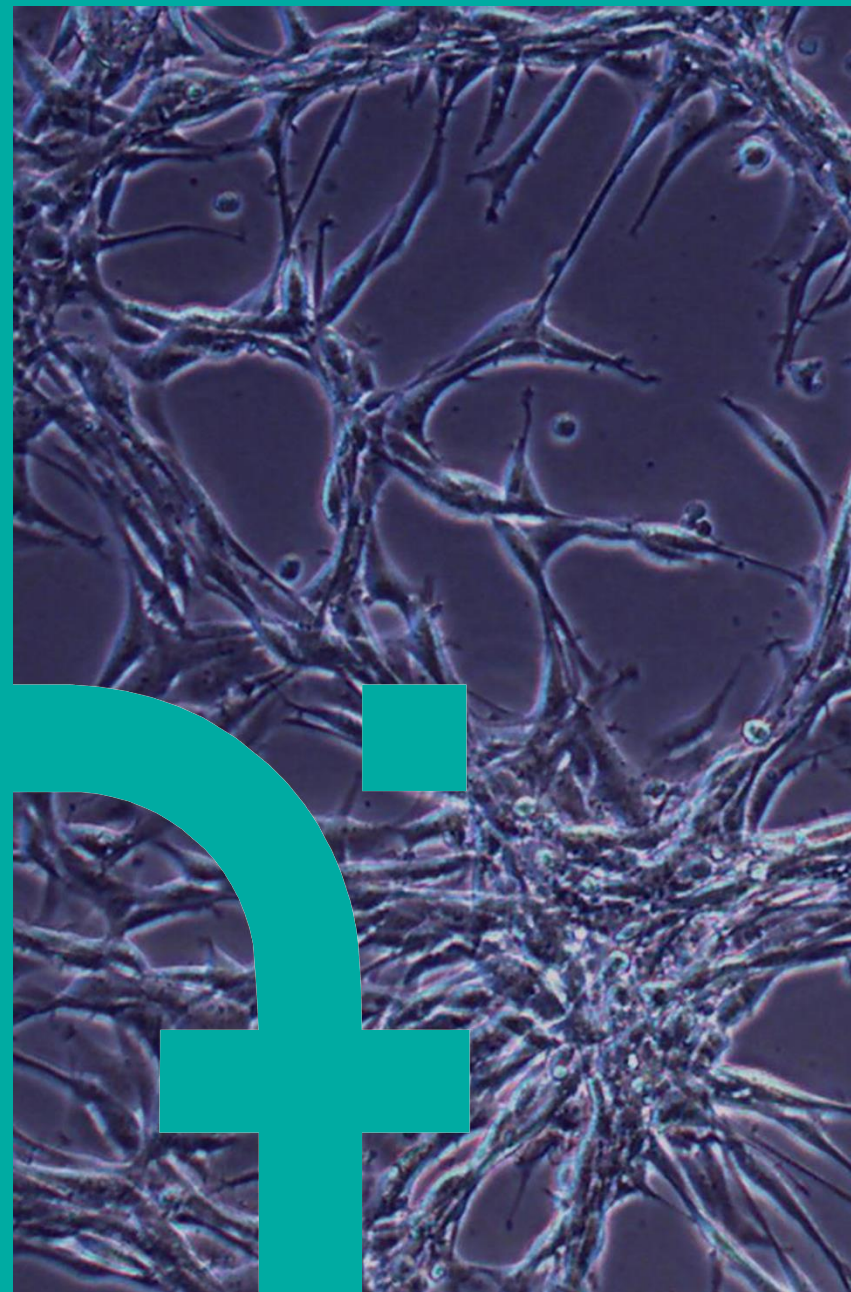
FEMTO-ST / MN2S / BIND



PhD supervised by Thérèse LEBLOIS and Agathe FIGAROL

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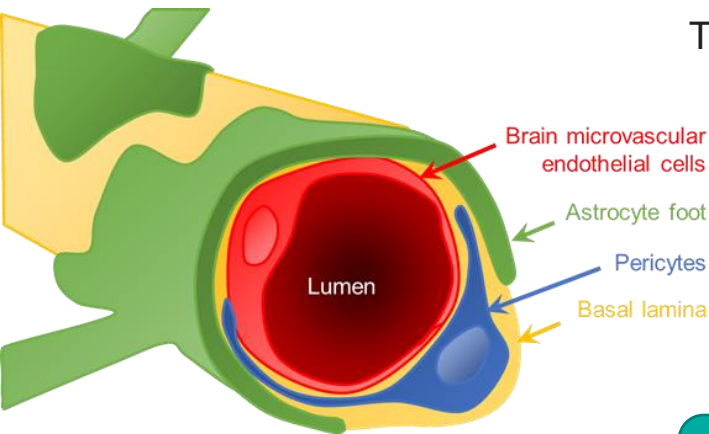


CONTEXT: glioblastoma multiforme and blood-brain-barrier

The glioblastoma multiforme (GBM) is the most frequent and aggressive brain cancer.

- Perturbation of brain communication
- Current treatment: chemotherapy + radiotherapy, with many surgeries
- Almost systematic recurrence, median survival 12 - 18 months

