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Deadly bacterial infection in pigs deciphered

New-born piglets often die painfully from infection with an intestinal bacterium. A team of researchers from 3 faculties at the University of Bern has now discovered how the bacterium causes fatal intestinal bleeding. They have thus made a breakthrough in veterinary research. Promising prospects for vaccinations and medications for use in humans too have now opened up.

The *Clostridium perfringens* bacterium is part of the large Clostridium genus which can cause various fatal illnesses in animals and humans. Clostridium infections are widespread. These bacteria are dangerous because they produce extremely strong poisons (toxins) which cause targeted damage to the host's cells. Dreaded diseases caused by Clostridium include botulism, tetanus, gas gangrene and intestinal infections, for example.
Horst Posthaus's group in the Institute of Animal Pathology at the University of Bern is researching an intestinal infection in pigs which is caused by *Clostridium perfringens*. 10 years ago, they were already able to demonstrate that the toxin produced by the bacteria, the so-called beta toxin, kills vascular cells and thus causes bleeding in the piglet's intestine. Until now, however, it was unclear why the toxin attacked specifically these cells and not others. Julia Bruggisser, biochemist and doctoral student at the Institute of Animal Pathology, has now succeeded in solving the puzzle of this mechanism in an interdisciplinary collaboration between three faculties. The findings from the study have been published in the specialist journal "Cell Host & Microbe".

A key molecule

Around five years ago, lab technician Marianne Wyder from the Institute of Animal Pathology came across a molecule called *Platelet-Endothelial Cell Adhesion Molecule-1* (PECAM-1 or even CD31 for short). It is located on the surface of various cells and plays a central role in intestinal bleeding in piglets. The actual role of the CD31 molecule is to regulate the interaction between inflammatory cells and the blood vessels. It predominantly occurs on cells which are located on the inside of blood vessels (so-called endothelial cells). During experiments, it was noticed that CD31 and the beta toxin are distributed almost identically on these cells. "Our project resulted from this initial observation," says Horst Posthaus. Julia Bruggisser from the Institute of Animal Pathology discovered that the toxin released by the bacteria in the intestine attaches to the CD31. Since the beta toxin numbers among the pore-forming toxins, it thus perforates the cell membrane and kills the endothelial cells. This results in damage to the vessels and bleeding in the intestine.

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Hochschulstrasse 6
3012 Bern
medien@unibe.ch

Researchers at the University of Bern join forces

Collaboration between multiple research groups at the University of Bern was essential for the success of the project. “For my research, I work in three laboratories at the university. Although it’s challenging, I learn a lot and above all, it’s fun,” says Julia Bruggisser. In addition to animal pathology, she also works with groups headed by Britta Engelhardt (Theodor-Kocher Institute) and Christoph von Ballmoos (Department of Chemistry and Biochemistry). “They had the right questions and ideas. We were able to bring our know-how concerning CD31 and methods and reagents which we had developed into the study,” says Britta Engelhardt. “It came together perfectly,” adds Christoph von Ballmoos.

Better prophylaxis and medications

The discovery makes it possible to develop better vaccines in order to prevent the fatal disease in pigs. “But we also want to investigate whether the attachment of beta toxin to CD31 on the endothelial cells also allows for the development of new forms of therapy, for vascular disease in humans, for example. We have already started more collaborations within the University of Bern to this end,” says Horst Posthaus.

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Publication details:

Julia Bruggisser, Basma Tarek, Marianne Wyder, Philipp Müller, Christoph von Ballmoos, Guillaume Witz, Gaby Enzmann, Urban Deutsch, Britta Engelhardt, and Horst Posthaus: CD31 (PECAM-1) serves as the Endothelial Cell-Specific Receptor of Clostridium perfringens β-Toxin. Cell Host and Microbes, June 4, 2020, https://doi.org/10.1016/j.chom.2020.05.003

Contact person:

Dr. Horst Posthaus, Institute of Animal Pathology (ITPA), University of Bern
horst.posthaus@vetsuisse.unibe.ch / Tel.: +41 31 631 23 99

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Hochschulstrasse 6
3012 Bern
medien@unibe.ch