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Stochastic reaction kinetics allows simulation of complex biological systems with inherent stochasticity, including systems with small population sizes, rare events, and multiple overlapping feedback and feedforward loops. We will discuss a simple and flexible stochastic simulation software package, Biosimulator, designed to implement fast and accurate stochastic simulation algorithms with broad applicability in systems biology. Featured output includes the ability to diagram Petri Nets describing the connectivity of each reaction, and to plot mean trajectories as well as frequency distributions of each reactant species over time. We will illustrate the application of this software to important problems in cancer research, including a model of the breast cancer stem cell niche and investigation of therapeutic strategies aimed at cancer stem cell eradication. We will discuss future directions, including the expansion of our stochastic simulation methods to study spatial effects in cancer modeling. (Received January 31, 2018)