Yeast 'rewired' to mate when starving

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(PhysOrg.com) -- New research has found that the mating habits of the dairy yeast depends on the levels of nutrients available as well as the availability of cells of the opposite "sex."

The researchers, led by Lauren N. Booth of the University of California, San Francisco, carried out a series of experiments on three species of yeast: the baker's yeast (Saccharomyces cerevisiae), dairy yeast (*Kluyveromyces lactis*) and human pathogen yeast (Candida albicans). All three species have three cell types: the haploids a and α, both of which carry a single set of chromosomes, and the product of their mating, the diploid a/α. They also produce haploid spores which are formed when the diploid divides.

The a and α "sexes" mate by fusing together and combining the two sets of chromosomes to form the diploid cell type, which is externally virtually identical to the haploids. In this condition all the mating genes are suppressed and it no longer secretes mating factors, which are secreted constantly in the haploid cells.

Each of the cell types has specific genes controlled by specific proteins. In the a cells the genes express a factor "MATa1," and the equivalent in the α cells is MATα2. In the diploid the factors combine to form a complex a1/α2 and this blocks the expression of the four genes involved in mating and the genes specific to the a and α cell types. The new research has discovered that the dairy yeast has evolved a different form of regulation.

In *S. cerevisiae* diploids the genes specific to the a and α cell types are regulated by the a1/α2 complex, which binds to the DNA near the genes it shuts down. Among the proteins expressed by the genes is an intermediate regulatory protein called RME1. In *C. albicans* the process is the same but RME1 is not present. In *K. lactis* RME1 is present and is shut down by the a1/α2 complex, but in this yeast RME1 is the only gene regulated by the complex, and it is RME1 that regulates the expression of the other genes.

The differences in regulation of gene expression might have little effect since regulation of the genes in each case depends on the presence of the a1/α2 complex. RME1 is not just regulated by the complex, however, and is also regulated in response to levels of nutrients and is activated in starvation conditions.

This means that in all three yeast species the "decision" to mate depends on there being haploids of the opposite type present and secreting the a or α mating factors, but in *K. lactis* the nutrient levels also have an influence, so that in starvation conditions mating is more likely. Mating is a necessary step in the production of spores, which can ensure the yeast's survival in hard times.

The researchers said a reorganization in a relatively recent ancestor *K. lactis* produced the indirect suppression of the mating genes by RME1. The overall logic of haploid specific genes active in the a and α cells and off in the diploid is preserved, but the "rewiring" integrated nutritional signals into the mating decision.

The paper is published in the journal *Nature*.

More information: Intercalation of a new tier of transcription regulation into an ancient circuit, Lauren N. Booth, et al., *Nature* 468, 959–963 (16 December 2010) doi:10.1038/nature09560