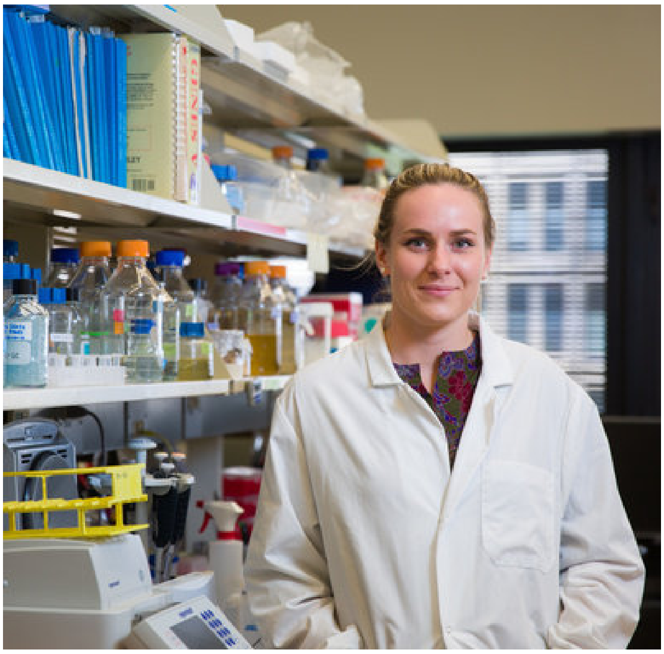
# Scientists seek a deeper understanding of how silver kills bacteria

3 October 2018, by Mark Lowey



Silver's popularity as a bacteria killer has led to companies embedding tiny, nano-sized silver particles in running shirts, underwear, socks, shoe insoles, food cutting boards, toothbrushes and an expanding array of other "antibacterial" consumer goods. But there is concern that these growing non-medical applications could lead to some bacterial strains becoming resistant to silver and other antimicrobial metals, says Natalie Gugala, a PhD student in Ray Turner's lab at the University of Calgary. Credit: Riley Brandt, University of Calgary

Silver has been used for centuries as an antimicrobial to kill harmful bacteria. Ancient civilizations applied the metal to open wounds. Ship captains tossed silver coins into storage barrels to keep drinking water fresh.

In hospitals today, silver is used in bandages to treat burn victims, destroy pathogenic microbes on catheters, and combat dangerous "superbugs" that have grown resistant to traditional antibiotic drugs.

But the molecular mechanisms of how silver kills bacteria, and how resistance to silver develops in these microorganisms, are not fully understood. Now a new study, led by Faculty of Science biological scientists at the University of Calgary, helps enhance understanding of silver's antibacterial properties.

The research team performed a chemical genetic screen on a "library" of 4,000 mutant strains of the bacterium Escherichia coli (E. coli), in which a unique gene in each strain has been "knocked out," or deleted.

The team identified the genes in all these strains that showed either resistance or sensitivity when exposed to silver—producing the first genetic map of the genes that contribute to either silver resistance or toxicity in E. coli.

"Our study is the first of its kind to evaluate the genetic response in cells allowed to grow in the presence of silver, and thus provide a list of genes for resistance and toxicity, and map them to biological processes," says Dr. Raymond Turner, PhD, professor of biochemistry in the Department of Biological Sciences.

**Study pinpoints new genes and molecular mechanisms involved in silver toxicity**

Natalie Gugala, a PhD student of Turner's, mapped all 225 genes that were either resistant or sensitive to their corresponding biological pathways. These cellular mechanisms included transporting metals through the cell wall, energy producing, regulating the cell, and other processes.

"We've shown that there are many different genes that are likely affected and several different pathways," says Gugala, lead author of the team's scientific paper.

"It is likely that silver acts in multiple ways on bacteria," says Dr. Gordon Chua, PhD, associate professor of integrative cell biology in the Department of Biological Sciences. "Our study identified new genes and molecular mechanisms involved in silver toxicity as well as resistance."

The team's paper, "Using a Chemical Genetic Screen to Enhance Our Understanding of the Antibacterial Properties of Silver," is published in the journal Genes.

**The important role of molecules in our health**

E. coli is just one of many microorganisms that can cause illness and life-threatening infections. Many bacteria and other microbes are becoming increasingly resistant to traditional antibiotics.

The team's research fits well with the Faculty of Science's Grand Challenges. Specifically, "Personalized Health at the Molecular Level" prioritizes research aimed at minimizing antibiotic resistance, and understanding the role molecules have in our health.

"We need to understand how silver works if we're going to continue using it and before we develop more silver-based antimicrobials," Turner says.

**Along with antibiotics: custom-designed metal antimicrobials**

Determining at the molecular level how silver and other metals, such as copper and gallium, are able to kill bacteria could lead to improved medical therapies. Some research shows adding a metal to a traditional antibiotic that doesn't work anymore makes the drug effective again, Turner notes. "I foresee us using custom-designed metal antimicrobials along with antibiotics.

"This personalized health approach, using studies like ours, leads to identifying a set of marker genes that could be used to select specific metal-antimicrobial therapies tailored to combat bacterial infections in individual patients," he adds.

Silver's popularity as a bacteria killer has led to companies embedding tiny, nano-sized silver particles in running shirts, underwear, socks, shoe insoles, food cutting boards, toothbrushes and an expanding array of other "antibacterial" consumer goods.

But there is concern that these growing non-medical applications could lead to some bacterial strains becoming resistant to silver and other antimicrobial metals—as some bacteria have done with traditional antibiotics. "We need to be sure that we're using these metals in the appropriate setting," Gugala says. "If we know how they work, we might be able to better prevent their inappropriate use."

**Robotics helped screen bacteria**

The team performed their chemical genetic screen using a robot, designed for automated handling and processing of high-density bacterial colony plates, in Chua's laboratory.

Researchers then used "colony-scoring" software to measure the differences in growth and size of each plate's bacterial colony. E. coli strains with genes deleted involved in producing sensitivity, or toxicity, to silver grew larger colonies. Strains with genes deleted involved with resistance grew smaller colonies.

The team used a novel chronic, non-lethal exposure approach compared with most previous research, which exposed bacteria to acute, lethal dosages of silver to determine toxicity only.

Kate Chatfield-Reed, then a PhD student of Chua's, helped "normalize," or standardize, the data to identify strains showing statistically significant changes in growth rate when exposed to silver, compared with untreated control plates.

**More information:** Natalie Gugala et al. Using a Chemical Genetic Screen to Enhance Our Understanding of the Antibacterial Properties of Silver, *Genes* (2018). DOI: 10.3390/genes9070344

Provided by University of Calgary

APA citation: Scientists seek a deeper understanding of how silver kills bacteria (2018, October 3) retrieved 24 June 2019 from https://phys.org/news/2018-10-scientists-deeper-silver-bacteria.html