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A combined process algebraic and a stochastic approaches to bone remodeling

In adult life the bone is being continuously resorbed and replaced by new bone. Here we present a stochastic model of the homeostatic nature of bone remodeling, where osteoclasts perform bone resorption which is equally balanced by bone formation performed by osteoblasts. The stochastic model is embedded in an algebraic process based on Shape calculus, which provides an effective multiscale description of the process. Our model considers increasing dimensionality from Rankl molecular signalling to osteoclast/osteoblast stochastic dynamics within a basic multicellular units (BMU) to a bone mass formation. We show that after a microfracture the simulated bone remodeling dynamics has timescale consistent with the biological process. Our combined methodology provides a first effective stochastic model of bone remodeling framework which could be used to test healthy and pathological conditions.