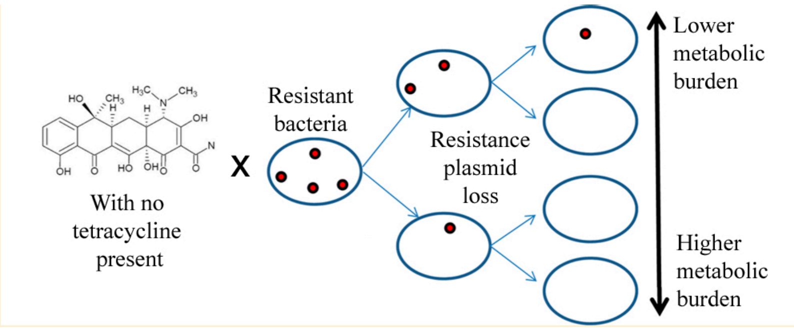
Deprived Bacteria Unable to Resist Antibiotics



Rice University [1] researchers "cured" a strain of bacteria of its ability to resist an antibiotic in an experiment that has implications for a long-standing public health crisis.

Rice environmental engineer Pedro Alvarez and his team managed to remove the ability of the Pseudomonas aeruginosa microorganism to resist the antibiotic medication tetracycline by limiting its access to food and oxygen.

Over 120 generations, the starving bacteria chose to conserve valuable energy rather than use it to pass on the plasmid – a small and often transmissible DNA element – that allows it to resist tetracycline.

The researchers' results, reported in the American Chemical Society [2] journal Environmental Science and Technology [3], are the latest in a long effort to understand the environmental aspects of antibiotic resistance, which threatens decades of progress in fighting disease.

"The propagation of antibiotic resistance has been perceived as a medical or microbiology-related problem," Alvarez said. "And it truly is a serious problem. But what many people miss is that it is also an environmental pollution problem. A lot of the antibiotic-resistant bacteria originate in animal agriculture, where there is overuse, misuse and abuse of antibiotics."

Alvarez contended that confined animal feeding operations (CAFOs) are potential sources of environmental contamination by antibiotics and the associated antibiotic-resistant genes that find their way into the ground, water and ultimately the food supply.

"We started with the hypothesis that microbes don't like to carry excess baggage," he said. "That means they will drop genes they're not using because there is a metabolic burden, a high energy cost, to keeping them."

The Rice researchers tested their theory on two strains of bacteria, P. aeruginosa, which is found in soil, and E. coli, which carries resistant genes directly from animals through their feces into the environment.

By slowly starving them of nutrients and/or oxygen through successive generations, they found that in the absence of tetracycline, both microbes dumped the resistance plasmid, though not entirely in the case of E. coli. But P. aeruginosa completely shed the genetic element responsible for resistance, which made it susceptible once again to antibiotics. When a high level of tetracycline was present, both microbes retained a level of resistance.

One long-recognized problem with antibiotics is that they tend to snatch defeat from the jaws of victory. If any antibiotic-resistant bacteria are part of a biological mix, whether in a person, an animal or in the environment, the weak microbes will die and the resistant will survive and propagate; this process is known by biologists as “selective pressure.”

So there is incentive to eliminate the resistance plasmid from bacteria in the environment as close to the source as possible. The experiments point to possible remediation strategies, Alvarez said. “There are practical implications to what we did,” he said. “If we can put an anaerobic barrier at the point where a lagoon drains into the environment, we will essentially exert selective pressure for the loss of antibiotic-resistant genes and mitigate the propagation of these factors.”

An anaerobic barrier may be as cheap and simple as mulch in the drainage channel, he said. “If you have a CAFO draining through a channel, then put an anaerobic barrier in that channel. A mulch barrier will do.” He said a mulch barrier only a meter thick could contact slow-moving groundwater for more than a month. “That may not kill the bacteria, but it’s enough to have bacteria notice a deficiency in their ability to obtain energy from the environment and feel the stress to dump resistant genes.”

Alvarez has been chipping away at the problem since moving to Rice from the University of Iowa in 2004, even without American funding for research. His study of the Haihe River in China, funded by the Chinese government and published last year, found tetracycline resistance genes are common in the environment there as well. “We tested water and river sediment and couldn’t find a sample that didn’t have them,” he said.

“Our philosophy in environmental engineering is that an ounce of prevention is worth more than a pound of remediation,” Alvarez said. “Prevention here is, basically, don’t let these genes proliferate. Don’t let them amplify in the environment. Stop them before they’re released. And one easy way is to put up an anaerobic barrier.”

Co-authors of the paper are Rice alumni Michal Rysz, now an environmental engineer at GSI Environmental Inc., Houston; William Mansfield, a scientist at the EPA in Dallas; and John Fortner, an assistant professor at Washington University, St. Louis. Alvarez is the George R. Brown Professor and chair of the Department of Civil and Environmental Engineering at Rice.

Source: Rice University [1]

Links:
[1] http://www.rice.edu/
[2] http://portal.acs.org/portal/acs/corg/content
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