Enzyme evolution plays an important role in generating the novel catalytic functions of the enzymes for the desired reactions and thus provides a promising route for bio-manufactures. Here, we give examples for discovering and optimizing the promiscuous enzymes and exploring their uses in reprogrammed biosynthetic pathways of Ginsenoside Rh2 and 2-Amino-1,3-propanediol. Through engineering the aminotransferases and the glycosyltransferase in vitro based on their catalytic mechanisms, we successfully repurposed the biosynthetic pathways for high production outcomes in vivo in hosts including Saccharomyces cerevisiae and Escherichia coli. These works demonstrate that enzyme evolution combined with the metabolic engineering is an efficient approach for environmentally friendly productions of pharmaceuticals and chemicals.