



## ***The impact of intensive and extensive rearing environment on mucosal immunity in the piglet (Gutwean)***

**The 'Gutwean' research project carried out by the University of Bristol and the Rowett Research Institute was a component of a multidisciplinary research programme on the weaned pig which was jointly funded by Defra, SEERAD, HGCA and BPEX.**

The objective of Gutwean was to determine the effect of weaning age, environment, nutrition and sow parity on the development of the mucosal immune system, and on the ability of piglets to make 'appropriate responses' to microbial and dietary antigens at weaning.

Piglets are born without any immunity and the maternal immunity which is passively transferred through suckling in the first 12-24 hours begins to diminish after weaning. It is therefore important for piglets to develop a fully competent immune system as quickly as possible to

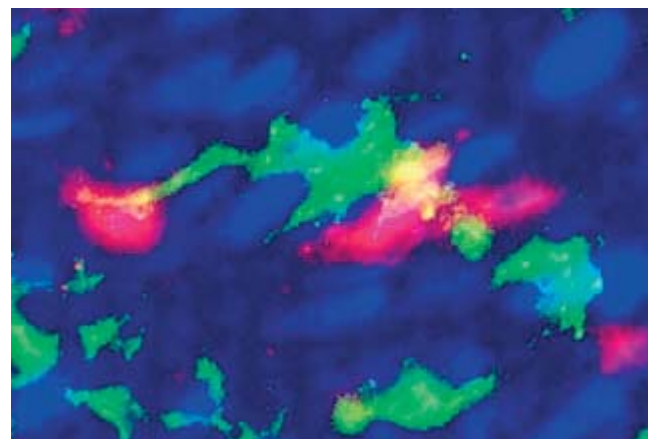
protect from disease, and to optimise growth and performance.

The immune system of piglets is presented with a wide range of antigens. Some antigens are from pathogenic organisms and some from the normal commensal flora in the gut, while others are 'harmless' environmental and food antigens. The immune system must respond appropriately – vigorously eliminating potential pathogens while not overreacting to harmless dietary antigens.

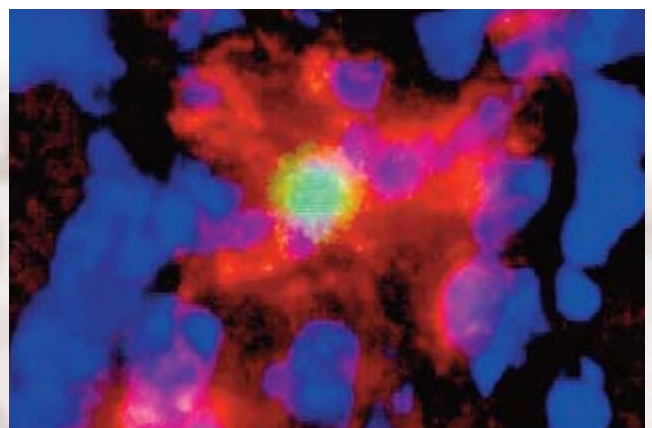
**As part of this project, immunological analysis techniques were developed and validated, allowing researchers to study the mucosal immunocompetence and microbial diversity in pig intestines. The analysis techniques used were:**

- **Multi-colour immuno-histology with computer assisted image analysis**
- **Analysis of genes encoding for immunologically relevant molecules – gene microarray and Real Time PCR**

**Using these techniques, the effect of different rearing environments on gut microbiota and the development of the mucosal immune system and its ability to respond to weaning was investigated.**



*Gut dendritic cell*



*FoxP3 cell in the intestinal lamina propria*

The healthy intestines of pigs contain very large numbers of bacteria of a variety of different species. Studies have shown that intestinal bacteria play a major role in driving the development of the mucosal immune system. In this project piglets were reared under a wide range of housing conditions and changes in their intestinal bacterial populations and the effects on mucosal immunity were investigated.

Rearing environments investigated:

- Indoor
- Outdoor
- Specific pathogen free isolator, treated with antibiotics.

### Approach

Advanced techniques were used to identify specific cellular interactions in mucosal tissues and to identify the cellular and molecular pathways that were activated during the first few weeks of life. The state-of-the-art molecular sequencing techniques used in the project allowed the detection of a wider range of bacterial species than conventional techniques. These exciting developments helped to unravel the complex interactions that occur between gut microbiota and the piglet's immune system. It also helped researchers to understand the effect different rearing environments had on gut microbiota and the development of the mucosal immune system, and its ability to respond at weaning.

### Results

Rearing environment was shown to have a marked effect on piglets' gut bacteria.

- 90 % of the bacteria in the guts of outdoor piglets were from the Phylum Firmicutes, in particular Lactobacillaceae
- Piglets reared indoors had reduced Lactobacillus and higher numbers of potentially pathogenic bacteria
- There was a strong negative correlation between the abundance of Firmicutes and pathogenic bacterial populations in the gut
- Housing environment also impacted on host gene expression, suggesting significant gut-specific gene responses are also related to early life environment.

To determine whether the changes in numbers of immune cells in the intestinal tissues of farm and isolator reared piglets would be reflected in their ability to respond to antigen challenges, piglets were transferred onto a soya-based diet at four weeks of age.

- Isolator-reared piglets showed a significantly greater serum antibody response than farm-reared piglets
- A greater response, as shown by isolator-reared piglets, is not necessarily beneficial since the increased response to dietary antigens could lead to harmful allergic reactions
- The isolator-reared piglets which 'over-reacted' to a dietary antigen had significantly fewer 'regulatory T cells' in their intestinal tissues than the farm-reared piglets; this suggests that rearing environment plays a pivotal role in the piglets' ability to generate these cells and regulate their response to mucosal antigens.

The project has shown that early-life environment significantly affects both gut microbial composition and mucosal immune function. A microbiota dominated by specific lactobacilli may function to maintain mucosal immune homeostasis and limit pathogen colonization.



While the Agriculture and Horticulture Development Board, operating through its BPEX division, seeks to ensure that the information contained within this document is accurate at the time of printing, no warranty is given in respect thereof and, to the maximum extent permitted by law, the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document. © Agriculture and Horticulture Development Board (AHDB) 2012. All rights reserved.

BPEX is a division of the Agriculture and Horticulture Development Board.