Biomimetic Peritoneal Cavity-on-a-Chip for Studying Ovarian Cancer Progression and Metastasis

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Introduction: Diseases of the abdominal cavity are typically diagnosed in late stages, resulting in poor patient prognosis with an average survival rate after recurrence of 3-6 months. The abdominal cavity, or peritoneum, is a biofluid filled cavity that houses vital organs, including the liver, stomach, and other major organs. A hallmark of these diseases is the dissemination of aberrant circulating cells in the biofluid that adhere to the mesothelial cells that line the cavity. The peritoneum is subject to dramatic changes in pressure as a consequence of breathing movements, as well as physical activity, movements from the gastrointestinal tract and many other factors. These mechanical movements could have a profound impact on mesothelial-circulating cell interactions that drive disease progression. However, the effect of these mechanical movements on cell behavior remains severely understudied due to the complexity of the peritoneum anatomy making it hard to visualize in-vivo. To overcome this challenge, we have developed a higly accessible platform for organ-on-a-chip models to study cancer progression and metastasis of the peritoneum.

Methods: 3D printed mold fabrication process

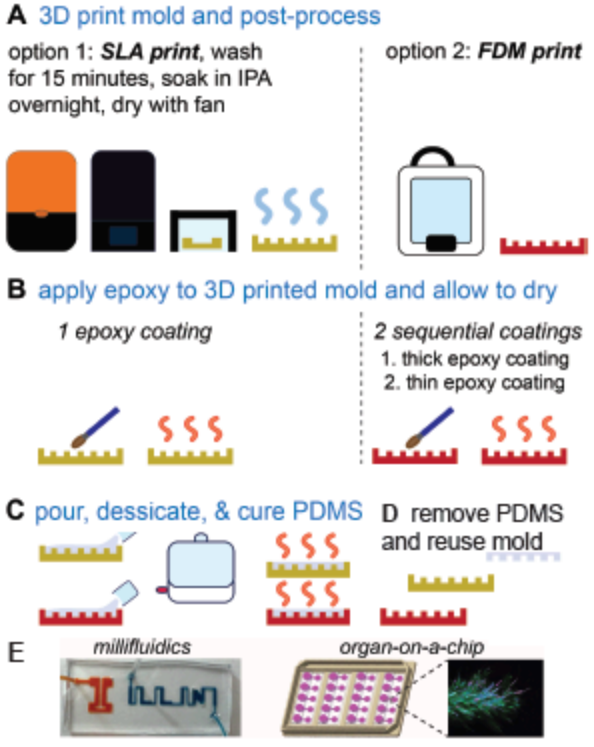

Figure 1. 3D printed SLA and FDM mold fabrication process. (A-E) Illustration depicting **(A)** printing and post-processing of molds, **(B)** epoxy coating strategies, **(C-D)** PDMS replica molding, and **(E)** millifluidic and organ-on-a-chip applications.

Generation of PDMS fluidic devices from 3D printed molds

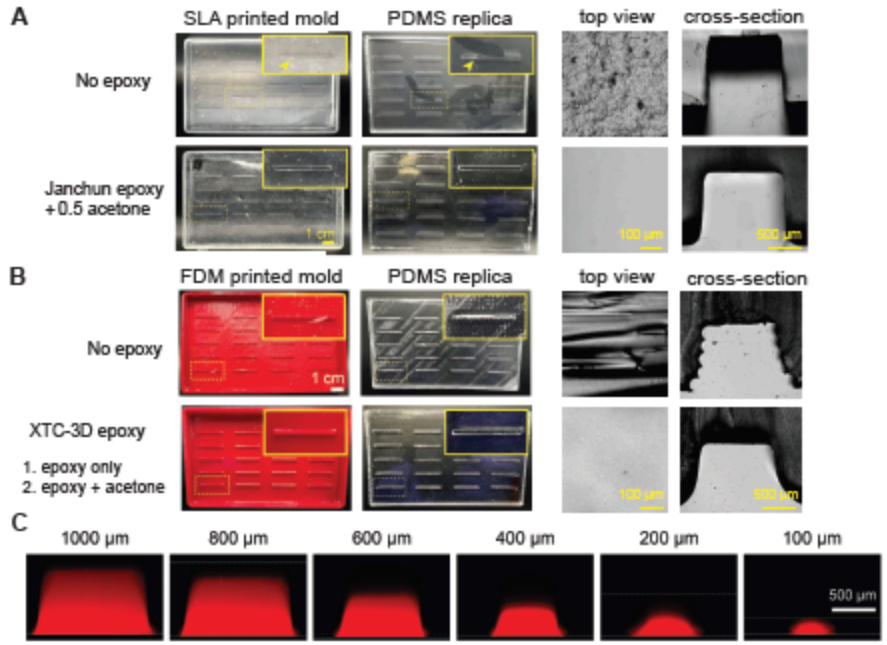

Figure 2. (A) SLA molds coated with epoxy yield PDMS replicas with improved surface properties. **(B)** FDM molds produce PDMS replicas with varying surface quality based on epoxy treatment. **(C)** Confocal images of fluorescent dextran show the fluid profile for channels with varied dimensions.

