

vascular tissue and migration of MSCs (Kalfas 2001). Fibroblasts then begin to lay down a stroma that helps support vascular ingrowth. As vascular ingrowth progresses, a collagen matrix is laid down while osteoid is secreted and then mineralized. This results in the formation of a soft callus around the fracture-undergoing repair. After a period, the callus turns into bony tissue forming a bridge of woven bone between the broken fragments. However, if proper immobilization is not applied the callus will not ossify and unstable fibrous unions will occur (Kalfas 2001). The remodeling stage is complete when the healing bone is restored to its original shape, structure and mechanical strength. This process can occur over months or years depending on the age of the patient and is accomplished by mechanical stresses acting on the bone.

### ***Function of bone cells in healing***

Bone, unlike most organs and tissues, has a natural tendency to regenerate and heal. According to the Diamond concept there are four conditions required for successful healing in fractures (Verdonk et al. 2015). The four conditions refer to the presence of an appropriate mechanical environment and osteoconductivity (scaffolds) and encouraging osteoconductivity with growth factors and cell to induce effective osteogenesis (Verdonk et al. 2015). This concept is dependent on each of the bone cells fulfilling their respective roles in the healing process (Table 1).

**Table 1.** Types of bone cells and function in healing (Amini et al. 2012).

<b>Cell Type</b>	<b>Function</b>
Osteoblasts	Cells that are derived from MSCs and are responsible for bone matrix (osteoid) synthesis and its subsequent mineralization.
Osteocytes	These cells are osteoblasts that become integrated within the newly formed osteoid, which eventually becomes calcified bone. They are ideally situated so they can respond to changes in physical forces that are subjected on the bone and to transduce information to cells on the bone surface guiding them to sites that require resorption or formation responses.
Osteoclasts	Osteoclasts function in the reabsorption of mineralized tissue and are found attached to the bone surface at sites of active bone resorption. Their characteristic feature is a ruffled edge where active resorption takes place with the secretion of bone-resorbing enzymes, which digest the bone matrix.

## **Common Bone Diseases and Available Solutions**

Bone defects can occur due to trauma, surgical excisions, congenital anomalies and degenerative disorders.

### ***Union and non-union fractures***

Unfortunately, the expected union of the bone as a result of this normal bone healing process does not always occur. Union of a bone is a process influenced by various factors, which can be delayed or even inhibited in 5–10% of all fractures resulting in major implications for the individual and increased economic costs to society