# Imprinting of body functions by manipulation of incubation temperature and its long-lasting effect on hatchability, performance and health in poultry

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'Imprinting' describes a fundamental process of life, which occurs during 'critical periods' of embryonic or early postnatal development and has effects that last into adult life and possibly over generations. It is probably realized by neuronal plasticity, as well as by a lasting, environment-induced (epigenetic) modification of the genome. A 'critical period' for the 'imprinting' of body functions is the development of feed back mechanisms, which occurs during the perinatal period. During this period the actual level at which physiological parameters are active may pre-determine a life-long 'set point' (or 'set ranges') for the respective regulatory system.

In poultry embryos, during the final days before hatching the thermoregulatory system develops feedback mechanisms. During this phase, the thermoregulatory system can be imprinted by manipulation of incubation temperature. The effect of this manipulation strongly depends on its duration. Effects of short-term or chronic changes in incubation temperature on embryonic as well as on post-hatching development and performance may be very different. Short-term changes in incubation temperature adapt the embryo to environmental fluctuations and, finally, improve robustness. Chronic changes leads to adaptation to the respective ambient temperature, e.g. cold or warm adaptation.

Chronic increase in incubation temperature during final incubation by 1°C, for instance, increased embryonic temperature as well as heat production, which is a prerequisite for an elevated thermoregulatory set point. Post-hatching, chronic warm incubated birds preferred higher ambient temperatures compared with the normal incubated control. Chronic cold incubation induced opposite effects. Related to the prenatal temperature experiences the neuronal thermosensitivity and c-fos expression of the hypothalamus showed long-lasting alterations.

Short-term increases in incubation temperature by 1°C during final incubation decreased heat production in chicken embryos and, finally, the embryonic body temperature. Obviously, such short-term temperature stimulation has long-lasting "training effects", which improves robustness and thereby health, welfare and performance in poultry.

In broiler chicks, for instance, chronic warm incubation during the last 4 days of incubation did not affect hatching results and later performance. But, short-term temperature stimulation improved hatching rate, induced a significantly higher percentage of hatched male chicks, increased body weight at slaughter and improved feed conversion. Finally, an incubation method that includes temperature stimulation is closer to a natural correspondence with the physiological needs of the embryo, and may therefore also have positive implications in the context of animal welfare and protection.

To further develop the protocols for temperature stimulation in practice and to investigate physiological mechanisms related to improved robustness and performance, a collaborative research project on "Circadian Incubation" was started together with PasReform Hatchery Technologies (NL), in broiler chicken. In the course of this project research will be done on central regulation of metabolism, feed intake and body weight in hypothalamic brain slices. First results of an immunohistochemical study showed long-lasting changes in the expression of Neuropeptide Y (NPY), which is involved this regulatory processes. The lower NPY expression in prenatally temperature stimulated male broiler chicks could be related to the better feed conversion and a lower basic metabolic rate compared with the normal incubated control.