Lyfish-inspired pumps: Researchers investigate next generation medical and robotic devices

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To the causal aquarium visitor, the jellyfish doesn't seem to be a particularly powerful swimmer; compared to a fish, it glides slowly and peacefully.

But for Janna Nawroth, a graduate student at the California Institute of Technology in Pasadena, the undulations of this simple invertebrate hold secrets that may make possible a new generation of tiny pumps for medical applications and soft robotics -- work she describes today at the American Physical Society Division of Fluid Dynamics (DFD) meeting in Long Beach, CA.

"Most pumps are made of rigid materials," says Nawroth. "For medical pumps inside the human body, we need flexible pumps because they move fluids in a much gentler way that does not destroy tissues and cells."

Nawroth is working with Caltech engineer John Dabiri, an expert on jellyfish propulsion. His research has shown these cnidarians tend to fall into two categories -- those that produce faster, harder strokes and those that create weaker but more efficient strokes. He has also studied the flows and eddies created by the strokes, which can be characterized by a dimensionless quantity called a Reynolds number.

"We're really lucky," says Nawroth. "The Reynolds numbers we see in

the movement of jellyfish of different sizes and ages are in the right range as what we need for medical applications."

As a step towards creating flexible pumps, Nawroth is studying how jellyfish shape and tissue composition adapt to the demands imposed by flow conditions at different Reynolds numbers. Jellyfish at millimeter scales, for example, exploit the small layer of water that adheres to their surface as they move and use it as additional paddle at no extra cost. Further, a clever arrangement of multiple pacemakers within the jellyfish body allow for a reliable yet tunable pumping mechanism.

In the future, Nawroth plans to use this practical understanding to help design a whole spectrum of flexible pumps that are optimized for different tasks and conditions.

More information: The presentation, "Learning from jellyfish: Fluid transport in muscular pumps at intermediate Reynolds numbers" is on Tuesday, November 23, 2010 . Abstract: meetings.aps.org/Meeting/DFD10/Event/134388

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