UDP-galactopyranose mutase (UGM) is a unique flavoenzyme that catalyzes the interconversion between UDP-galactopyranose (UDP-Galp) and UDP-galactofuranose (UDP-Galf), without any net transfer of electrons. UGM is a central enzyme involved in the biosynthesis of galactofuranose (Galf). Galf forms a major component of different glycoconjugate structures, lipids and polysaccharides of disease-causing fungi, Aspergillus fumigatus and protozoan parasites such as Trypanosoma cruzi and Leishmania major. Current treatments for diseases caused by these pathogens are limited and use compounds that are either highly toxic or expensive. Thus, new drug development strategies are required for combating these lethal diseases. The unique chemistry of UGMs and its implication in the virulence of pathogenic bacteria, fungi and protozoa and its absence in humans make it a potential drug target. Though bacterial UGMs have been somewhat characterized in detail using structural and biochemical methods, major questions about the catalytic and structural properties of eukaryotic UGMs remain unanswered. Thus, the determination of three-dimensional structures of eukaryotic UGMs might help us in elucidating the enzymatic mechanism of this class of enzymes and potential inhibitor design. The research described in this dissertation address these longstanding questions by providing the first three-dimensional structural details and biochemical characterization of eukaryotic UGMs.