Hydrogels are crosslinked polymer networks that store large amounts of water. Major components of tissues in our body are built of dynamic hydrogels, termed extracellular matrix (ECM), composed of complex mixtures of proteins and sugars that are secreted by cells. The ECM is specific to a particular cell and tissue type and provides numerous biochemical and biophysical signals that instruct cells to perform specific functions, for example, to multiply, migrate or differentiate. The instructive role of the ECM is crucial in building a tissue, in keeping it functional over long periods, and in regenerating it after damage. Inspired by nature, we have been developing fully synthetic and dynamic hydrogels that can mimic some of the key functions of natural ECM. In this talk, I will highlight recent efforts in my lab to develop hydrogels that emulate the native hydrogels that control the unique functions of stem cells in our tissues. Moreover, I will describe our emerging molecular toolbox to fabricate tissues in vitro based on hydrogel-guided stem cell self-organization.