The multicomponent mammalian Target of Rapamycin Complex 1 (mTORC1) is a major hub for extracellular nutrient and growth factor inputs that promotes growth. In response to amino acid (AA) stimulation, mTOR is shuttled to late endosomal/lysosomal compartments (LELs), where it binds to the Ragulator-Rag complex and forms active mTORC1. We have found that members of the proton-assisted amino acid transporter (SLC36/PAT) family are critically required for AA-dependent mTORC1 activation in human cells. PATs are primarily shuttled to the LELs of rapidly dividing cells, where immunolocalisation and co-immunoprecipitation studies indicate that they form part of a Rag-containing, AA-sensing complex or ‘nutrisome’ on these compartments. Our work in flies, human cell culture and now in xenografts of human cancer cell lines suggests that increased PAT activity may be especially important in the growth of tumour cells. We propose that the LEL location of PATs in these cells allows them to be incorporated into autolysosomes, where intraluminal AAs can promote growth and reformation of lysosomes in starvation and/or hypoxic conditions. These recent mechanistic insights into the regulation of mTORC1 raise new possibilities for selective modulation of this pathway in the future.