Technical Note no. 6 **March/April 2018**

Brief note on gut defences and their modulation

Intestinal homeostasis requires tolerance of commensal microorganisms but appropriate responses to noxious insult to facilitate optimum gut functioning (e.g. nutrient acquisition). The gut barrier, comprising the microbiota and their products, mucus layers, host-derived antimicrobial compounds (e.g., host defence peptides (HDP), IgA), epithelium, and underlying immune tissues, performs these essential functions.

At hatch, in chickens, functional macrophages and heterophils are present in gut tissue (Kaspers et al., 2015), or rapidly mature, and HDPs are present, with mucosal scrapings showing pronounced bacterial killing (Butler et al., 2016). Adaptive responses take longer to develop with significant infiltration of B and T cells into the intestinal tissue occurring from around 7 days of age (doa) and endogenous intestinal IgA detected from 7 - 14 doa in conventional birds (Kaspers et al., 2015; Lammers et al., 2010). Similarly, in conventional pigs, T and B cells take some time to arrive in the lamina propria, with dendritic cells more rapidly appearing after birth. From 2 weeks of age CD4+ T cells colonise the intestinal mucosa, CD8+ from 3 weeks and B cell/plasma cells from 2 – 4 weeks (IgM+) to 6 weeks (IgA+) (Stokes et al., 2017). Thus, gut innate immunity is more developed and particularly important in young monogastric animals, while adaptive responses require microbial colonisation of the intestine for (normal) development (Kaspers et al., 2015).

Various factors may influence the development of intestinal immune defences, most notably exposure to microorganisms/antigen, as demonstrated by comparisons between germ-free and conventional animals. Other important factors include use of antimicrobials, maternally-derived factors (e.g. antibodies, hormones, antioxidants, etc.), stressors (e.g. weaning, feed deprivation, etc.), genetics and rearing environment (Broom and Kogut, in press).

These factors require serious consideration in the context of gut immune system development and support of (particularly young) animals for optimum health and productivity. Chicks do not receive on-going maternal immune protection after absorption of the yolk sac and piglets are born devoid of passive immunity due to the epitheliochorial placenta of pigs preventing the passage of immunoglobulins *in-utero*, which are additional factors that contribute to the vulnerability of chicks and piglets at birth/hatch (or a period thereafter) and vaccine/immune responses.

Modern animal production practices have become somewhat artificial (e.g. separation from parents, high hygiene, etc.) and may contribute to the acquisition of a suboptimal microbiome by these animals, and the possibility of immune dysfunction. In addition, animals may be transported long distances prior to placement on farm, which can interrupt natural access to feed and water.

In light of the above, young animals have a particular reliance on innate immunity, as well as at other times of potential compromise (e.g. weaning, transport, etc.). Antibiotic growth promoters helped to compensate for the issues outlined but are no longer an option and so research is focussed on other strategies. These include methods to promote the acquisition of passive immunity, innate defences and the development of acquired responses. For example, in swine, supplementing sow diets with short-chain fructooligosaccharide increased colostral IgA and influenced development of intestinal immune function in their offspring (Le Bourgot et al., 2014). Genetics and various products (including pro and/or prebiotics, exogenous antibodies, phytocompounds, acids, specific innate (e.g. pattern recognition receptor) ligands) continue to be investigated for their ability to appropriately influence the gut microbiome and/or innate and adaptive immune development/responses, including early intervention (parents, *in-ovo*) (Gadde et al., 2017).

Conclusion

Innate gut defences are critical for optimum health and performance. Neonatal monogastric animals have well developed innate immune defences and thus rely on such responses (as well as passive immune protection) during early life or times of perturbation. These components should be the focus of appropriate immunomodulatory strategies, particularly as we better understand the intricacies of maintaining efficient intestinal defence and homeostasis.

References

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