

## Fighting the Future: Mason Scientists Address Bacteria's Resistance to Modern Antibiotics

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**"The students are really frontline researchers and are integral to the success of research on bacterial resistance," says Prof. Robin Couch, shown above working with student Elissa Williams.**

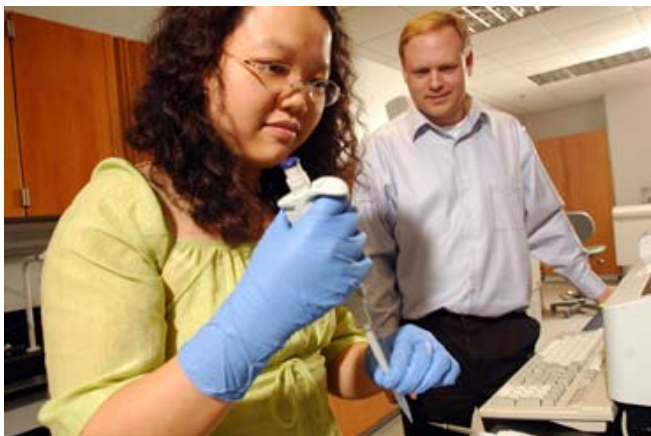
*Photo by Evan Cantwell*

By [James Greif](#)

Antibiotics that work today may not work tomorrow. It's a serious problem that several researchers at Mason are bent on solving. Bacteria are becoming more resistant to common antibiotics, partially due to overuse of this class of medicine.

"Basically, bacteria have two choices: Become resistant or die," says Timothy Born, professor in the Department of Chemistry and Biochemistry.

"Bacteria are very resourceful and have developed resistance mechanisms to essentially every antibiotic that has been developed," Born explains. "Antibiotics are killing off the weak bacteria and leaving a strong set of bacteria that reproduce and carry a resistance to certain drugs."



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**"Bacteria are very resourceful and have developed resistance mechanisms to essentially every antibiotic that has been developed," says Timothy Born, shown in his lab with student Minh Nguyen.**

*Photo by Evan Cantwell*

This resistance is leaving doctors with fewer options for treating bacterial infections. The phenomenon is already causing major problems in hospitals where staph infections that do not respond to antibiotic treatments are becoming more common.

Researchers in Born's laboratory are investigating specific enzymes that could be new targets for novel antibacterial compounds. Through his research, Born hopes to prevent bacterial pathogens from synthesizing methionine, an amino acid that bacteria manufacture, but humans do not. Preventing the synthesis of methionine would prevent bacteria from multiplying at the rate necessary to cause an infection.

Barney Bishop, assistant professor in the Department of Chemistry and Biochemistry, is taking a different approach to the antibiotic resistance problem. Bishop's lab is studying a family of peptides named "defensin." In previous studies, these peptides have demonstrated antimicrobial activity against a broad spectrum of microbes, including bacteria, fungi and viruses.

"We believe that analyzing these peptides will help create new strategies for combating bacterial and viral infections. Our lab intends to use these antimicrobial peptides in the design of novel therapeutic agents."

Assistant professor Robin Couch is also working on potential new antibiotic treatments using an approach similar to the one being used in Born's lab. However, Couch's lab is focusing on the isoprene biosynthetic pathway, which provides important chemicals for critical cellular processes in all living things. Since the human pathway is different from that of bacteria, a drug could target this pathway and not affect humans adversely.

Couch looks at his research in stages. "First, you must identify a target for medicine and then validate that target. Next, you set out to prove that by inhibiting this target, you will kill the bacteria."

### **Another Tool for Researchers**

Understanding and predicting ways in which bacteria are able to mutate and adapt are important components to developing new solutions to antibiotic resistant bacteria. In another discipline altogether, the Evolutionary Computation Laboratory at Mason uses a type of artificial intelligence to understand and predict how existing evolutionary systems work.



**Kenneth De Jong works on computational modeling that can help to better comprehend bacterial resistance to antibiotics.**

*Creative Services photo*

Under the direction of Kenneth De Jong, the laboratory uses Darwinian-like computer models to better comprehend these systems. These adaptive models could be used to better understand how bacteria become resistant to antibiotics such as penicillin.

De Jong uses agent-based models in which the interplay between agents helps the models behave more like the complex events they are simulating. The model is constructed using available data, and the agents in the model interact and produce an outcome over time.

"Capturing complex adaptive systems in a model is a science and an art," says De Jong. "The art is selecting what information needs to be included in the model."

Agent-based models are useful when studying antibiotic resistance because the agents in the model adapt to a situation, much like bacteria do.

The laboratory also uses complex adaptive systems models to study the impact that policy changes might have on future outcomes, which could provide valuable information

when determining the best course of action for public health policy. De Jong compares this process to the models that meteorologists use to predict the weather.

“For example, what if we stopped using antibacterial soap as a general policy? What effect would that have on bacteria?” De Jong asks. “To help answer policy questions such as this, we could create a complex adaptive system model and make an informed prediction about what might happen.”

### **The Hope of New Treatments**

Pharmaceutical companies usually focus their research and development efforts on chronic illnesses rather than infectious diseases. This leaves a huge void in an area of research that could be critical as current antibiotics lose their effectiveness. As a result, government agencies such as the FDA and NIH have an interest in antibiotic resistance research at universities like Mason and are willing to provide funding.

Couch sees a great parallel between the research of the three scientists in the Department of Chemistry and Biochemistry. While the researchers work on their own individual projects with separate research teams, the professors share a similar approach and commonality in the methodology of the research.

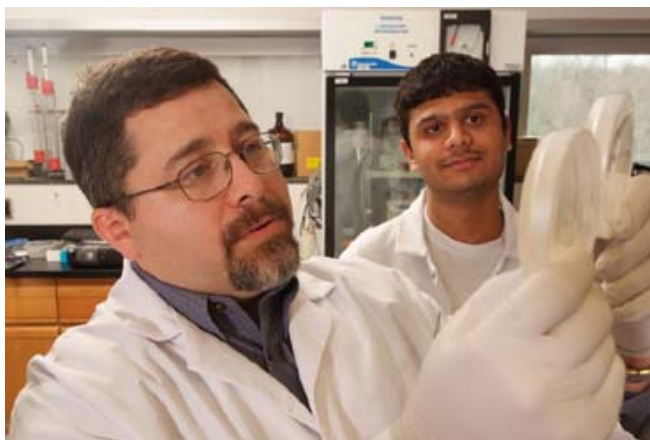
In the future, the scientists may have the opportunity to combine their efforts. For example, the peptides used in Bishop's research could be used in conjunction with drugs developed in his Mason colleagues' laboratories.

A mix of undergraduate, graduate and postdoctoral students also work with the professors on student-led projects. “The students are really frontline researchers and are integral to the success of research on bacterial resistance,” Couch says.

Born notes that bacteria will likely adapt to “whatever we throw at them.” The key to success in the battle against bacteria is increasing the number of options that doctors have to fight infections, he says.

“The answer doesn't lie within one approach or solution,” Couch agrees. “This is why we must attack the problem from different angles.”

“I have tremendous respect for bacteria's ability to adapt and survive,” Born adds. “However, if we continue to develop novel weapons against bacteria, we will have the option to switch to new treatments when old methods become ineffective.”



**Barney Bishop's lab is studying a family of peptides named "defensin" that have demonstrated antimicrobial activity against a broad spectrum of microbes, including bacteria. Above, Bishop works with student Jay Patel.**

*Photo by Evan Cantwell*

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