Cell growth on moving curvatures, towards gut-on-a-chip

Valentin Chalut[1]*, Damien Le Roy[2], Delphine Delacour[3], Anne-Laure Deman[1], Caterina Tomba[1]

[1]Univ Lyon, Université Claude Bernard Lyon 1, CNRS, INSA Lyon, Ecole Centrale de Lyon, CPE Lyon, INL, UMR5270, 69622 Villeurbanne, France
[2]Institut Lumière Matière, ILM-UMR 5306, CNRS, Université Claude Bernard Lyon 1, 69622 Villeurbanne, France
[3]Cell Adhesion and Mechanics Lab, Université de Paris, CNRS, Institut Jacques Monod, F-75006, Paris, France.
*valentin.chalut@univ-lyon1.fr

The intestine is an organ with many levels of curvature, deformed by a combination of muscular, mainly related to digestion, and external movements, produced for example by the passage of the food bolus. This complex architecture can be affected in case of severe pathologies that are not yet fully understood and still require effective treatments, such as the Hirschsprung's disease(1).

As the standard 2D *in vitro* and animal models may be inadequate for such organ modelling, a new promising *in vitro* approach has been recently investigated, the Organ-on-Chip. The Gut-on-Chip consists in partially reproducing the intestine to study the influence of a treatment on its various structural, mechanical and chemical parameters(2). However, the movement and deformation of the intestinal epithelium remain poorly studied, although they are predominant in the gut.

To develop this aspect, we grew several types of epithelial cells, such as intestinal organoids (Fig. 1a), on different substrates reproducing the intestinal barrier (Fig. 1b), and which can be deformed by a magnetic field (Fig. 1c) taking inspiration from the soft robots technology(3). Such wavy membranes can remotely achieve deformation amplitude of 1.4 to 1.7 mm at 140 mT (Fig. 1d & e) and a radius of curvature of about 1 to 2 mm. This technology also provides the advantage of supporting Matrigel intestinal villi replicas, which are 500 µm high and 200 µm wide in the real organ(4).

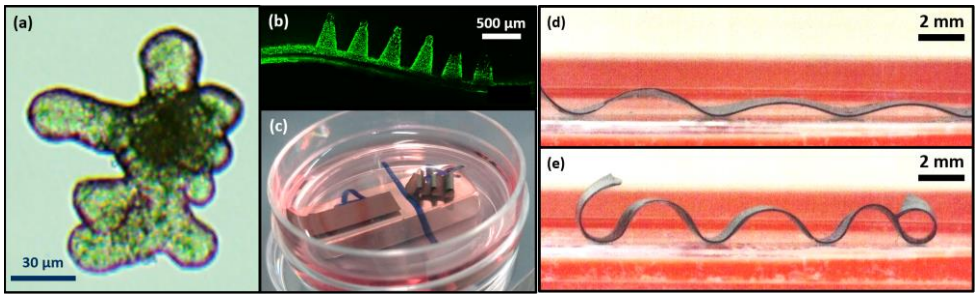

Figure 1: (a) Phase contrast image of a gut organoid cultured in 3D. (b) PDMS villi replicas on a deformed membrane covered with MDCK (Madin-Darby Canine Kidney) cells (nuclei in green, H2B-GFP). (c) Magnetic membranes covered with Caco-2 (Cancer Colon) cells in a 35 mm petri dish on a permanent magnet. (d) Magnetic membranes in water under a magnetic field of 5 mT and (e) 140 mT.

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