

# Nature or nurture: How does an animal get its microbiome?

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Alexander Okamoto holds a skate egg case in the Marine Resources Center, Marine Biological Laboratory, Woods Hole. Credit: Marine Biological Laboratory

We know that sharks are voracious eaters, but what do we know about the source of its microbiome? To date, not much. But a recent study from the University of Chicago and the Marine Biological Laboratory (MBL) fills a gap in understanding the microbiome associated with a close relative in the Chondrichthyes, a class of fish that includes sharks, rays and skates.

"There's a new understanding that microbiomes are very important for all [multicellular organisms](#)," said MBL Senior Scientist David Mark Welch, senior author on the paper. "We're essentially taking what we've learned from the NIH Human Microbiome Project, including the central role the microbiome plays in [human health](#), and recognizing that microbiomes play a role in a wide variety of organisms, particularly marine organisms."

Among the ocean dwellers, corals and certain fish have had their microbiomes analyzed, but "there are huge gaps [in knowledge], and one of them has been the microbiomes of non-bony fish—sharks, rays, skates and other cartilaginous fish," Mark Welch said.

An animal can acquire its microbiome in three different ways, the team's study explains. First, the parent can transmit all or part of its microbiome to its offspring. Second, the animal can acquire it during social or sexual interactions with other members of its species. And third, animals can recruit microbes from their environment through contact with fluids, habitat, or diet. Humans acquire their microbiome in all three ways.



An adult little skate (*Leucoraja erinacea*) in the Marine Resources Center, Marine Biological Laboratory. Credit: Andres Pruna

First authors Katelyn Mika and Alexander Okamoto were inspired to discover how the microbiome originates in the little skate (*Leucoraja erinacea*) in 2018, when they were spending the summer at the MBL with University of Chicago Professor Neil Shubin. The little skate's embryo develops in the contained environment of an egg case, commonly called a devil's purse.

"The skate egg case is a very interesting place to study microbiome development because the egg is separate from the outside world up until [about two-thirds of the way through] development, when little apertures open in the egg case and there starts to be an exchange with seawater,"

said Mark Welch. "So, you can ask the question more easily than in other organisms, is there vertical transmission of the microbiome? Namely, does the mother pass on part of her microbiome to the offspring?"

"We began wondering what happens with the little skate's microbiome, given the egg's fairly dramatic life-history changes," said Okamoto. "[The egg case] is basically dumped on the bottom of the ocean, abandoned by its parent for many months, and then it opens up suddenly and seawater rushes in."

The team used next-generation sequencing to characterize the microbial community at six points in the skate's embryonic development. Their efforts yielded the first evidence of vertical transmission of the [microbiome](#) from parent to offspring in the Chondrichthyes.



A little skate embryo in its case, commonly called a devil's purse. Credit: Laurel Hamers

Their findings are a useful step in the study of microbiomes, which can be indicators of how well an organism is doing in its environment, said Mark Welch.

"We know that a lot of marine species are under stress because of anthropogenic changes, global warming," he said. "One of our broader goals is to be able to study the microbiomes of these organisms and determine very quickly, how healthy are they?"

There's plenty of room for more research on animal microbiomes, said Mika—including on sharks.

"There's a chain catshark at the MBL whose eggs look incredibly similar to the skates' eggs," she said. "They go through the same sort of development where they're in that egg case for the first two thirds, then they have slits that open, and then they finish developing with that open waterflow through the [eggs](#). I'm desperate to know if their microbiomes are similar to the skates' or if they're totally different."

The research was published in *Animal Microbiome*.

**More information:** Katelyn Mika et al, Bacterial community dynamics during embryonic development of the little skate (*Leucoraja erinacea*), *Animal Microbiome* (2021). [DOI: 10.1186/s42523-021-00136-x](https://doi.org/10.1186/s42523-021-00136-x)

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