# BIOMIMETIC ORGANS-ON-CHIP

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Throughout life, tissues adapt to large deformations and folding due to organ activity, like in the lung alveoli, the acini in the mammary glands, the ridges in the skin, and the small intestine. For example, intestinal barrier (or epithelium) is characterized by folding that occurs at different scales during development and during digestion, with two main compartments at the cell level: the concave regions, called crypts, and the convex finger-like protrusions, called villi.

Crypts are mainly occupied by stem cells, which allow a regular renewal of the tissue, by differentiating and migrating along the villi, on the top of which cells are extruded [1]. Therefore, curvature may have a particular relevance in regulating cell function. By growing organoid monolayers on surfaces with curved patterns *in vitro*, stem cells are mainly observed on the concave regions where curvature is the highest [2,3], but on flat surfaces stemness and segregation are retained [4]. How this segregation occurs over time with respect of curvature is not clearly reported and the feedback between curvature and stemness is a major open question.

Moreover, a link has been observed between pathologies and tissue architecture, highlighting the importance of **understanding the interaction between tissue curvature and cell behavior, to also understand the origin of digestive system pathologies and to develop new treatments**. For this, the classical 2D in-vitro models do not allow to replicate the microstructure of the intestine and its movements, and the animal model is relatively too different from human beings, or not viable for very serious pathologies. The organ-on-chip approach is very promising because it consists in mimicking organs on a small scale, with in addition the possibility of using human cells.

Various works have been recently conducted to mimic the microstructures of the intestine [2,3,5]. However, these guts-on-chip are static and do not accurately reproduce the movements of the intestine, although these movements may influence the tissue structure and are essential to the digestion function. With the aim to develop a gut-on-chip with villi and crypts that can be moved in a controlled and reproducible manner, we got inspiration by soft robots. Thus, we have created deformable magnetic polymer membranes with shape memory, with the advantage of being remotely controlled using an external magnetic field, ranging from 5 to 140 mT (Fig. 1). It is therefore possible to tune the motion of the crypt-villus structures in a non-invasively manner, in order to study cell growth under dynamic constraints that mimic intestinal movements.

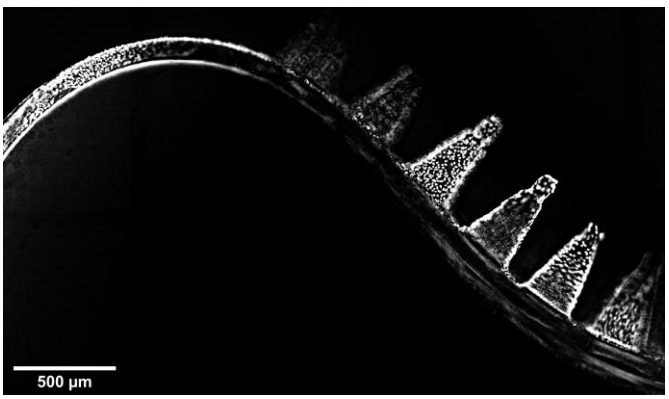


Figure 1. Epithelial cells (nuclei in grey) on PDMS pillars on a magnetic composite membrane curved by the application of an external magnetic field.

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