Engineering human pluripotent stem cell-derived neurovascular systems to model neurological disease and explore therapeutic strategies

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My research focuses on engineering human pluripotent stem cell (hPSC) fates for applications in developmental and disease biology, drug screening, and regenerative medicine. During my graduate studies, I developed a process for differentiating human pluripotent stem cells (hPSCs) to endothelial cells possessing a blood-brain barrier (BBB) phenotype. In conjunction with renewable sources of pericytes, astrocytes, and neurons, we created a fully-human, scalable, BBB co-culture model that possesses physiological barrier properties and is being evaluated for its ability to predict brain uptake of small molecule drugs. For my postdoctoral work, I have been developing methods to improve the diversity and scope of neural differentiation from hPSCs. We devised a novel platform for generating pure neural stem cells (NSCs) from hPSCs in a fully defined and scalable manner and then used this platform to uncover biological cues that deterministically regulate posterior neural patterning, thereby generating uniform populations of NSCs possessing fixed positional identities corresponding to specific hindbrain and spinal cord domains. We are currently incorporating these defined NSCs onto custom surfaces that facilitate spatiotemporal control over cell behavior in an effort to improve the derivation of neuronal subtypes such as motor neurons. As an independent investigator, I will integrate the technology developed during my graduate and postdoctoral studies to engineer hPSC-derived, disease-specific *in vitro* neurovascular models that will serve as tools for dynamically assessing drug efficacy, identifying novel druggable targets, and studying progressive neurodegeneration in a dish.

Education

Ph.D., Chemical Engineering, 2012, University of Wisconsin, Madison, WI
B.S., Chemical Engineering, 2006, University of Illinois, Urbana, IL

Selected publications

1. **Lippmann ES**, Al-Ahmad A, Azarin SM, Palecek SP, and Shusta EV. A retinoic acid-enhanced, multicellular human blood-brain barrier model derived from stem cell sources. *Scientific Reports* 4:4160 (2014).
2. **Lippmann ES**, Estevez-Silva MC, and Ashton RS. Defined human pluripotent stem cell culture enables highly efficient neuroepithelium derivation independent of small molecule inhibitors. *Stem Cells* 32:1032-1042 (2014).
3. Sha J, **Lippmann ES**, McNulty J, Ma Y, and Ashton RS. Sequential nucleophilic substitutions permit orthogonal click functionalization of multicomponent PEG brushes. *Biomacromolecules* 14:3294-3303 (2013).
4. **Lippmann ES***, Azarin SM*, Kay JE, Nessler RA, Wilson HK, Al-Ahmad A, Palecek SP, and Shusta EV. Derivation of blood-brain barrier endothelial cells from human pluripotent stem cells. *Nature Biotechnology* 30:783-791 (2012). (*Equal contributions)
5. **Lippmann ES**, Weidenfeller C, Svendsen CN, and Shusta EV. Blood-brain barrier modeling with co-cultured neural progenitor cell-derived astrocytes and neurons. *Journal of Neurochemistry* 119:507-520 (2011).