About mitochondrial importWhile the mitochondrial genome encodes a handful of proteins, most of the hundreds of proteins that reside in the mitochondrion are encoded by nuclear genes, translated in the cytoplasm, and imported into mitochondria via a series of complex molecular machines. Many of the proteins imported into mitochondria are involved in respiration, which is not an essential process: S. cerevisiae is able to carry out either fermentative growth on carbon sources such as glucose, or respiratory growth on nonfermentable carbon sources such as glycerol and ethanol. However, since maintenance of the mitochondrial compartment is essential to life, mutations that completely disrupt mitochondrial import are lethal.About the TIM23 complexThe Translocase of the Inner Mitochondrial membranereceives proteins from the Translocase of the Outer Mitochondrial membraneand either directs them into the mitochondrial matrix or facilitates their integration into the mitochondrial inner membrane. The membrane-embedded core of the complex is composed of three essential proteins: Tim23p, Tim17p, and Tim50p. Tim23p and Tim17p, which share sequence similarity, comprise the twin-pore structure through which precursor proteins translocate. Tim23p alone has the ability to form a voltage-sensitive channel, but Tim17p is required in vivo for maintenance of the twin-pore architecture and for normal function of the pore. Tim17p also has a role in sorting incoming proteins to the mitochondrial matrix or the inner membrane. Tim50p interacts with precursor proteins and with Tim23p to guide precursors from the TOM complex to the TIM23 complex. Two additional non-essential components, Tim21p and Pam17p, interact with the core of the TIM23 complex and may modulate its activity.Proteins destined for the mitochondrial matrix require the action of a sub-complex of the TIM23 complex, known as the import motor or presequence translocase-associated motorcomplex. Its catalytic component is Ssc1p, a member of the heat shock 70 protein family commonly referred to as mtHsp70, which undergoes cycles of binding and release of the precursor, hydrolyzing ATP and changing conformation in the process. The nucleotide release factor Mge1p promotes this cycle by facilitating the dissociation of ADP from Ssc1p. Other components include Tim44p, an essential subunit that mediates the association of the core TIM23 complex with the PAM complex; Pam18p, a J-protein cochaperone that stimulates the ATPase activity of Ssc1p; and Pam16p, a J-like protein that binds to Pam18p and regulates its activity. Pam17p mediates the association between Pam16p and Pam18p. Once imported proteins reach the mitochondrial matrix, their correct folding is facilitated by a soluble complex consisting of Ssc1p and its cochaperones Mdj1p and Mge1p.A subset of proteins destined for insertion into the mitochondrial inner membrane is translocated via the TIM23 complex but then inserted laterally into the inner membrane rather than entering the mitochondrial matrix. This mechanism is currently not understood in detail. The TIM23 complex adopts different conformations during the two kinds of import, but it is unclear whether this inner membrane import is accomplished by the core complex alone, or by the entire TIM23 complex including the import motor subunits.About TIM50 Tim50p is an essential protein, highly conserved throughout evolution, with orthologs identified in other fungi as well as in human, D. melanogaster, C. elegans, and A. thaliana. The protein is anchored in the mitochondrial inner membrane and exposes its large C-terminal domain to the intermembrane space, with the small N-terminal domain exposed to the matrix. The IMS domain of Tim50p interacts with the Tim23p import channel and this interaction is essential for the transfer of precursors between the TOM and TIM23 complexes. Analysis of truncation mutants shows that the IMS domain by itself is sufficient for the function of the full-length protein. Tim50p appears to function as a receptor for the entire TIM23 complex. Tim50p can be cross-linked to all types of TIM23 complex substrates, indicating that it is involved in the translocation of precursors destined for the matrix, inner membrane, and intermembrane space. Tim50p also appears to regulate the gating of the channel formed by Tim23p; in the absence of the translocation substrates, the IMS domain of Tim50p is capable of inducing the Tim23p pore to close, thus controlling the permeability of the mitochondrial inner membrane.