Development of 'Human-on-a-Chip' device technology: A paradigm shift in biological evaluation and disease model

DEVICE DEVELOPMENT PROGRAMME (DDP)
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Objectives

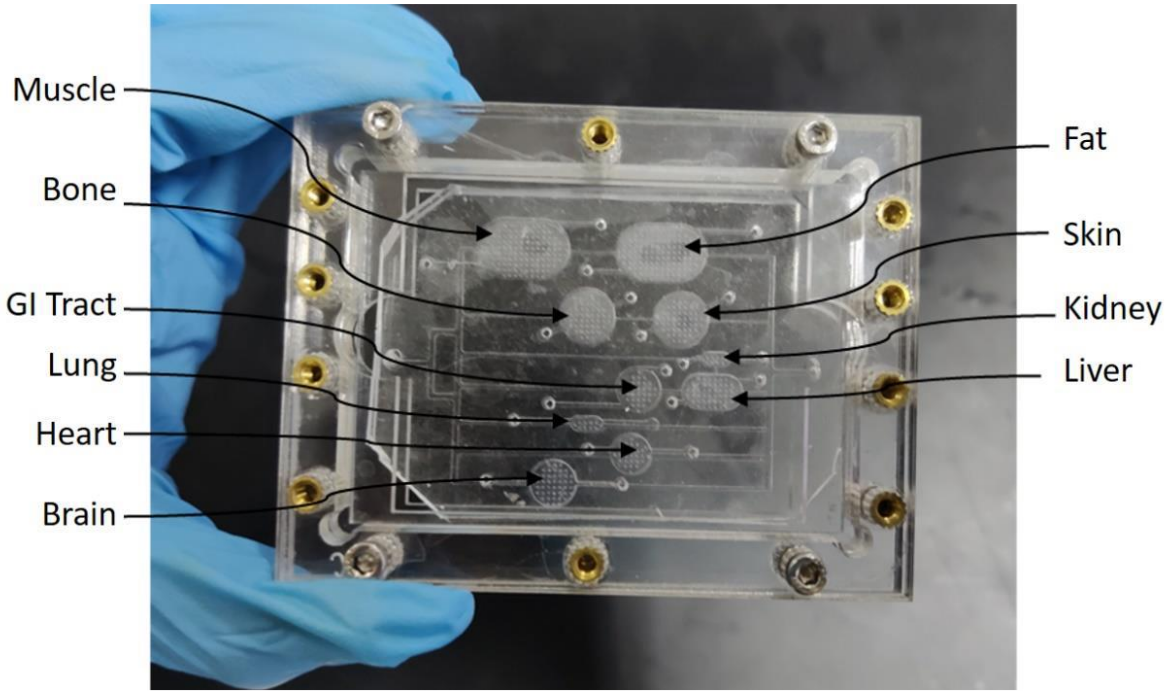
The main aim of the present proposal is, to develop a **human-on-a-chip** technology for pre-clinical evaluation of drugs/chemicals/medical devices in a cost-effective manner and thereby reduce the overall developmental costs. The objectives of the present proposal are;

- Development of 'Human-on-a-Chip' device technology
- biological evaluations using 'Human-on-a-Chip'
- disease modelling using 'Human-on-a-Chip'

Methodology

The chamber layer, as well as the vasculature layer fabricated using PDMS. The membrane separates the cell culture chamber layer and the vasculature layer prepared from polycarbonate membrane with defined pore size and thickness. The vasculature layer also includes micropillars which support the membrane and provide capillaries like structures inside the vascular layer. Further surface treatment of polycarbonate membrane using 5% APTES at elevated temperature enables more cellular attachment and tight bonding between individual layers.

The chamber layer and the vasculature layers were designed using computer-aided design (CAD) software and printed onto plastic photographic films. Mold preparation is carried out through soft lithography. Briefly, two sheets of dry-film photoresist are laminated onto a glass slide and exposed to the UV by using mask aligner. The exposed region developed using a developer solution. Developed mold further kept under UV light for the optimal polymerisation of the dry-film. PDMS mixed with the curing agent in a weight ratio of 10:1 and poured onto the mold after degassing. The PDMS then cured in a conventional hot air oven at 70°C for 2hr. The cured PDMS peeled off from the mold and thoroughly cleaned using isopropanol, 70% ethanol and distilled water followed by drying. The PDMS layers then plasma treated and the membrane sandwiched between the layers. The whole setup placed in a hot air oven for proper bonding. The bonded PDMS layers can autoclave and place inside the PMMA case for further experiments.



Device model

Achievements

1. PDMS multi-organ on a chip device with 3 organs.
2. Single chamber perfusion model for evaluating toxicity of nanoparticle exposure.
3. Human-on-a-chip for biological evaluation
4. Vascularized membrane integrated human-on-a-chip mode