Numerical simulations in organ-on-a-chip microfluidic devices

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ABSTRACT

Organ-on-a-chip (OoC) microfluidic devices are an innovative and valuable technology capable of accurately recapitulating human physiology by providing an artificial tissue-like microenvironment [1], [2]. Due to its excellent characteristics, such as cost-effectiveness, portability, ease-of-use, and the ability to provide a 3D microenvironment suitable for cell growth, these hold a tremendous potential to revolutionize the research in biology and personalized medicine, and also constitute a potential alternative to traditional animal testing [3], [4]. By combining engineering, fluid dynamics, and cell biology, these models allow studying in detail the development and design of micro/nanoparticles, to model human physiology, investigate the molecular and cellular mechanisms underlying disease formation and progression, gain insights into the performance and effect of responsive drug delivery nanocarriers, in a single device [2], [5]. Despite the progress made in the development of these devices, they are rather new and still require additional validation and characterization [5]. In this regard, numerical simulations are getting attention and have proved to be a useful and effective auxiliary tool for in vitro testing [6]. These present several advantages namely the possibility of optimizing the devices in terms of geometry and materials properties, and verify their ability in a faster and cheaper way than practical tests. Furthermore, through computational techniques, some critical parameters difficult to measure in vitro can be estimated, such as pressure, velocity, shear rate, shear stress, and temperature.

In this regard, this Minisyposium seeks to gather interesting and outstanding research papers focusing on novel micro/nanofluidic and lab-on-a-chip devices combined with numerical simulations addressing, for instance, the biofluid flow, solid mechanics, thermal, and mass transfer phenomena, cell handling processes, and cell mechanics, resorting to single-phase or multiphase models. Since numerical simulations are still scarce in these areas, this Minisymposium expects to encourage researchers to share their investigations and provide the participants a set of studies of interest for their works.

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