Synthetic human embryo-like structures: A new paradigm for human embryology

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Early human embryonic development remains mysterious due to drastic species divergences between humans and other mammalian models and limited accessibility to human embryo samples. Recent studies from my laboratory and others have shown that under suitable culture conditions human pluripotent stem cells (hPSCs) can undergo intricate morphogenetic events and self-organize to form patterned human embryo-like structures in vitro. These synthetic human embryonic tissues hold great promises for advancing human embryology and reproductive medicine. In this talk, I will first discuss a micropatterned hPSC-based neuroectoderm developmental model, wherein pre-patterned geometrical confinement induces emergent patterning of neuroepithelial and neural plate border cells, mimicking neuroectoderm regionalization during early neurulation. In the second part of my talk, I will discuss a hPSC-based, synthetic model of human post-implantation development that recapitulates key developmental landmarks successively, including pro-amniotic cavity formation, amnion-epiblast patterning, primordial germ cell specification, and development of the primitive streak with controlled anteroposterior polarity. Together, our studies have developed powerful synthetic embryological platforms and provided new understandings of previously inaccessible but critical embryogenic events in human development.