Protein pattern formation is essential for the spatial organization of intracellular processes like cell division, and flagellum positioning. A prominent example of intracellular patterns is the oscillatory pole-to-pole oscillations of Min proteins in E. coli whose function is to ensure precise cell division. Cell polarization, a prerequisite for processes such as stem cell differentiation and cell polarity in yeast, is also mediated by a diffusion-reaction process. More generally, these functional modules of cells serve as model systems for self-organization, one of the core principles of life. Under which conditions spatio-temporal patterns emerge, and how these patterns are regulated by biochemical and geometrical factors are major aspects of current research. In this talk I will review recent theoretical and experimental advances in the field of intracellular pattern formation, focusing on general design principles and fundamental physical mechanisms.