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Technology for Investigating and Engineering Stem Cell Fate

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Since the reported derivation of human embryonic stem cells in 1998, a decade of major developments in regenerative medicine research has revolutionized our perspectives on the feasibility of cell-based therapies. In particular, advances in adult stem cell research have led to cells being tested as therapeutic agents in an array of clinical trials. We can hope for great advances in the treatment of major illnesses that currently afflict millions and are major economic burdens (ranging from cancer to cardiac and degenerative diseases).

There is now a great need for novel technologies to accelerate stem cell science and engineering. Cell population heterogeneity poses a major obstacle to understanding complex biological processes, with the characteristics specific to stem cells often obscured by average measurements of impure populations. In order to assess heterogeneity within stem cell populations, we have developed microfluidic devices containing thousands of nanoliter-scale bioreactors for the culture of single cells or colonies. Alternative designs were fabricated, tested and optimized through multiple rounds of prototyping until we could satisfy the demanding requirements of stem cell systems. The novel capabilities of this technology offers new avenues to interrogate otherwise inaccessible mechanisms governing mammalian cell growth and fate decisions.

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