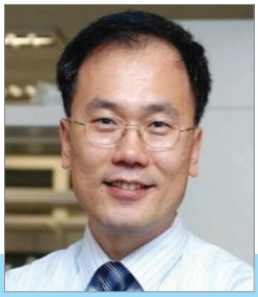
NanoBiotech Laboratory



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Member of the Korean BioChip Society
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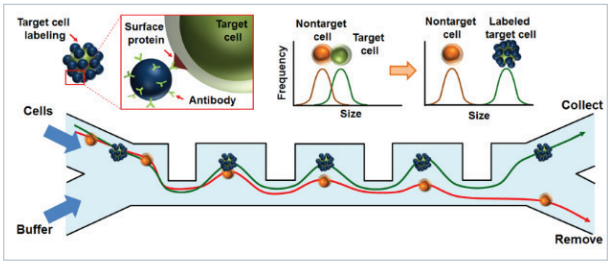
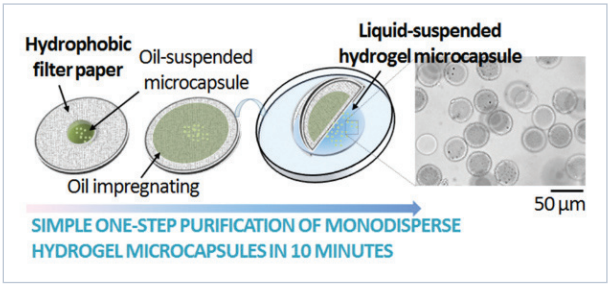
Recent progress of lab-on-a-chip technology is challenging for the development of nanobiotechnology and integrative bioengineering. Particularly, micro/nano fluidics has been a key technology for the realization of micro total analysis systems (μTAS) or lab-on-a-chip as well as the next generation bio-tools for drug discovery, diagnostics, and tissue engineering. This research area covers the design and development of miniaturized devices that manipulate liquid samples at nanoliter volumes, allowing biological assays to be integrated and accomplished on a small scale with minimum time and cost. Prof. Park's research focuses on the development of a nanobiosensor, microfluidic device and lab-on-a-chip as a new platform for biological sample processing, separation, and detection, including optoelectrofluidics, hydrophoretic separation, magnetophoretic assay, and cell-based assay. From June 2008, his laboratory has been selected to receive a National Leading Research Laboratory Program grant through the National Research Foundation of Korea funded by the Ministry of Science, ICT and Future Planning

Inertia-activated cell sorting: This paper demonstrates an inertia-activated cell sorting method to separate cells based on their surface protein expression by using inertial microfluidics [1]. Target cells are immune-specifically reacted with antibody-coated microbeads and then separated from nontarget cells. As a proof of concept, separation of MCF-7 breast cancer cells from U937 lymphoma cells was achieved with 97.6% target cell recovery rate, 95% nontarget cell rejection ratio, 73.8% purity, and an enrichment ratio of 93 at a total flow rate of 8.75 mL h–1 without using any external forces.

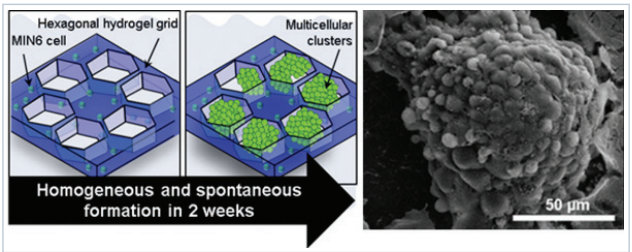


Rapid one-step purification of single-cells: A simple one-step purification method of alginate microcapsules containing a single live cell from oil to aqueous phase was demonstrated by oil impregnation via commercially available hydrophobic filter paper [2]. The filter paper promotes quick depletion of the surrounding oil which guarantees the monodispersity of

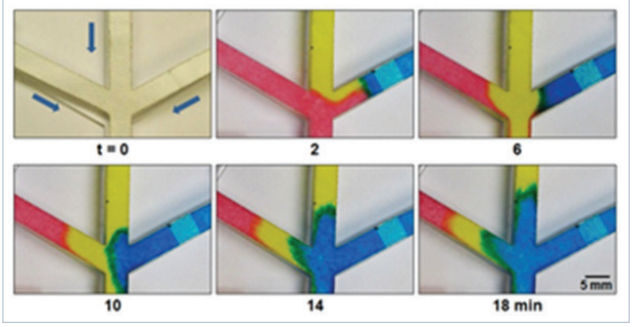


microcapsules, shortens the time required and simplifies the laborious process for washing out the residual oil phase. We expect that this method for the simple and rapid purification of encapsulated single-cell microcapsules will attain widespread adoption, assisting cell biologists and clinicians in the development of single-cell experiments.

