Experimental evidence suggests that, in order to maximize performance, biological networks often operate near the brink of failure. Because of the connections between such “tipping points” and the critical points of second order phase transitions, the methods of statistical and nonlinear physics are useful for studying these systems. My research in this area explores phase transitions and critical dynamics in both networks of genes and networks of neurons. Modeling phase transitions in gene regulatory networks has led us to propose a general mechanism underlying some cancers. Modeling phase transitions in neuronal networks has allowed us to identify features of the brain’s wiring that are key for optimal information processing. For both networks of genes and networks of neurons, studying how evolution shapes the path to criticality gives us insights into robustness and fragility in these systems.