Glycogen, a branched polymer of glucose, is a storage molecule whose accumulation is under rigorous nutritional control in many cells. In S. cerevisiae, glycogen biosynthesis involves three processes: nucleation, elongation, and ramification, or branching. GLG1 and GLG2 encode self-glucosylating glycogenin glucosyltransferasesinvolved in glycogen nucleation. Both Glg1p and Glg2p are able to use UDP-glucose to produce a short alpha-glucosyl chain covalently attached to an internal tyrosine residue. Glycogen synthaseis then able to extend the linear alpha-chains of glycogen by catalyzing the formation of alpha-glucosidic bonds from UDP-glucose at the non-reducing ends. Branches can be added into the glycogen molecule by Glc3p, the glycogen branching enzymein S. cerevisiae. No enzyme that releases the glycogen chain from Glg1p or Glg2p has been identified.GSY2 encodes the majorityof the glycogen synthase activity in S. cerevisiae. GSY2 mRNA begins to accumulate when approximately 50% of the environmental glucose is gone, and peaks when environmental glucose is exhausted, similar to other glycogen metabolism genes. GSY2 is also induced by nitrogen starvation, environmental stresses, and stationary phase. Transcription of GSY2 is under complex regulation, with positive regulation by Snf1p, and by Msn2p/Msn4p through stress response elements, and negative regulation by Pho85p, and by cAMP-dependent protein kinase activity by both STRE-dependent and -independent mechanisms. Gys2p activity is also regulated at the protein level through the actions of protein kinases and protein phosphatases. The Pcl8p and Pcl10p cyclins direct Pho85p phosphorylation of Gsy2p, which decreases Gsy2p activity, and the Gac1p-Glc7p phosphatase dephosphorylates Gsy2p, which increases Gsy2p activity. GSY2 shows similarity to human glycogen synthase genes GYS1 and GYS2.