Design of Cell Recognition Biomaterials and Prospect for Development of Cadherin-Marices Engineering

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Recently, embryonic stem (ES) and induced pluripotent stem (iPS) cells have shown remarkable potential to treat human diseases. Biomaterials are rapidly being developed as powerful artificial microenvironments to study and control stem-cell fate, such as proliferation and differentiation. Further the multi-disciplinary approach using cell biological and biomaterials technologies promises to have a profound impact on stem-cell biology and tissue regeneration. Over the last few years, synthetic biomaterial design has demonstrated an unquestionable potential for use as extracellular microenvironment for regenerative medicine and tissue engineering. But, the complexities associated with natural material have driven the development of synthetic biomaterials for use as 2D or 3D extracellular microenvironments. Our recent advances include biomaterial-based artificial extracellular matrix formed by immobilizing cell-recognizable molecule, growth factors and cytokines. Here, we summarizes some of the most recent developments on the construction of novel extracellular matrix using chimera proteins of adhesion molecules (e.g., E-cadherin, N-cadherin, or vE-cadherin) for ES cell proliferation and differentiation (**Fig. 1**)

Our novel E-cadherin-based engineered extracellular matrix showed fascinating results:
(1) Highly homogeneous differentiation of definitive endoderm cells under single-cell level; (2) Uniform distribution of growth factors resulted in controlled differentiation even in lower concentration of soluble factors; (3) completely defined and xeno-free culture due to the absence of serum and feeder layers; (4) highly functional hepatocytes within short period of differentiation; (5, 6) striking effect of matrix-dependent cell sorting for isolation and enrichment of mature hepatocytes for possible elimination of contaminated and poorly differentiated cells; (7) the unique opportunity for continuous monitoring of cellular behavior in different stages of differentiation *(Haque et al., 2011, Biomaterials)*.
Taken together, our novel recombinant ECM is advantageous for generating homogeneous population of differentiated cells without any enzymatic stress and cell sorting, suggesting that the improved method of differentiation is highly promising for clinically significant adult cells (hepatocytes, cardiomyocytes, or pancreatic cells). We established a novel biomedical field in cadherin biology named as “Cadherin Engineering” which can be applied to “Cell-cooking Plate” for ES/iPS cells in regenerative medicine.

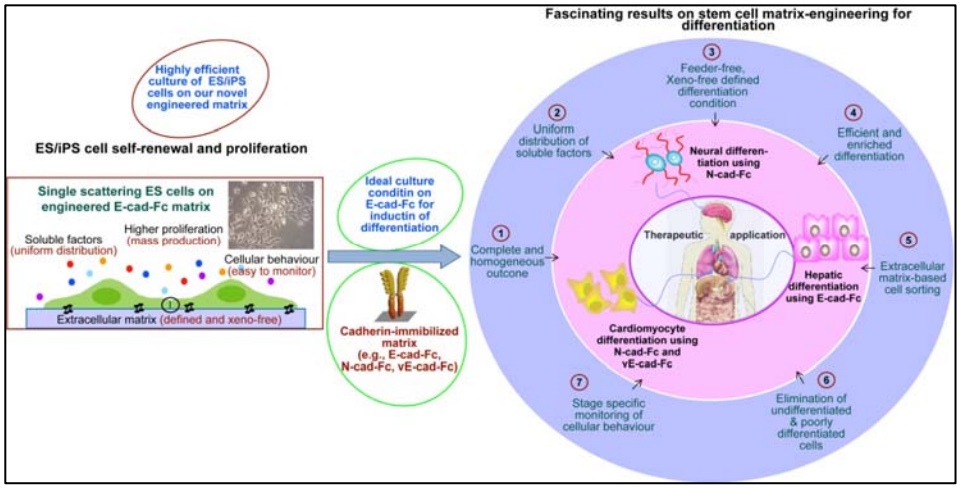

Figure 1:
The research achievements using our biomaterial-based extracellular matrix (E-cad-Fc) for culture and differentiation of ES/iPS cells.

Related References:

1. *Haque A. and Akaike T et al., 2011, Biomaterials 32:* 2032-2042.
2. Meng Q, *Haque A. and Akaike T et al., 2012, Biomaterials 33:* 1414-1427.
3. *Haque A. and Akaike T et al., 2012, Biomaterials 33, 5094-5106.*