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The Hydrodynamics and Odorant Transport Phenomena of Olfaction in the Hammerhead Shark ALEX RYGG, BRENT CRAVEN, Penn State University — The hammerhead shark possesses a unique head morphology that is thought to facilitate enhanced olfactory performance. The olfactory organs, located at the distal ends of the cephalofoil, contain numerous lamellae that increase the surface area for olfaction. Functionally, for the shark to detect chemical stimuli, water-borne odors must reach the olfactory sensory epithelium that lines these lamellae. Thus, odorant transport from the aquatic environment to the sensory epithelium is the first critical step in olfaction. Here we investigate the hydrodynamics and odorant transport phenomena of olfaction in the hammerhead shark based on an anatomically-accurate reconstruction of the head and olfactory chamber from high-resolution micro-CT and MRI scans of a cadaver specimen. Computational fluid dynamics (CFD) simulations of water flow in the reconstructed model reveal the external and internal hydrodynamics of olfaction during swimming. Odorant transport in the olfactory organ is investigated using a multi-scale approach, whereby molecular dynamics (MD) simulations are used to calculate odorant partition coefficients that are subsequently utilized in macro-scale CFD simulations of odorant deposition. The hydrodynamic and odorant transport results are used to elucidate several important features of olfactory function in the hammerhead shark.

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