⇒ Major challenge in the development of treatments.



The BBB = blood brain barrier:

- Physical and metabolic barrier
- Protection from external aggression
- Blood filtration => allows the passage of waste, nutrients, O₂, CO₂

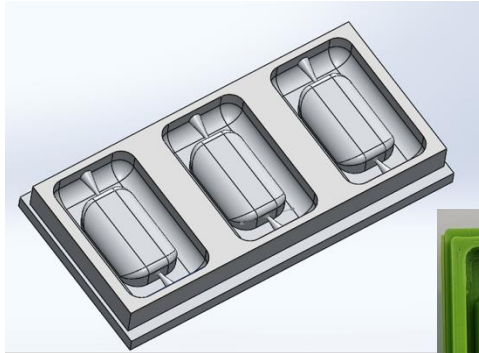
GBM impact



Lack of understanding of
consequences + mechanisms

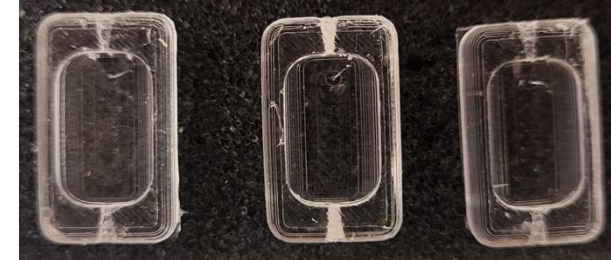
Objective: to develop a new BBB-on-chip model with a complex vascularization to recreate a vascular microenvironment and simulate tumoral conditions