Novel 3D printed platform for organ-on-a-chip live-cell imaging

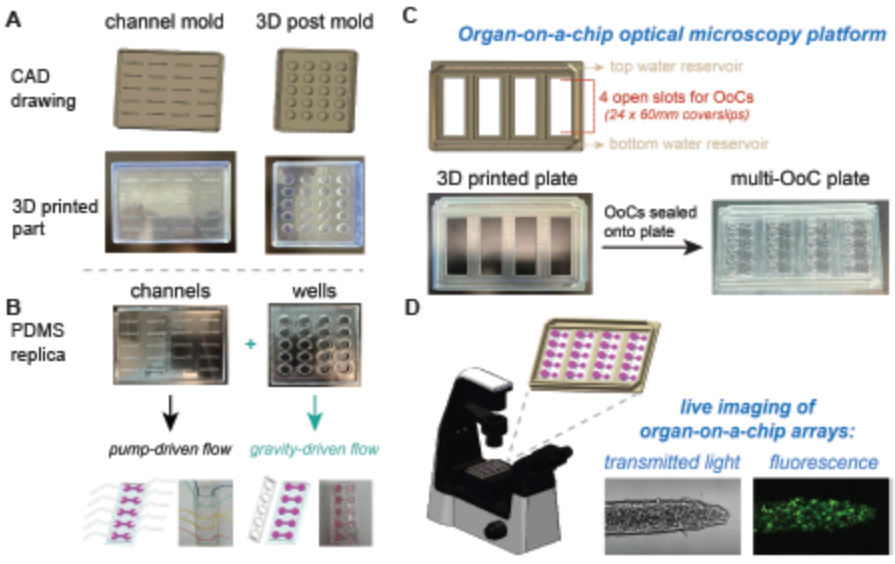

Figure 3. (A) CAD designs and 3D printed molds for channels and posts. **(B)** PDMS replicas yield multi-format OoC devices for pump- and gravity-driven flow. **(C-D)** 3D printed platform for the fabrication and live-cell imaging of OoC arrays.

Ovarian cancer spread in a biomimetic peritoneal cavity-on-a-chip

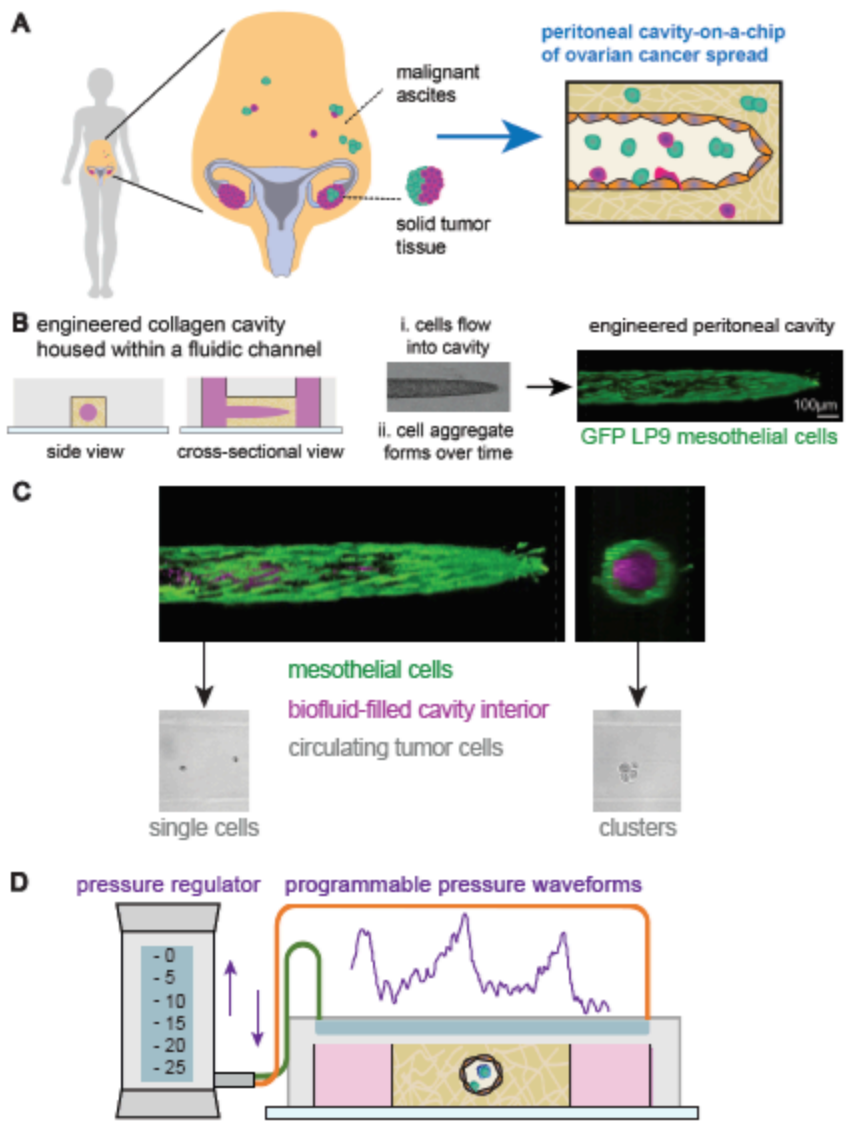

Figure 4. (A) Ovarian cancer spread is modeled using a peritoneal cavity-on-a-chip. **(B)** Mesothelial cell-lined collagen cavity supports tumor cell dissemination. **(C)** Confocal fluorescence images show mesothelial cells and biofluid; GFP LP9 cells (green) and Qtracker 655 in fluid (magenta). **(D)** Pressure regulator applies dynamic waveforms to mimic physiological forces.

Conclusions: Here, we established an accessible 3D printed platform for PDMS device fabrication and a scalable approach for organ-on-a-chip generation and live-cell imaging for diverse biomedical applications.

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