CHAPTER 17

Bioengineering Complexity and Tuneability in Hydrogels

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Introduction

Hydrogels are water swollen polymeric chains that are cross-linked through different chemical or physical mechanisms (Utech and Boccaccini 2016). Given the hydrated nature and potential for physical and chemical tuneability, these materials have been explored and applied for applications in medicine since the 1960s (Buwalda et al. 2014). While initial work was mainly focused on developing bioinert structures and improving stability for drug delivery applications (Lee et al. 2013), our growing capacity to engineer at the molecular level has resulted in an increasingly diverse and powerful tool-kit to synthesize hydrogels with unprecedented chemical and physical properties (Peppas et al. 2006).

Hydrogels are being developed with a diverse set of properties including the capacity to be easily synthesized and modulated (Alakpa et al. 2016), elicit specific biological responses (Mata et al. 2010); display chemical and physical anisotropy (Mendes et al. 2013b); and adapt, change, and respond to different stimuli (Mortisen et al. 2010). These materials are opening opportunities to recreate *in vivo* environments *in vitro* to study for example biological processes or more effectively test drugs and to more

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