PATENT
TECHNOLOGY SUMMARY
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This AFRL Scientist's Trip Leads Her to a Patent that Can Save Lives

Inspiration comes in many forms. It can even occur while reading a magazine on a plane. That's what happened to Camilla Mauzy, Ph.D., of the Air Force Research Laboratory (AFRL) while traveling. It eventually led to her latest patent.

"While on temporary duty travel in 2005 I read an article in a science magazine describing nanobodies. The stability and ease of production made them especially amenable for needed DoD products," she recalled.

Nanobodies are an unconventional form of antibodies. While having some similar functions as regular antibodies, nanobodies are structured differently. Whereas conventional antibodies are large, complicated proteins comprised of two functional units, called VH and VL, nanobodies don't have VL domains but only have a smaller subset of the VH domain (VHH). Despite this, they are known for being highly stable. This inherent stability allows the nanobody to perform under field conditions, with its extremes in temperatures and humidity. They can remain functional (binding their target molecule) in temperatures as high as 176°F and in extreme pH levels. Additional nanobody advantages include being much easier and cheaper to produce compared to normal antibodies.

TECHNOLOGY

PATENT NUMBER:
US 11,339,208 B1

TECHNOLOGY NAME:
Camelidae Single-Domain Antibodies Against Yersinia Pestis and Methods of Use

INVENTOR:
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Serge Victor Marie Muyldermans

TECHNICAL PROJECT OFFICE:
AFRL 711 Human Performance Wing

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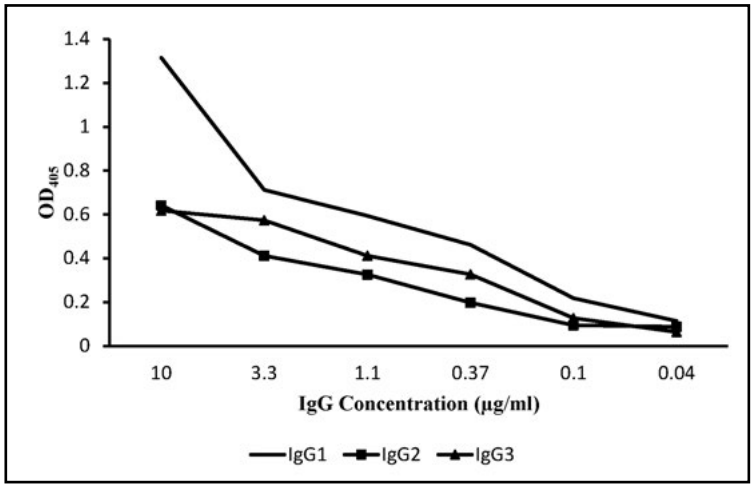

A graph of the binding response of IgG isolated from an immune alpaca to Y. pestis YscF (ELISA).

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This patent, Mauzy's seventh to date, describes nanobodies which have been developed to several surface proteins to the bacteria Yersinia pestis (Y. pestis). Y. pestis is a gram-negative bacillus that causes plague in its natural form and is considered a Class-A biological weapon. Gram-negative bacteria are particularly problematic to combat because they are resistant to many drugs and most available antibiotics.

"Nanobodies are naturally occurring single-domain antibodies found in camelids (animals from the same family as camels). Nanobodies also have several properties which make them excellent components for therapeutics, sensors, and synthetic biology elements," Mauzy said. "First, they consist of only the target binding domains found in antibodies (i.e., the VHH), therefore they are very small (15 vs. 150 kilodalton found in normal antibodies). This property allows them to be produced in large quantities in bacteria. This small size also allows them to access small clefts in target molecules. There are reports that they can even cross into the brain."

Mauzy began developing nanobodies to fight Y. pestis in 2007, moving the technology approach on to create Pseudomonas nanobodies for fuel biocontaminant sensors in 2017. She began collaborating with a known international expert in the field while developing the pestis patent.

"We worked with Serge Muyldermans at Vrije Universiteit Brussel for development of these nanobodies. Dr. Muyldermans was the first scientist to identify the utility of these naturally occurring small antibodies," Mauzy explained.

Being awarded the patent for this development in 2022, Mauzy sees several advantages for its use.

"Firstly, I see development of Y. pestis LcrV therapeutics using our nanobodies sequences -- which would not require refrigeration -- to provide onsite therapeutic protection against Y. pestis infection while allowing transportability for field use or in underdeveloped countries," she began. "Secondly, the full three-protein set of Y. pestis nanobodies against the three surface proteins could be used as capture elements in simple lateral flow tests for field testing or decontamination analysis."

Mauzy also suggested using nanobodies in assisting in decontaminating equipment as well as modifying nanobodies for use in more complex live bioproducts.

"I am especially interested in examination of nanobodies for uses in the gut or lung as a synthetic biology microbiome product to scan and remove toxins and/or pathogenic bacteria," she said.

This is yet another breakthrough for Mauzy whose career has been filled with firsts. Those include initiating the first human performance genetics efforts in the DoD to work through the Institutional Review Board's concerns with genetic-specific training, developing the first Air Force research program in Military Working Dog Performance Genetics, and recently being the first to identify a panel of urinary biomarkers which can predict the manifestation of Acute Mountain Sickness prior to accent while still at sea level.

Mauzy added that this patent was achieved thanks to the significant contributions of David Riddle, Ph.D., and Lt. Col. Jeremiah Betz.

Of course, she has come across many unexpected results during her career. She says those are particularly valuable.

"Keep an eye open for unusual or unexpected results – those can reveal something interesting if examined further."

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