Sea Grant Oregon

Preventing fish disease with biotechnology

THE FISH DOCTOR IS IN. For almost 25 years, Jo-Ann Leong has been seeing her patients in a variety of habitats—from their native rivers to what she calls the "fish hospital" near Oregon State University. But Leong isn't interested in treating or curing fish diseases. Rather, she has devoted her scientific career to preventing them.

The "fish hospital," OSU's Center for Salmon Disease Research, is a spotless, well-organized assortment of tanks holding thousands of trout and salmon. Here, Leong works to find new, high-tech ways to protect fish from the infectious hematopoeitic necrosis virus (IHNV), a disease that kills an estimated 30 percent of Pacific Northwest salmon and trout.

Leong has not always worked in such a pristine environment. She earned what she laughingly calls her "slime badge" knee-deep in cold rivers. Even a molecular biologist, she is quick to note, has to get out in the field sometimes.

Leong's work has brought her up close to thousands of salmonids, in the field and in the lab. Since 1983, Oregon Sea Grant has been a major source of funding for her work.

"Marine biotechnology is an orphan child for many organizations," Leong points out. "For Sea Grant, it's a priority."

Jo-Ann Leong studies the makeup of genes that induce a strong immune response in fish.

Leong's speciality is genetic research focusing on the natural disease-prevention mechanisms of fish. Although the work itself seems esoteric, its outcome could have fundamentally practical effects.

The world population is projected to grow to 8.5 billion people by 2025. Fish offer a relatively cheap and abundant way of providing protein to that population. But there aren't enough fish in the wild to do the job, and so aquaculture—fish farming—is seen as an important answer to feeding a hungry world. World aquaculture is expected to grow to 20 million tons within the next year.

But there are problems. Aquaculture grows fish in close quarters, and that makes farmed fish an easy target for disease which can wipe out entire stocks almost overnight. Conventional treatments—antibiotics and pharmaceuticals—pose several problems. Not only are they difficult to administer (imagine trying to give every fish a shot or a pill), but they also pose risks of tainting the fish in ways that could threaten consumer health.

Consequently, Leong is looking for ways to get the fish, in effect, to immunize themselves.

Using recombinant DNA techniques, Leong clones fragments of viral genes and inserts them into benign bacteria, which then synthesize the viral proteins into a vaccine "soup." In the lab, young fish can be immersed in this soup to inoculate them against IHNV.

The technique is far from perfect or cost-effective. It's not even Leong's ultimate goal. Ideally, she wants to use the same sorts of techniques to create a "fish vector" that can carry the viral gene directly into the genetic structure of the fish. Such a vector would allow the animals to express the viral gene in their own cells, effectively creating a "DNA pill" that would immunize the fish from within.

Leong hopes to use this technique to create commercially viable fish vaccines that are also environmentally safe.

Although she has made her career—and risen to become chair of OSU's distinguished Department of Microbiology—working with fish, that's not what Leong expected to do when she was studying at the University of California San Francisco Medical Center, where she earned her doctorate in microbiology specializing in human RNA tumor viruses.

But when she came to work at OSU in 1975, then-department head Dr. John Fryer told her of the millions of fish dying every year from viral diseases. Scientists had almost no idea what was causing the problem or how to cope with it—and that fueled Leong's curiosity.

"I had never heard of fish viruses," she recounts, "and almost nothing was known about their molecular structure. It was fascinating to me." She took on the challenge to uncover that structure and slowly, painstakingly add to the body of knowledge that eventually would lead to DNA-based vaccines.

More than two decades later, Leong remains fascinated by her work and its potential. "What is really exciting are the discoveries being made about the fish immune response," Leong says. "We need to understand how fish respond to infectious pathogens and what correlations can be made between the mammalian and piscine systems. Without that understanding, it would be difficult to develop control and intervention strategies to prevent disease outbreaks in the many new species being developed for aquaculture today."

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