Biomimetic Microfluidics

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Abstract:
Through developments in 3D fabrication technologies in recent years, we can now build and characterize much more sophisticated 3D platforms than was previously possible. We can create regions of differing polarity and hydrophobicity, mix passive and binding behaviours, and regions of differing flexibility/rigidity, hardness/softness. In addition, we can integrate materials that can switch between these characteristics, enabling the creation of biomimetic microfluidic building blocks that exhibit switchable characteristics such as programmed microvehicle movement (chemotaxis), switchable binding and release, switchable soft polymer actuation (e.g. valving), and detection. These building blocks can be in turn integrated into microfluidic systems with hitherto unsurpassed functionalities that can contribute to bridging the gap between what is required for many applications, and what we can currently deliver [1]. The emerging transition from existing engineering-inspired 2D to bioinspired 3D fluidic concepts represents a major turning point in the evolution of microfluidics. Implementation of these disruptive concepts may open the way to realise biochemical sensing systems with performance characteristics far beyond those of current devices. A key development will be the integration of biomimetic functions like self-awareness/self-diagnosis of condition and self-repair capabilities to extend their useful lifetime [2]. In this contribution, I will present ideas and demonstrations of practical ways to begin building a biomimetic function toolbox that could form the basis of futuristic microfluidic systems. Examples will include chemotactic microvehicles that can collaborate to perform sophisticated functions at specific locations [3] and precision control of flow behaviour in channels using light [4]. Strategies for creating high resolution (sub-200 nm) 3D soft-polymer responsive structures will be discussed.

References

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