BBB-on-chip design



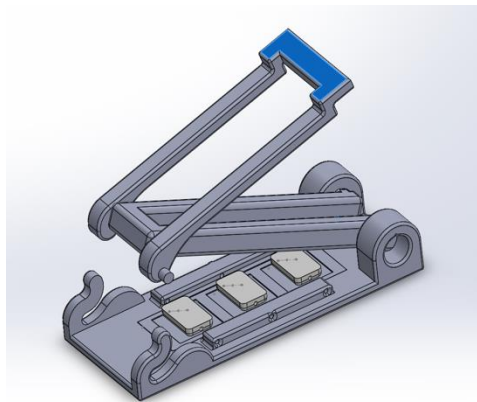
PLA mold

PDMS pouring



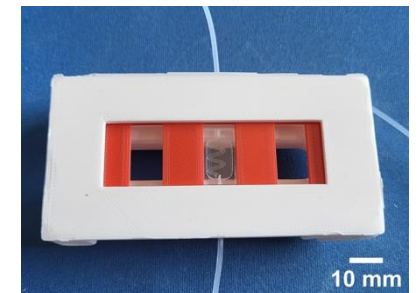
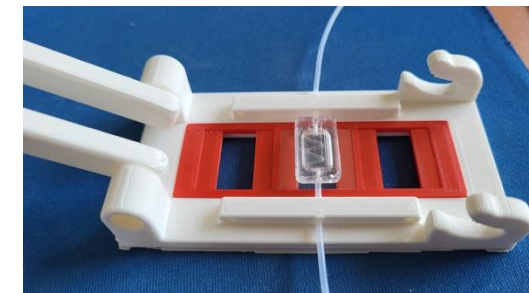
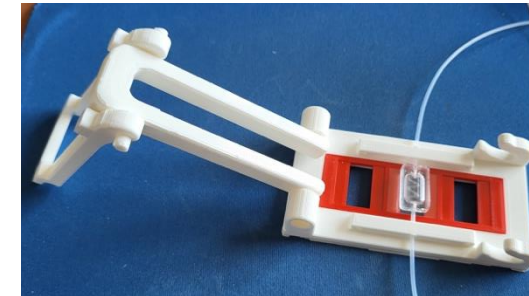
PDMS microchip

CAD + 3D printing



Lock and play device

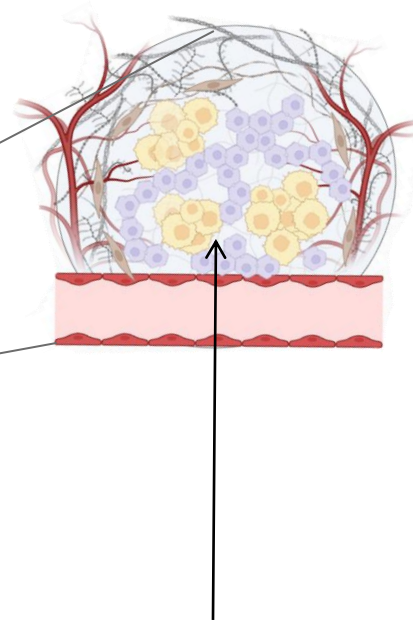
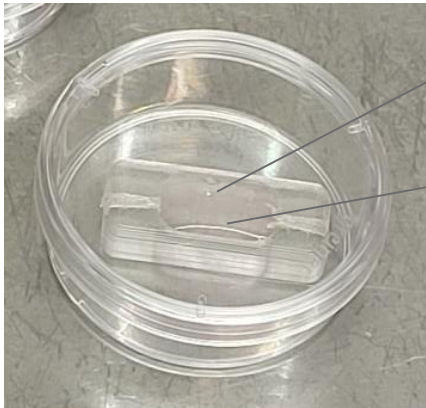
Sealed but reversible closure of the microchip with glass cover



BBB-on-chip composition

Hydrogel as 3D scaffold

- 3D cell organization and interactions
- Extracellular matrix protein



3D cell culture

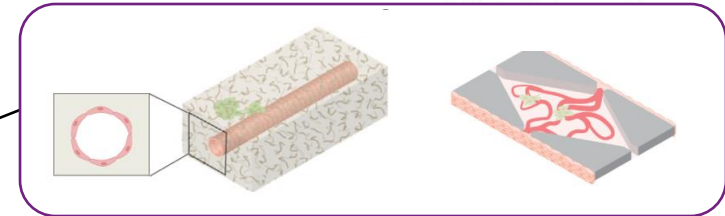
- HBMEC : Human Brain Microvascular Endothelial cells
- HA : Human astrocytes
- HP : Human pericytes
- **U-87 : Tumoral cells**

Macro-

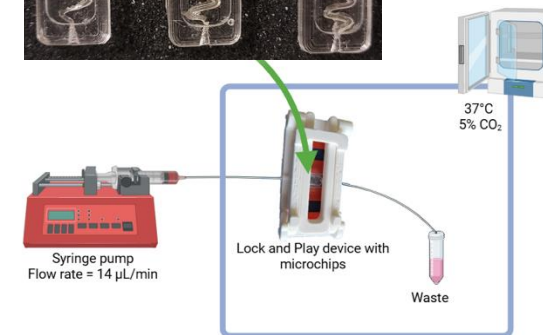
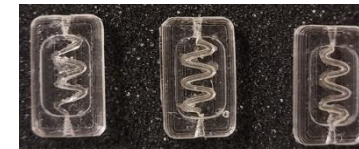
- Arteriole template based

