In adults, bone continues to undergo constant remodelling in response to mechanical load, changes in local calcium levels, and a wide range of paracrine and endocrine factors. This dynamic process regulates the balance between bone formation and resorption, which occurs in both compact and trabecular bone, and is governed by bone-producing cells (osteoblasts) and bone-resorbing cells (osteoclasts). The remodelling starts by osteoblasts triggering osteoclasts to break down bone matrix. The activated osteoclasts form a ruffled border in the area of bone resorption and release organic acids and lysosomal enzymes to break down the inorganic and organic bone components, respectively. As a result of this process, calcium is released into the bloodstream. Over time, osteoblasts replace osteoclasts and begin to lay down new lamellar bone on top of the old bone (Marks Jr. and Odgren 2002; Raggatt and Partridge 2010).

Most bones in the body are comprised of two morphologically and functionally different forms of bone. The outer layer consists of compact bone, also referred to as cortical bone. Compact bone is made up of densely packed collagen fibrils, which form concentric rings (lamellae). The lamellae are organised in perpendicular frames giving compact bone its rigid properties suitable for mechanical support. The inner layer is composed of a loosely organised and porous trabecular bone, also known as cancellous or spongy bone. Trabecular bone, which surrounds the bone marrow, has a more metabolic function (Marks Jr. and Odgren 2002). Cartilage is a connective tissue, which does not have any neural, lymphatic or vascular supply. The cells embedded in the dense ECM of the cartilage are called chondrocytes (Temenoff et al. 2000). The ECM of cartilage is made up of proteoglycans and collagen, which is responsible for the mechanical strength and architecture of the tissue (Ringe et al. 2002). Cartilage is predominantly present in between the joints of the long bone. As a result, they are subjected to continuous wear and tear, thereby leading to its degeneration. Cartilage can be damaged even due to trauma like sport injuries or accidents (Mano and Reis 2007; Hunziker 2002). For the cartilage to regenerate efficiently it is important to mimic its ECM. Hence the main focus for tissue engineering is the regeneration of the ECM. Since hydrogels resembles the aqueous rich environment of a cartilage tissue, they are considered suitable for cartilage tissue engineering (Lee et al. 2001; Li et al. 2009).

Bone defects can occur due to trauma, surgical excisions, congenital anomalies and degenerative disorders. More than 500,000 bone graft procedures are performed every year to address bone fractures and other orthopaedic-related injuries resulting from a variety of surgical, degenerative and traumatic causes (Greenwald et al. 2001; Laurencin et al. 2006). Injuries to the oral and maxillofacial complex are particularly challenging to repair as morphologically complex structures are damaged. The current treatment options such as autologous or allograft bone inadequately address the functional and aesthetic reconstruction of craniofacial bone due to limited supply, lack of contouring, donor-site morbidity, and other associated surgical complications (Kim et al. 2009; Schwartz et al. 2009; Sen et al. 2007). This chapter will focus on the use of hydrogels for bone regeneration. Briefly discuss about various types of hydrogel synthesis and parameters to be considered for designing of hydrogel for bone regeneration.