In vitro formation of homogeneous MIN6 cell clusters: To effectively form homogeneous cell clusters in vitro, we made cell-containing hydrogel membrane constructs with an adapted grid structure based on a hexagonal micropattern [3]. Homogeneous cell clusters of pancreatic insulinoma (MIN6) cells were spontaneously generated in the floating hydrogel membrane constructs, including a hexagonal grid structure (size of cavity: 100 μm, interval between cavities: 30 μm). Interestingly, 3D clustering of MIN6 cells mimicking the structure of pancreatic islets was coalesced into a merged aggregate attaching to each hexagonal cavity of the hydrogel grid structure. The fate and insulin secretion of homogeneous cell clusters in the hydrogel grid structure were also assessed. The results of these designable hydrogel–cell membrane constructs suggest that facultative in vitro β-cell proliferation and maintenance can be applied to biofunctional assessments.



Programmed sample delivery on a pressurized paper: This paper reports a method to control the fluid flow in paper-based microfluidic devices simply by pressing over the channel surface of paper, thereby decreasing the pore size and permeability of a non-woven polypropylene sheet [4]. As a result, fluid resistance is increased in the pressed region and causes flow rate to decrease. In addition, we demonstrate flow rate control in a Y-shaped merging paper and sequential delivery of multiple color dyes in a three-branched paper. Furthermore, sequential delivery of multiple fluid samples is performed to demonstrate its application in multi-step colorimetric immunoassay, which shows a 4.3-fold signal increase via enhancement step.



Key Achievements

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2. M. G. Lee, J. H. Shin, C. Y. Bae, S. Choi, **J.-K. Park**, "Label-free cancer cell separation from human whole blood using inertial microfluidics at low shear stress," Analytical Chemistry, 85, 6213–6218, 2013.
3. W. Lee, C. Y. Bae, S. Kwon, J. Son, J. Kim, Y. Jeong, S.-S. Yoo, **J.-K. Park**, "Cellular hydrogel biopaper for patterned 3D cell culture and modular tissue reconstruction," Advanced Healthcare Materials, 1, 635-639, 2012.
4. H. Hwang, **J.-K. Park**, "Optoelectrofluidic platforms for chemistry and biology," Lab on a Chip, 11, 33-47, 2011.
5. M. S. Kim, T. Kim, S.-Y. Kong, S. Kwon, C. Y. Bae, J. Choi, C. H. Kim, E. S. Lee, **J.-K. Park**, "Breast cancer diagnosis using a microfluidic multiplexed immunohistochemistry platform," PLoS One, 5, e10441, 2010.

Achievements 2014/2015

1. J. H. Shin, M. G. Lee, S. Choi, **J.-K. Park**, "Inertia-activated cell sorting of immune-specifically labeled cells in a microfluidic device," RSC Advances, 4, 39140-39144, 2014.
2. D.-H. Lee, M. Jang, **J.-K. Park**, "Rapid one-step purification of single-cells encapsulated in alginate microcapsules from oil to aqueous phase using a hydrophobic filter paper: Implications for single-cell experiments," Biotechnology Journal, 9, 1233-1240, 2014.
3. C. Y. Bae, M.-k. Min, H. Kim, **J.-K. Park**, "Geometric effect of the hydrogel grid structure on in vitro formation of homogeneous MIN6 cell clusters," Lab on a Chip, 14, 2183-2190. 2014.
4. J. H. Shin, J. Park, S.-H. Kim, **J.-K. Park**, "Programmed sample delivery on a pressurized paper," Biomicrofluidics, 8, 054121, 2014.