Micro-vascularization

- Capillaries self-assembled



Vascular architecture complexification required



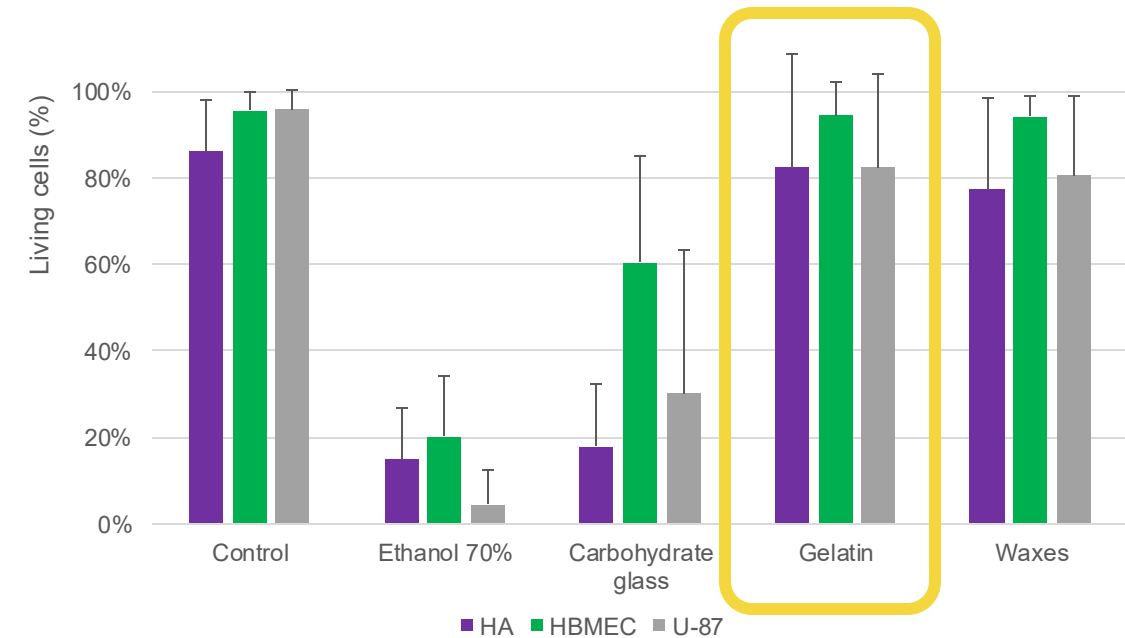
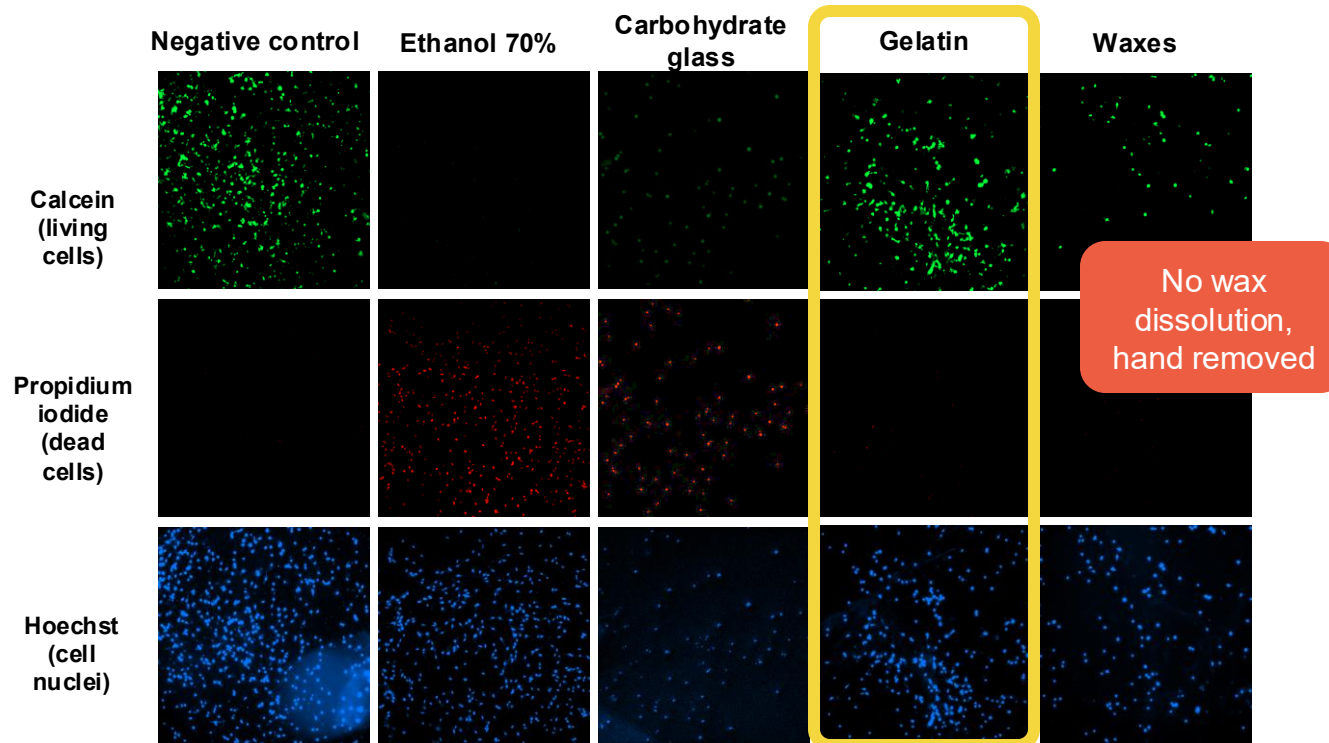
Dynamic culture

