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A Computational Model of Bone Resorption Behavior

Bone resorption by osteoclasts plays a fundamental role in the bone remodeling cycle which serves the purpose of repairing micro-damage and/or achieving mineral homeostasis. This process is also essential in growth and remodeling of bone, where it is tightly coupled to bone formation by osteoblasts. In order to study the static and dynamic behavior of bone resorption, a computational model of bone resorption has been developed using a cellular automaton method and its hybrid method with finite element calculation. In the model, essential features of bone resorption include the interaction of osteoclasts with the bone matrix and with other osteoclasts, and a recruiting signal for osteoclasts from osteocytes that can sense the change in mechanical properties of the bone matrix such as strain and strain-energy density. The computational model provides a theoretical tool to address various questions on bone resorption in terms of the shape and size of resorbed bone. From the simulations of the computational model of bone resorption, it is found that the process of bone resorption is strongly affected by the strength of interactions between osteoclasts with the bone matrix and with other osteoclasts, external mechanical loads, and velocity of a blood vessel.