The human skeletal system serves as the support system for the body. The skeletal system has five major functions: support, storage of minerals and lipids, blood cell production, protection, and leverage. Osteoclasts and osteoblasts are two of the most significant bone specific cells. Osteoclasts are involved in the destruction of bone and osteoblasts are involved in the rebuilding of bone.

Bone tissue is in a continual state of flux as osteoclasts secrete acids to dissolve hydroxyapatite and enzymes to break down the collagen while osteoblasts construct new bone (both minerals and collagen). The continual state of renewal forms the basis of bone healing. Massive trauma resulting in the destruction or removal of bone tissue necessitates reconstructive surgery before the bone can properly heal.

The current medical treatment for reconstructing bone is to use completely synthetic material, an autograft, or an allograft. The procedure of an autograft removes bone from an undamaged portion of the patient’s body and is then transplanted into the damaged portion. The procedure of an allograft is similar to that of the autograft except that the bone comes from a donor.

Scientists and engineers are currently working on several alternatives to the current medical treatments. An ideal bone substitute should function much like an autograft in that it should be biocompatible and induce the body’s natural bone making process so that the substitute will eventually be replaced by natural bone.

Pro Osteon (approved by the FDA in 1992), marketed by Interpore International, is the only currently available bone substitute using hydroxyapatite. It uses treated coral as a source of hydroxyapatite. Pro Osteon is manufactured by heating coral at 200 degrees Celsius for 24 to 60 hours to obtain 95% hydroxyapatite. The material is then formed into a block, or granules, and then irradiated with gamma rays to ensure sterilization. The porous structure allows osteoclasts to easily migrate into the matrix and begin breaking it down. Osteoblasts can immediately begin reconstruction. The naturally porous structure of the coral limits the strength of the material. Pro Osteon is only approved for use in low stress areas of the body.

Megagraft 1000 is a bone structure that is being produced by OsteoMedica. The synthetic bone is composed of high-purity hydroxyapatite produced from simpler components. The process involves reacting phosphoric acid, calcium metal, and calcium hydroxide at 700 to 850 degrees Celsius to form a nearly pure hydroxyapatite matrix that is as strong as the naturally occurring form. The pore size can be matched to the pore size of the bone being replaced therefore it can be used in higher stressed areas of the body than where the Pro Osteon can be used.

One alternative being developed by Interpore International is to combine bone growth factors from the patient’s own blood or from bone marrow with their Pro Osteon product to give a replacement bone. The bone growth factors cause the graft to be replaced with natural bone from the outside and within the graft, accelerating the rate of replacement. Another method is to use a biodegradable polymer as a carrier for the bone growth factors. The polymer would serve to fill the void left by the missing bone while the surrounding bone grows, into the gap. Since the polymer is biodegradable, the graft would break down as the new bone grows. However, a polymer must be found that degrades at the correct rate or the patient would be left with missing bone after the polymer is gone, but before the bone has finished growing.