# Effects of birth weight and postnatal nutrition on neonatal sheep: III. Regulation of energy metabolism[1,2]

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**ABSTRACT:** This study investigated effects of birth weight and postnatal nutrition on regulation of energy metabolism in the neonatal lamb. Low (mean ± SD 2.289 ± 0.341 kg, n = 28) and high (4.840 ± 0.446 kg, n = 20) birth weight male Suffolk × (Finnsheep × Dorset) lambs were individually reared on a liquid diet to grow rapidly (ad libitum fed, ADG = 337 g, n = 20) or slowly (ADG = 150 g, n = 20) from birth to live weights (LW) up to approximately 20 kg. At birth, small newborns had higher plasma concentrations of urea nitrogen (mean ± SEM 8.31 ± 0.25 vs 6.39 ± 0.32 m*M*, $P = 0.002$) and somatotropin (ST, 49.1 ± 17.0 vs 10.8 ± 4.3 ng/mL, $P = .045$) and lower IGF-I (36.1 ± 6.8 vs 157.7 ± 21.8 ng/mL, $P < 0.001$) than large newborns. Plasma glucose (1.42 ± 0.23 vs 2.63 ± 0.95 m*M*, $P = 0.147$) and insulin (0.09 ± 0.02 vs 0.13 ± 0.06 ng/mL, $P = 0.264$) concentrations did not differ. Urea nitrogen concentration in plasma peaked and then declined rapidly in all lambs during the first week postpartum, and plasma ST declined on a body-weight-related basis from birth. During rearing to 20 kg LW, plasma insulin was higher in low- vs high-birth-weight lambs. Lambs fed ad libitum had greater plasma concentrations of glucose, urea nitrogen, insulin, and IGF-I compared to those fed a restricted diet (ADG = 150 g). The results suggest that during the early postpartum period, newborn lambs exhibit the fetal characteristic of high rates of amino acid oxidation. The results also support the notion that, at birth, low-birth-weight lambs are less mature than high-birth-weight lambs in aspects of metabolic and endocrine development, which may enhance their capacity to utilize amino acids for energy production and to support gluconeogenesis during the immediate postpartum period. Being small at birth also resulted in elevated plasma insulin concentrations when adequate nutriment to support moderate or rapid growth was provided postpartum, although it remains to be elucidated whether this more chronic effect persists in the longer term.

Key Words: Growth, Hormones, Lambs, Metabolism, Nutrition

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## Introduction

Transition from prenatal to postnatal life requires maturation of biological systems essential for survival and growth (Mellor, 1988; Silver, 1990). Under appropriate environmental and nutritional conditions, vital life support systems can mature sufficiently to allow extremely low birth weight lambs to survive and achieve rapid growth (Greenwood et al., 1998). However, the period before onset of rapid growth appears to be longer in small vs larger newborn lambs, suggesting that their metabolic systems require a longer period of adaptation to postnatal life.

Metabolic adaptations are necessitated by major changes in the quantity and composition of nutrients supplied to the perinatal animal. In well-fed neonates, the total nutrient supply greatly exceeds that of the late-gestation fetus, in which nutrient supply and growth are increasingly constrained by the placenta (Mellor and Murray, 1982). Also, the composition of nutrients changes from primarily glucose and amino

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