Rational approaches to modifying cells to make molecules of interest are of substantial economic and scientific interest. Most of these efforts aim at the production of native metabolites, expression of heterologous biosynthetic pathways, or protein expression. Reviews of these topics have largely focused on individual strategies or cell types, but collectively they fall under the broad umbrella of a growing field known as cell factory engineering. Here we condense >130 reviews and key studies in the art into a meta-review of cell factory engineering. We identified 33 generic strategies in the field, all applicable to multiple types of cells and products, and proven successful in multiple major cell types. These apply to three major categories: production of native metabolites and/or bioactives, heterologous expression of biosynthetic pathways, and protein expression. This meta-review provides general strategy guides for the broad range of applications of rational engineering of cell factories.