60. Octopamine Inhibits Pharyngeal Pumping and Egg Laying and Stimulates Locomotion.
Mark Alkema, Niels Ringstad, Bob Horvitz
HHMI, Dept. Biology, MIT, Cambridge, MA 02139, USA

Octopamine is a biogenic amine implicated in several invertebrate behaviors. Octopamine biosynthesis requires a tyrosine decarboxylase (TDC) to convert tyrosine to tyramine and a tyramine beta-hydroxylase (TBH) to convert tyramine to octopamine. We characterized a *C. elegans* tyrosine decarboxylase gene (*tdc-1*) and a tyramine-beta-hydroxylase gene (*tbh-1*). We showed that *tdc-1* deletion mutants lack tyramine and octopamine, whereas *tbh-1* deletion mutants lack only octopamine. This observation indicates that *tdc-1* is required for tyramine biosynthesis and that *tdc-1* and *tbh-1* are required for octopamine biosynthesis. *tdc-1* and *tbh-1* expression overlap in the RIC interneurons and the gonadal sheath cells. *tdc-1*, but not *tbh-1*, is expressed in the RIM motor neurons and four uterine cells. These expression patterns suggest that the RIC interneurons and gonadal sheath cells are octopaminergic and the RIM motor neurons and UV cells are tyraminergic.

tdc-1 mutants have several behavioral defects that are not shared by *tbh-1*mutants, suggesting a role for tyramine in the suppression of head oscillations upon anterior touch and in reversal behavior (Alkema *et al*. **14** IWM 2003). *tbh-1* and *tdc-1* mutants share several behavioral defects: they fail to properly inhibit egg laying and pharyngeal pumping in the absence of food and move more slowly than wild-type animals. *tbh-1* and *tdc-1* mutants are also hypersensitive to exogenous serotonin in assays of locomotion, pharyngeal pumping and egg laying. Our results indicate that endogenous octopamine inhibits pharyngeal pumping and egg laying and stimulates locomotion and thus acts antagonistically to serotonin in these behaviors. Mutations in *tdc-1* and *tbh-1* suppress the pharyngeal pumping defect but not the egg-laying defect of serotonin-deficient *tph-1* mutants. Food-deprived *tbh-1* and *tdc-1* mutants, much like food-deprived animals mutant for the serotonin-reuptake transporter MOD-5, become almost immobilized when they encounter a bacterial lawn. *tbh-1* deletions can suppress the resistance to exogenous serotonin in locomotion assays of animals mutant for the serotonin-gated chloride channel MOD-1. Furthermore, *mod-1*; *tbh-1* double mutants display a hyperenhanced slowing response similar to that of the *tbh-1* single mutants. These data suggest that *tbh-1*acts downstream of or in parallel to *mod-1* in the modulation of locomotion. *mod-1* is expressed in a small number of motor neurons and interneurons, including the octopaminergic RIC neurons (Eric Miska, unpublished observation). This finding suggests that serotonin release can hyperpolarize the RIC interneurons and thereby inhibit octopamine signaling.