- Cellular medium perfusion
- Reproduction of the blood flow

Sacrificial materials for macro-vascularization complexification (arteriole):

Synthesis → molding in PDMS → demolding for transfer inside BBB-on-chip → dissolution assays

Hydrogels without microchip + sacrificial materials (45 min) → material dissolution → incubation (24 h) → live/dead test



- Tested on tumoral cells (U87-MG), endothelial (HBMEC) and astrocytes (HA)
- Gelatin biocompatibility + easy processing

Hydrogel and micro-vascularization (capillaries)

CD31: HBMEC tight junctions
Hoechst: nuclei of HBMEC, HA, HP



Hannah HANCE
ISIFC student

Hyaluronic acid

0 mg/mL

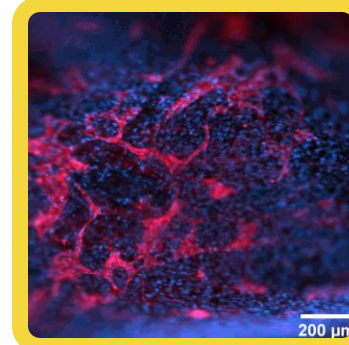
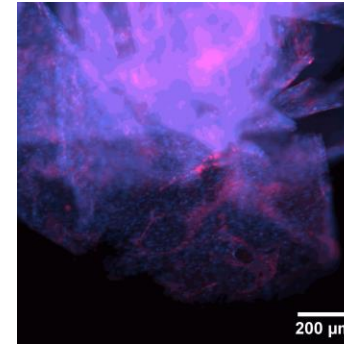
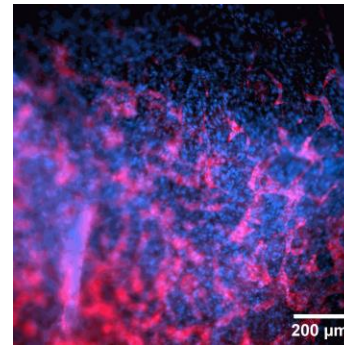
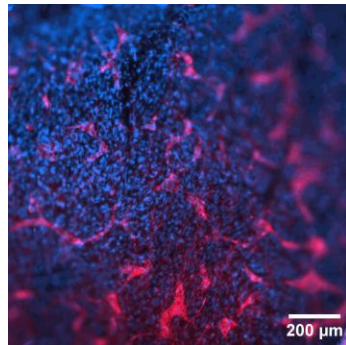
2,5 mg/mL

