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(54) **Title:** COMPOSITIONS AND METHODS FOR PRODUCING CHEMICALS AND DERIVATIVES THEREOF

(57) **Abstract:** The present invention provides methods for producing a product of one or more enzymatic pathways. The pathways used in the methods of the invention involve one or more conversion steps such as, for example, an enzymatic conversion of guluronic acid into D-glucarate (Step 7); an enzymatic conversion of 5-ketogluconate (5-KGA) into L-Iduronic acid (Step 15); an enzymatic conversion of L-Iduronic acid into Idaric acid (Step 7b); and an enzymatic conversion of 5-ketogluconate into 4,6-dihydroxy 2,5-diketo hexanoate (2,5-DDH) (Step 16). In some embodiments the methods of the invention produce 2,5-furandicarboxylic acid (FDCA) as a product. The methods include both enzymatic and chemical conversions as steps. Various pathways are also provided for converting glucose into 5-dehydro-4-deoxy-glucarate (DDG), and for converting glucose into 2,5-furandicarboxylic acid (FDCA). The methods also involve the use of engineered enzymes that perform reactions with high specificity and efficiency. Additional products that can be produced include metabolic products such as, but not limited to, guluronic acid, L-iduronic acid, idaric acid, glucaric acid. Any of the products can be produced using glucose as a substrate or using any intermediate in any of the methods or pathways of the invention.

