Controlling cell behavior using nanohybrid platforms

Tae-Hyung Kim

School of Integrative Engineering, Chung-Ang University, Seoul, 06974, Korea

Email: thkim0512@cau.ac.kr, Tel: +82-2-820-5469

Stem cells have emerged as valuable sources for regenerative therapy and drug screening. In this study, we report a new type of hybrid platform that enables both manipulating cancer cell morphology and controlling stem cell differentiation.

First, graphene oxide (GO) was used as an efficient cytophilic material. The vertically-coated GO microwell arrays were fabricated via a simple micro-contact printing technique, which enabled donut-like cancer cell spheroid generation. The effects of chemotherapeutic agents on different types of cancer spheroids were rapidly assessed based on automatic microscopy image-based computational analysis. The uniformity of GO film, a key component for controlling cellular morphology, was further improved by optimizing GO-coating conditions and applying low electrical energy and low oxygen plasma (LOLP) treatment. Without using any chemicals and proteins, cancer cells were simply and easily micro-patterned on various platforms (e.g., glass, gold electrode, and polydimethylsiloxane)

Besides an effort to manipulate cell morphology, we attempted to advance a platform that enables the automatic differentiation of stem cells into neuronal cells. The metal-organic framework (MOF) nanoparticles were designed and synthesized for the long-term release of retinoic acid, which is a key differentiation factor for inducing neurogenesis. By optimizing several experimental parameters, we could trap single nanoparticles in single nanoholes with 98% efficiency. Remarkably, after two weeks of differentiation, we found that the neural stem cells (NSCs) on the functional platform showed successful conversion to neural cells without adding the differentiation factors to the culture medium. Therefore, we can conclude that the developed hybrid platforms are useful for various biomedical engineering research areas.