Nutrient-sensing mechanisms in eukaryotic cells

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G-protein coupled receptors, non-transporting nutrient carrier homologues and active nutrient carriers, have recently been shown to act as nutrient sensors in eukaryotic cells (Holsbeeks et al. 2004). They directly monitor the level of nutrients in the extracellular environment. Yeast cells have been at the forefront of research into eukaryotic nutrient-sensing systems. They contain a GPCR system that activates cAMP synthesis in response to glucose and sucrose in the medium. The first non-transporting nutrient carrier homologues that act as nutrient sensors have also been discovered in yeast. Snf3 and Rgt2 control the induction of genes encoding actively transporting glucose carriers by low and high glucose levels respectively. Yeast cells contain a similar system using the amino acid permease homologue Ssy1 for amino acid induction of actively transporting amino acid carriers. Similar proteins have recently been discovered in other eukaryotes. The yeast PKA pathway can also be activated by other nutrients although in this case an increase in cAMP does not seem to be involved. Elucidation of the nutrient-sensing mechanisms involved has led to discovery of the first actively transporting nutrient carriers acting as nutrient sensors. The Gap1 amino acid permease acts as a sensor for amino acid activation, Mep2 as a sensor for ammonium activation and Pho84 as a sensor for phosphate activation. Hence, part of the transporter/receptors (or 'transceptors') combine a function as nutrient transporter and receptor while others have lost detectable transport capacity to become pure receptors. Activation of signal transduction pathways by nutrients adds a new layer to the regulatory network controlling cellular metabolism and proliferation.

Holsbeeks I., O. Lagatie, A. Van Nuland, S. Van de Velde and J.M. Thevelein (2004) The eukaryotic plasma membrane as a nutrient-sensing device. Trends in Biochemical Sciences 29, 556-564