5 mg/mL

Collagen, fibrinogen, thrombin

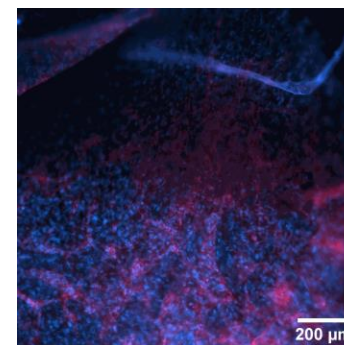
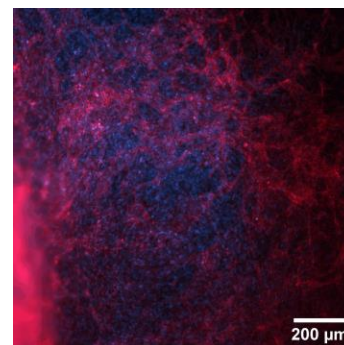
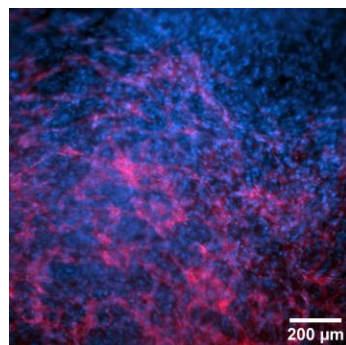
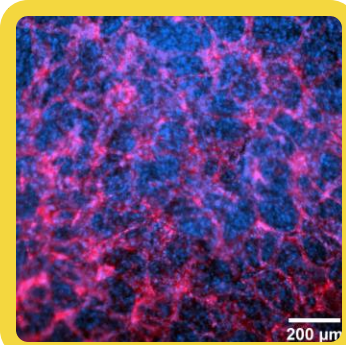
0 mg/mL, 10 mg/mL, 1 U/mL

