

New study shows how microbial transmission can affect adaptive behavior

Discovery could translate into personalized, microbiome-based therapies and interventions

By Rithwik Kalale, ASU News
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Most of us are familiar with natural selection — the process where organisms with traits better suited to their environment are more likely to survive and reproduce, passing those traits to their offspring. As a result, the genes and behaviors of the species adapt according to their environment and circumstances.

While this process happens over the course of generations, a research team led by [Taichi Suzuki](#), a joint assistant professor at Arizona State University's Biodesign Institute and College of Health Solutions, found that transmission of a mammal's microbiome alone can affect behavior in a short time — within four generations — and result in a new trait that can be passed down to offspring without altering its genes.

[The study](#), which published in Nature Communications and was done in collaboration with researchers from Max Planck Institutes, Rutgers University and Cornell University, aimed to look at how artificial selection acts on the host and its microbiome, which according to Suzuki, is an emerging topic in evolutionary biology and domestication.

To find out whether selection-driven changes in mammalian physiology or behavior can be caused by the microbiome alone, Suzuki and his team turned to mice and observed their locomotive behavior.

“To identify which aspects of physiology or behavior were most influenced by the microbiome, we performed fecal transplant experiments using two distinct microbiomes and compared a wide range of traits in germ-free mouse recipients,” he said. “To our surprise, behavior — especially activity level — showed the strongest microbial influence, far exceeding effects on morphological traits such as body weight or size.”

The study found that mice receiving microbiomes from low-activity donors became less active themselves. One bacterium in particular stood out: *Lactobacillus*.

“We found that a metabolite produced by *Lactobacillus*, indolelactic acid (ILA), plays a key role in influencing behavior,” Suzuki said. “Although ILA itself does not easily reach the brain, by calming the immune system and lowering inflammatory signals that travel to the brain, it can indirectly affect mood, activity and behavior.”

The connection between gut microbes and behavior is known as the gut-brain axis.

Suzuki’s work offers something rare: experimental evidence that behavioral changes in response to selection can be mediated solely through microbial transmission.

“There are many evolutionary theories proposing that the microbiome plays a role in adaptation to rapid environmental and climate changes,” he said. “This work provides experimental support for those ideas.”

In nature, the global spread of house mice is an example of this theory in action.

“House mice migrated with humans from Western Europe to the Americas over the past 200 years,” Suzuki said. “In this short evolutionary period, mice in the Americas have already shown evidence of adaptation, differing in body size and behavior depending on whether they live in cold or warm climates.”

His team demonstrated that these behavioral differences could partly emerge through microbiome selection alone.

“We demonstrated that high-activity behavior, characteristic of ancestral mice from Western Europe (likely reflecting higher metabolic demands in colder climates), can change to low-activity behavior (as seen in warm-climate populations in Brazil) simply by selecting mice with low activity and transferring the microbiome across four generations,” he said.

The study’s findings suggest that microbiome-mediated adaptation could help animals — and potentially humans — adjust to rapid environmental change far faster than genes alone allow.

“Just as conservation genetics considers genetic diversity, incorporating microbial diversity and microbiome-based approaches can advance fields ranging from conservation and domestication to biomedical research,” Suzuki said.

His team is now studying 16 different wild rodent populations across Arizona’s [“Sky Islands”](#) to understand how microbial diversity supports adaptation in natural environments.

Beyond evolution and adaptation, the implications also extend into biotechnology and medicine.

