# An automated chip with a rapid prototypable cell culturing layer for multiplexed organs-on-chips

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## Introduction

Organs-on-chips (OoC) have great potential for disease modeling, reducing animal testing, and personalized medicine. In achieving this potential, automation and parallelization of OoCs play a significant role, as it increases reproducibility, throughput, and sampling frequency. However, automated microfluidic chips come with an extensive and complex network of channels and valves which is needed to achieve programmed fluid routing [1]. Fabrication of these chip is therefore both expensive and time-consuming. As a result, the cell culturing compartments are generally designed for simple 2D cell culture and are rarely changed to reflect different tissue physiologies. To address this, we designed two chips which have decoupled fluid routing and cell culturing layers with 16 and 32 independently addressable chambers. The cell culturing layer can be fabricated using rapid prototyping (RPT) techniques and fits one general purpose fluid routing layer. In addition, we have made chips with two different RPT layer compartments: one for round blood vessels and one with pillars for engineered heart tissues (EHTs).

## Experimental procedure

The chips were made from PDMS using standard multilayer soft lithography. Wafer molds were made for the flow and control layers and the mold for the RPT layer was micromilled. Round channels were made from PDMS as reported in [2]. The design for the EHT compartments is based on [3].

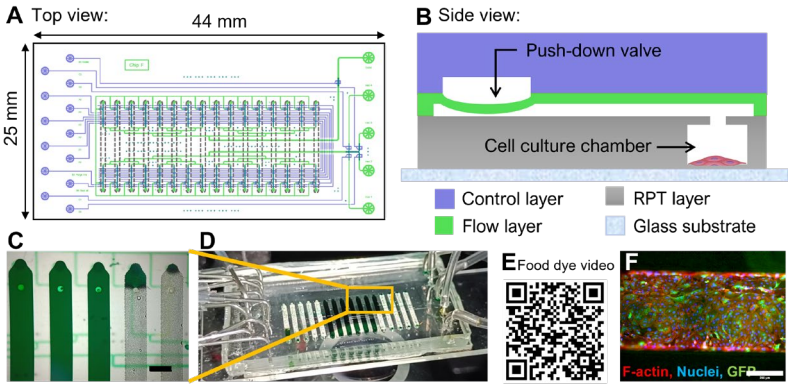


***Figure 1**: a) Top view of the chip with 16 chambers. b) Side view of the chip layers. c) & d) Chip with chambers designed for micro EHTs filling with food coloring (scale bar 1 mm). e) Video of chambers filling. f) Endothelial cells cultured in round channels (scale bar 250 µm).*

## Results and Discussion

Fig. 1 shows the design of the chip (a) and a side view schematic of the layers and valve working principle (b). In a first chip, we show that the chambers can be filled independently (c-e) with food coloring. In a separate rapid prototyping layer, we show that we can make round channels and culture green fluorescent protein (GFP)-expressing human umbilical vein endothelial cells (HUVECs) for at least 3 days (Fig. 1f).

## Conclusion and Outlook

In summary, we show that we are able to fabricate automatable microfluidic chips with multiplexed, rapid prototyable cell culturing chambers. As the next step, we will culture HUVECs and cardiomyocytes in the chips with blood vessel and EHT chambers, respectively, and perform automated dynamic dosing of stimulation factors.

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## References

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