The files provided with this project are linked to our microfluidic-based Liver-Lobule-Chip (LLoC) initiative. This project focuses on developing a polydimethylsiloxane (PDMS) device capable of hosting 3D liver cell cultures within artificial liver lobules, recreating a physiologically relevant environment. The artificial liver lobules, situated in the lower layer, are segregated from the main fluid inlet chambers and replicate *in vivo* architecture. Cell media enters the lobules and is radially guided towards the central vein mimetic in each lobule. Once the top layer is in position, the media is directed out through this layer for off-chip collection.

The files "LLoC_lower_layer.dfx" and "LLoC_top_layer.dfx" are 2D CAD representations of the complete dual-layered system, suitable for generating a soft lithography mask for master fabrication. Conversely, "LLoC_excl_diff.dfx" and "LLoC_3D_16th_slice.dfx" are designed for import into COMSOL Multiphysics 6.0 (Comsol, Burlington, MA, USA) to simulate velocity, shear stress, and glucose profiles within the lower layer and liver lobule structures.

The simulation model combines fluid flow analysis with mass transfer analysis for glucose. Glucose, with a diffusion coefficient of 6.16 × 10−10 m^2/s and a concentration of 11 mM in cell culture media, is utilized to represent nutrient consumption by cells within the artificial liver lobules. Computational fluid dynamics (CFD) analysis incorporates the coupling of Navier-Stokes and continuity equations. The fluid is modeled as an incompressible Newtonian fluid, with a density of 1.009 g/cm^3 and a dynamic viscosity of 0.93 mPa·s, matching the properties of DMEM culture medium supplemented with 10% FBS at 37°C.

The flow, ranging from 0.25 to 1.0 µL/min, was simulated using no-slip boundary conditions. The pressure at the outlets was set to zero, and the flow rate at the inlet was adjusted accordingly.
To minimize computational time, only one artificial liver lobule was analyzed to evaluate the flow field and glucose distribution. Since each artificial liver lobule exhibits radial symmetry, a slice representing $1/16^{th}$ of the entire lobule served as the computation domain. Subsequently, the results were extrapolated to the entire artificial liver lobule. The geometry was meshed using COMSOL's physics-controlled mesh setting, with the mesh element size set to fine.
For the entire LLoC simulation, the Brinksman assumption for porous media was employed to reduce computational demand. We treated the diffusion channels around the lobule as a porous structure and calculated the porosity and permeability of this region. These values were then used to model the area surrounding the artificial lobules as a porous medium using the Brinkman equation, allowing us to simulate the entire LLoC.