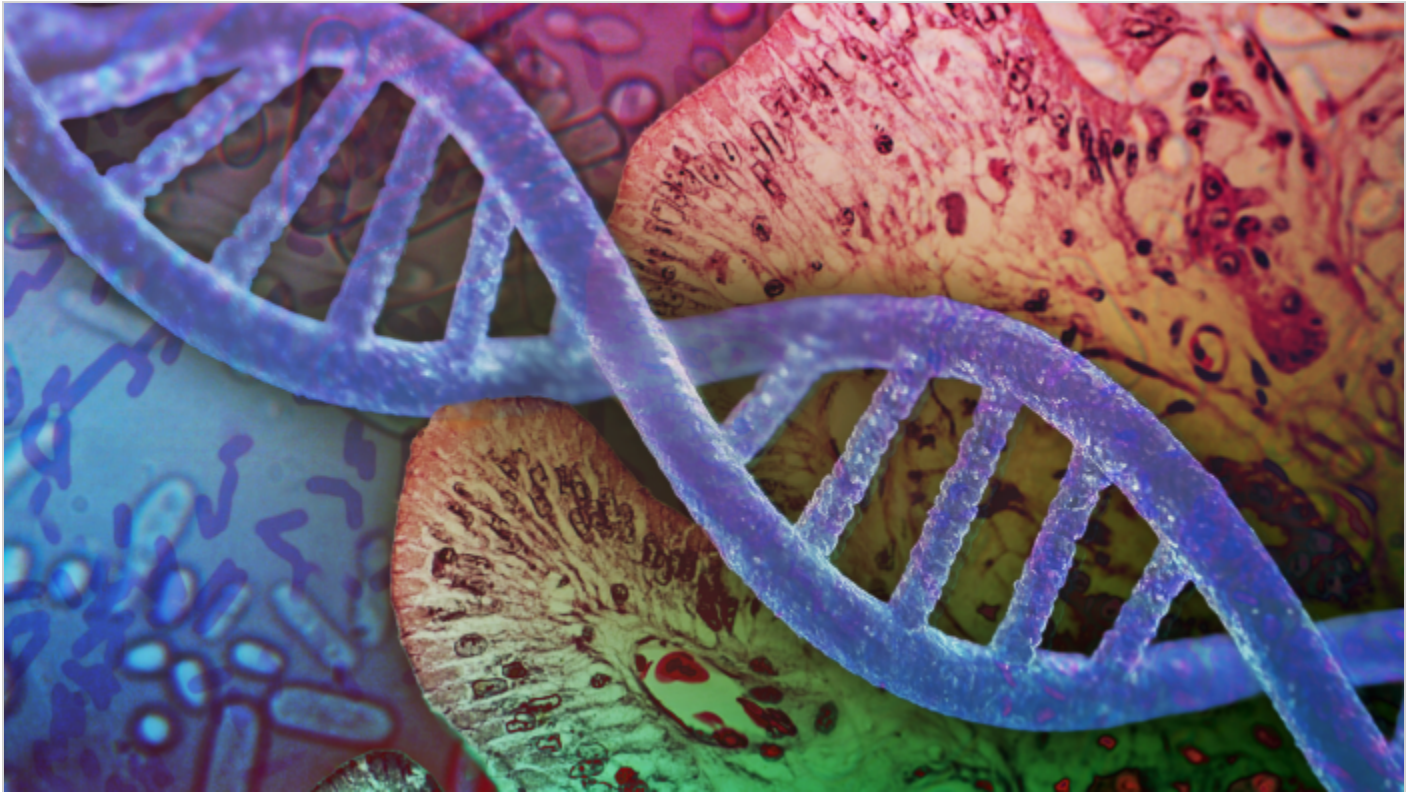
“The possibilities are endless,” Suzuki said. “Rather than offering a single or a few probiotic strains for everyone, it may one day be possible to engineer a microbiome from a person’s own microbial community, growing it in a bioreactor or animal model, selecting for desired functions and then using that community or selected strains for personalized treatment.”

Although this research was a breakthrough, Suzuki explained the field is still in its infancy.

“This is the first study to demonstrate how microbiome engineering can work in animals, and further studies are needed to replicate these results across different traits and systems,” he said. “The cost of microbiome engineering remains high when using animal models, so developing scalable, high-throughput systems that mimic the gut environment will be a key step toward translating these findings into microbiome-based therapies or interventions.”

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Main image



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Taichi Suzuki