Potato (*Solanum tuberosum* L.) tubers are strong sink organs. Sucrose, being the major product of transitory starch degradation in leaves ("source"), is exported via the phloem to potato tubers ("sink"), where several enzymes and pathways are involved in starch synthesis and starch breakdown to reducing sugars (glucose and fructose). Both starch and free sugars play important roles during tuber formation (biosynthesis of starch) and during storage of potatoes (breakdown of starch). Carbohydrate metabolism in potato tubers depends on their physiological state, environmental conditions of plant growing and harvest date. During storage at temperature above 10°C, the sprouting of tubers occurs and the hydrolytic pathway of starch breakdown is activated. However, potato tubers are typically stored at about 4°C in order to minimize sprout growth, losses associated with reduction of weight and development of bacterial and fungal diseases. The main drawback of the low temperature tuber storage is the accumulation of reducing sugars via the phosphorolytic pathway. This phenomenon is referred to as cold-induced sweetening (CIS). Quantitative analysis reveals that up to 25% of the carbon present in starch may be converted to soluble sugars during storage at 4°C, but an equivalent amount is not lost in respiration when tubers are stored at 25°C. Starch breakdown must therefore be stimulated at low temperature. Reducing sugar content in cold-stored potatoes is a major problem for the potato processing industry. The high frying temperature used for the production of potato chips and French fries causes a non-enzymatic Maillard reaction between free aldehyde groups of reducing sugars and free amino groups of amino acids and proteins which results in dark chip color products, unacceptable to consumers. Carbohydrate metabolism in potato tubers includes the enzymes of starch synthesis, starch breakdown, glycolysis, hexogenesis (i.e. formation of glucose and fructose), oxidative pentose phosphate pathway and mitochondrial respiration. In dormant potato tubers very little metabolic activity takes place except for slow starch degradation and synthesis of sucrose with energy provided by glycolysis and respiration. With time of storage, the degradation processes are stimulated. The biochemistry of the processes in potato tubers is well known, but cellular and genetic mechanisms involved in their regulation still remains to be elucidated. In this project, genetic, genomic and proteomic approaches will be applied to study reducing sugar accumulation in tubers of diploid potato. We hypothesize to reveal significant differences in reducing sugar content in reciprocal progenies as a result of temperature-dependent cytoplasmic effects on the accumulation of reducing sugars in potato tubers.