OLE1 encodes the sole S. cerevisiae Delta-9 fatty acid desaturase, an ER membrane protein required for the production of monounsaturated fatty acids. Because these fatty acids are critical components of cell membranes, the OLE1 gene is essential unless the media are supplemented with unsaturated fatty acids. The primary products of Ole1p are palmitoleicand oleicfatty acids, formed from palmitoyland stearoylCoA, respectively. The Ole1p sequence is similar to homologs in rat and humanover the majority of the protein, including a cluster of histidine residues that coordinate the binding of a diiron-oxo prosthetic group within the catalytic site. The rat and yeast proteins are similar enough that exogenously expressed rat protein can rescue an ole1 null mutant. However, Ole1p has an additional C-terminal, 113 amino acid extension, which encodes a cytochrome b5-like domain not found in mammalian desaturases. In animal cells, cytochrome b5 is thought to be the electron donor for fatty acid desaturation. In contrast, the yeast cytochrome b5is dispensable for the synthesis of unsaturated fatty acids because Ole1p contains inherent electron donor activity. The rat protein is unable to rescue an ole1 cyb5 double mutant.OLE1 is highly regulated at the levels of both transcription and mRNA stability. OLE1 transcription is decreased in response to high fatty acid levelsand increased in response to low oxygenand low temperature. Much of the transcriptional regulation is mediated by two homologous ER membrane-bound transcription factors, Spt23p and Mga2p. In response to stimuli, both Spt23p and Mga2p are activated by ubiquitin-dependent processing into their soluble forms, and then targeted to the nucleus. Independent of the transcriptional regulation, OLE1 mRNA is also stabilized under fatty acid free conditions and destabilized when fatty acids are added to the growth medium. Mga2p, but not Spt23p, contributes to the regulation of OLE1 mRNA stability.