

ABSTRACT NOT FOR CITATION WITHOUT AUTHOR PERMISSION.

The title, authors, and abstract for this completion report are provided below. For a copy of the full completion report, please contact the author via e-mail at zielin1@uwindsor.ca.

Questions? Contact the GLFC via email at research@glfc.org or via telephone at 734-662-3209 ext. 119.

Molecular specialization of the sea lamprey gustatory chemosensory system

Project ID – 2023-ZIE-541020

Barbara Zielinski¹, Réjean Dubuc^{2,3}, Gheylen Daghfous³

¹Dept. of Integrative Biology, University of Windsor, Windsor, ON, N9B 3P4

²Département de neurosciences, Faculté de médecine, Université de Montréal, C.P. 6128, succ. Centre-ville, Montréal, Québec, H3C 3J7

³Groupe de Recherche en Activité Physique Adaptée, Département des Sciences de l'Activité Physique, Université du Québec à Montréal, Montréal, Québec, H3C 3P8

July 2026

ABSTRACT:

This study examines the molecular mechanisms of gustatory signal transduction responses to bile acid and bitter tastants in taste chemosensory cells and defines the central mechanisms involved in transmitting gustatory signals in the brain.

The findings associated with the first objective document sea lamprey taste bud neural responses to tastants (Polat et al., 2025) and chemosensory signal transduction in these taste buds (Aurangzeb, PhD thesis 2026). Messenger RNA for sea lamprey vomeronasal receptor proteins V1R324, V1R4, V1R342 and V2R1, as well as for G-proteins and the ion channel TRPM5 was observed in the lateral pharyngeal region (which contains taste buds). The receptor V1R324 is a candidate for lamprey taste chemoreception, as RNA for V1R324 was observed in the pharyngeal region containing taste cells and in the liver, but absent from other tissues. Sea lampreys also possess the ASIC1 acid sensing channel for sour taste, as RNA for ASIC1 was seen in the lateral pharyngeal region and ASIC1 immunolabeling was located in a subpopulation of taste bud cells. Investigation of the pharmacology of lamprey pharyngeal chemosensory neural responses supports the function of G proteins and of phospholipase C for chemosensory responses to bitter (denatonium) and to the bile acid taurocholic acid. The transient receptor potential melastatin 5 (TRPM5) channel functions for taste cell responses to the bitterant denatonium, but not to the bile acid taurocholic acid.

The second objective of this proposal was to characterize the central organization of the gustatory system in lampreys and to determine whether gustatory inputs influence the neural circuits responsible for locomotion. To address this objective, we combined anatomical and electrophysiological approaches to define the central pathways originating from peripheral taste buds and evaluate their functional impact on brainstem and spinal motor networks. We previously established that primary afferents from the taste buds projected directly to the nucleus of the solitary tract (NTS). Under the present grant proposal, we found that the NTS projects to several brainstem structures, including direct inputs to reticulospinal neurons, trigeminal motor neurons, and the parabrachial nucleus. Double-labeling anatomical experiments further demonstrated that NTS neurons project to parabrachial neurons, which in turn project to the posterior tuberculum, a region containing dopaminergic neurons, thereby revealing a previously unrecognized multisynaptic pathway linking gustatory processing to higher-order brain centers.

Our electrophysiological analyses uncovered an exceptionally robust functional coupling between peripheral taste buds and the locomotor command system. Stimulation of individual taste buds evoked prolonged excitatory responses

in reticulospinal neurons, the command neurons for swimming. A single taste bud was capable of exciting multiple reticulospinal neurons, while individual reticulospinal neurons received convergent inputs from several taste buds, demonstrating extensive integration of gustatory information within the locomotor network. Furthermore, activation of peripheral taste buds generated strong behavioral responses as sustained excitatory responses in spinal motoneurons directly involved in swimming. Collectively, these findings establish that the gustatory system is tightly integrated with the neural circuits controlling locomotion, in a manner comparable to other sensory modalities such as vision, olfaction, mechanoreception, and the vestibular system. This work provides fundamental new insights into sensorimotor integration and suggests that modulation of the gustatory system could profoundly influence lamprey motor behavior, with important implications for the development of novel strategies to control invasive lamprey populations.