Dirty pigs beat disease

Living like a pig could be good for you, according to research showing that dirty piglets pick up 'friendly' bacteria that help them to develop robust immune systems later in life.

The results provide support for the hygiene hypothesis, which suggests that a lack of exposure to microbes in early life can affect development of the immune system and increase susceptibility to certain disorders, such as allergies and inflammatory bowel disease.

Denise Kelly, a gut immunologist at the University of Aberdeen, UK, who worked on the study, says that the results provide the first direct link between early exposure to microbes, immune health and gene expression (I. E. Mulder *et al. BMC Biol.* 7, 79; 2009). Until now, she says, that link had been circumstantial. "There has been a lot of hearsay around gut microbiota and how it influences immune function and susceptibility to diseases and allergies."

Although many researchers now accept the hygiene hypothesis, says Jean-François Bach, an immunologist at the University of Paris Descartes, there are still questions about how it works, including what role the microbiota has in the gut and how infection helps to protect against disease. "This paper shows that the first days of life are very important," he adds.

The researchers took 54 piglets and divided them equally between an outdoor environment, an indoor environment and isolated conditions in which they were fed antibiotics daily. The scientists then killed piglets on day 5 (neonatal stage), day 28 (weaning age) and day 56 (nearing maturity) to study their gut tissue and faeces.

The study found that 90% of bacteria in the guts of the outdoor piglets came from the phylum Firmicutes. Most of these were Lactobacillaceae, a family of bacteria known for their ability to limit intestinal pathogens such as *Escherichia coli* and *Salmonella* species. By contrast, Firmicutes made up less than 70% of the gut flora in indoor pigs and slightly more than 50% of that in isolated pigs. Pigs from these cleaner environments also had much smaller proportions of bacteria from the Lactobacillaceae.

Kelly's team also found that the differences in gut microbes affected the expression of genes associated with the piglets' immune systems. Animals raised in the isolated environment expressed more genes involved in inflammatory immune responses and cholesterol synthesis,

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Outdoor pigs had more 'friendly' gut bacteria than indoor pigs.

whereas genes linked with infection-fighting T cells were expressed in the outdoor-bred pigs.

Glenn Gibson, a food microbiologist at the University of Reading, UK, says that previous studies have suggested that immune responses are linked to organisms in the gut. "This study takes a step forwards by tallying the gene-expression response into this," he says. However, he adds, because the study was carried out in pigs, there is no way to be certain that the results are relevant to humans.

Jonathan Rhodes, a gastroenterologist at the Royal Liverpool University Hospital in Liverpool, UK, points out that people with chronic inflammation of the digestive tract, known as Crohn's disease, have reduced numbers of Firmicutes, as did the cleaner piglets. But, he adds, patients with Crohn's also have reduced overall bacterial diversity, similar to the outdoor pigs, suggesting that the results might not extrapolate directly to human disease.

Kelly argues, however, that the comparable organ sizes of humans and pigs, and the similarities between the microorganisms found in their guts, makes pigs good model animals for such studies. ■

Natasha Gilbert

Correction

The News Feature 'Reflecting the past' (*Nature* 462, 30–32; 2009) suggested that wolves from reintroduction programmes might find their way to the Oostvaardersplassen reserve. In fact, the closest wolves are expanding from eastern Europe without human help. In addition, what was described as cattle 'wallows' are better termed 'scratching pits', as the cattle use their hooves to make them rather than rolling on their backs.