Diabetic patients have impaired heart rate control. In diabetic rats ex vivo heart rate was significantly decreased compared to non-diabetic animals. Why this is the case remains unknown.

Within sinoatrial nodal cardiomyocytes heart rate is determined by rhythmic oscillations in Ca\(^{2+}\) and other ions, the so-called Ca\(^{2+}\) and membrane clocks. The Ca\(^{2+}\) clock primarily involves the intracellular Ca\(^{2+}\) store, the sarcoplasmic reticulum, and Ca\(^{2+}\)-handling proteins such as the sarco/endoplasmic reticulum Ca\(^{2+}\)-ATPase (SERCA2a) and its regulator phospholamban (PLB). The membrane clock involves membrane ion transporters such as the hyperpolarisation-activated cyclic nucleotide-gated channel (HCN4) and Na\(^+-\)Ca\(^{2+}\) exchanger (NCX). The functional HCN4).

In part, a result of change in membrane clock proteins (non-functional HCN4).

We conclude the lower intrinsic heart rate in diabetic rats is, in part, a result of change in membrane clock proteins (non-functional HCN4).