0 mg/mL, 5 mg/mL, 1 U/mL



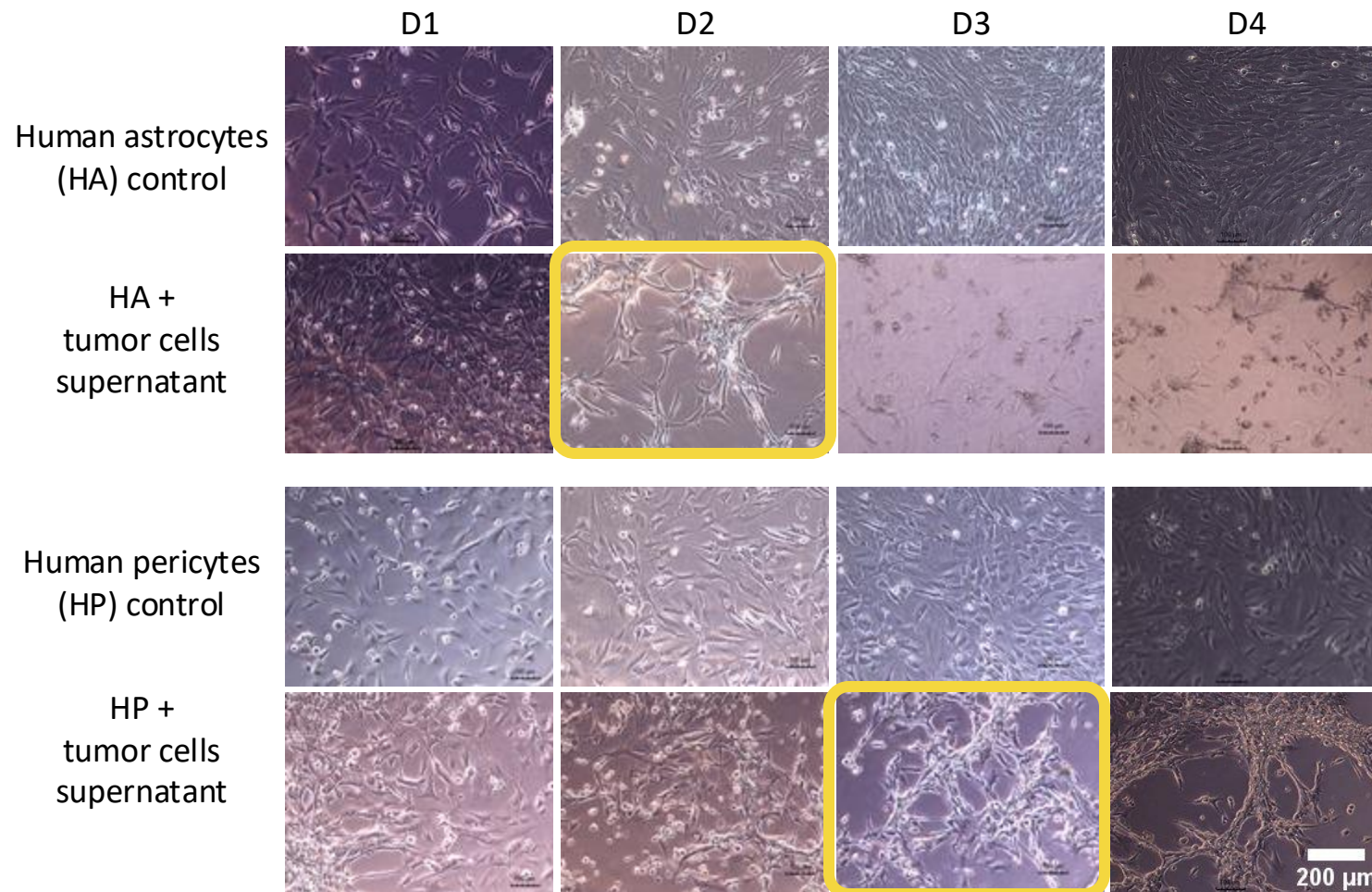
5 mg/mL, 6 mg/mL, 10 U/mL

2.5 mg/mL, 6 mg/mL, 10 U/mL



Capillaries self-assembly
in optimization

Tumoral impact on BBB cells



In collaboration with



Lafortune CHOUMESSI
M1 BS intership



Joyce PELISSIER
ISIFC student



Céline ELIE-CAILLE
Associate Prof.
FEMTO-ST

Astrocytes and pericytes with tumor cell supernatant: ↘ proliferation + “cancerous” morphology on day 2 or 3

BBB-on-chip design

- ✓ Microchip design: CAD → 3D printing → PLA mold → PDMS pouring → PDMS microchip
- ✓ Lock-and-play device: CAD → 3D printing

Vascular architecture complexification

- ✓ 3 sacrificial materials assessed: carbohydrate glass / gelatin / paraffin & polyester waxes
- ✓ Gelatin is the most adapted material for the vascular architecture complexification

Hydrogel composition

- On-going work to determine the optimized composition of the hydrogel
- ✓ Early endothelial tubular network formation (precursor of capillary network)

Tumoral impact

- ✓ Morphology modification of astrocytes and pericytes in contact with tumoral supernatant
- On-going work for protein and particles measurement (extracellular vesicles)

**Vascular design
simulation**

M2

Perfusion

**Arteriole and
capillary formation**

**Cellular coculture
(tumoral cells)**

BTS

THANK YOU FOR YOUR ATTENTION
ANY QUESTION?