QUORUM SENSING

Fungal quorum sensing: *in vino veritas*?

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URLs
Online Links
Entrez Genome Project: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=genomeprj

Candida albicans
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=genomeprj&cmd=Retrieve&dopt=Overview&list_uids=9526

Saccharomyces cerevisiae
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=genomeprj&cmd=Retrieve&dopt=Overview&list_uids=9518

Entrez Gene: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=gene

ARO8
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=gene&cmd=Retrieve&dopt=full_report&list_uids=852672

ARO9
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=gene&cmd=Retrieve&dopt=full_report&list_uids=856539

Quorum sensing is traditionally thought to be associated with the bacterial realm, but this form of cell–cell communication has also been reported in fungi. For example, in the pathogenic fungus *Candida albicans* the transition from the yeast to the filamentous growth form is controlled by quorum sensing, although the downstream signal-transduction pathways involved remain unknown. Now, Hao Chen and Gerald Fink have found that the morphological switch from the yeast to the filamentous form in *Saccharomyces cerevisiae* is also controlled by a quorum-sensing system, and they report the details of this system in a recent issue of *Genes and Development*.

Chen and Fink began their hunt for a quorum-sensing system in *S. cerevisiae* using a conditioned medium from *S. cerevisiae* stationary-phase cells, as it is a potent inducer of the transition from yeast to filamentous growth (for haploid cells this means an invasive growth response and for diploid cells the stimulation of pseudohyphal growth). Two active molecules — the aromatic alcohols phenylethanol (PheOH) and tryptophol (TrpOH) — were purified from the medium and were shown to stimulate the morphological transition. Double mutants lacking the genes that encode two transaminases required for the biosynthesis of aromatic alcohols, *ARO8* and *ARO9*, were then generated. A haploid *aro8*/*aro9* mutant was defective in invasive growth, and this defect could be suppressed by the addition of PheOH; a diploid *aro8*/*aro8 aro9*/*aro9* strain was defective in pseudohyphal growth, and this defect could be suppressed by both PheOH and TrpOH; this suggests that these aromatic alcohols are essential for the morphological change.

Further work revealed that the cell-surface protein Flo11p is necessary for the PheOH/TrpOH-induced morphological switch and that this is mediated through the protein kinase A (PKA) signalling pathway, with a requirement for both the PKA subunit Tpk2p and its downstream effector Flo8p. Given that the G protein and G-protein-coupled receptor upstream of Tpk2p are not required, the authors suggest that Tpk2p might have a direct role in PheOH and TrpOH sensing.

Analysis of the correlation between the production of aromatic alcohols and cell density showed that the production is cell-density-dependent, a hallmark of quorum-sensing systems. Moreover, PheOH and TrpOH production was found to be subject to positive-feedback control by TrpOH.

Finally, what regulates the production of these aromatic alcohols? In *S. cerevisiae* it has long been known that the transition from the yeast to the filamentous form is induced by nitrogen starvation, and Chen and Fink found that the production of both PheOH and TrpOH is regulated by nitrogen availability, with production being repressed by high-nitrogen conditions and activated by low-nitrogen conditions. So, in *S. cerevisiae*, the morphological transition from yeast to filamentous growth is controlled by a quorum-sensing system that, in addition to being cell-density-dependent, can also respond to nutrient limitation.

Both *S. cerevisiae* and *C. albicans* produce three aromatic alcohols; tyrosol, TrpOH and PheOH. Tyrosol, a quorum-sensing alcohol in *C. albicans*, had no effect on *S. cerevisiae*, and TrpOH and PheOH had no effect on *C. albicans*. The authors conclude that the differential effects of these signalling molecules "suggest that fungi, like bacteria, have evolved molecular signals that evoke species-specific behaviours".

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ORIGINAL RESEARCH PAPER Chen, H. & Fink, G. R. Feedback control of morphogenesis in fungi by aromatic alcohols. *Genes Dev.* **20**, 1150–1161 (2006)